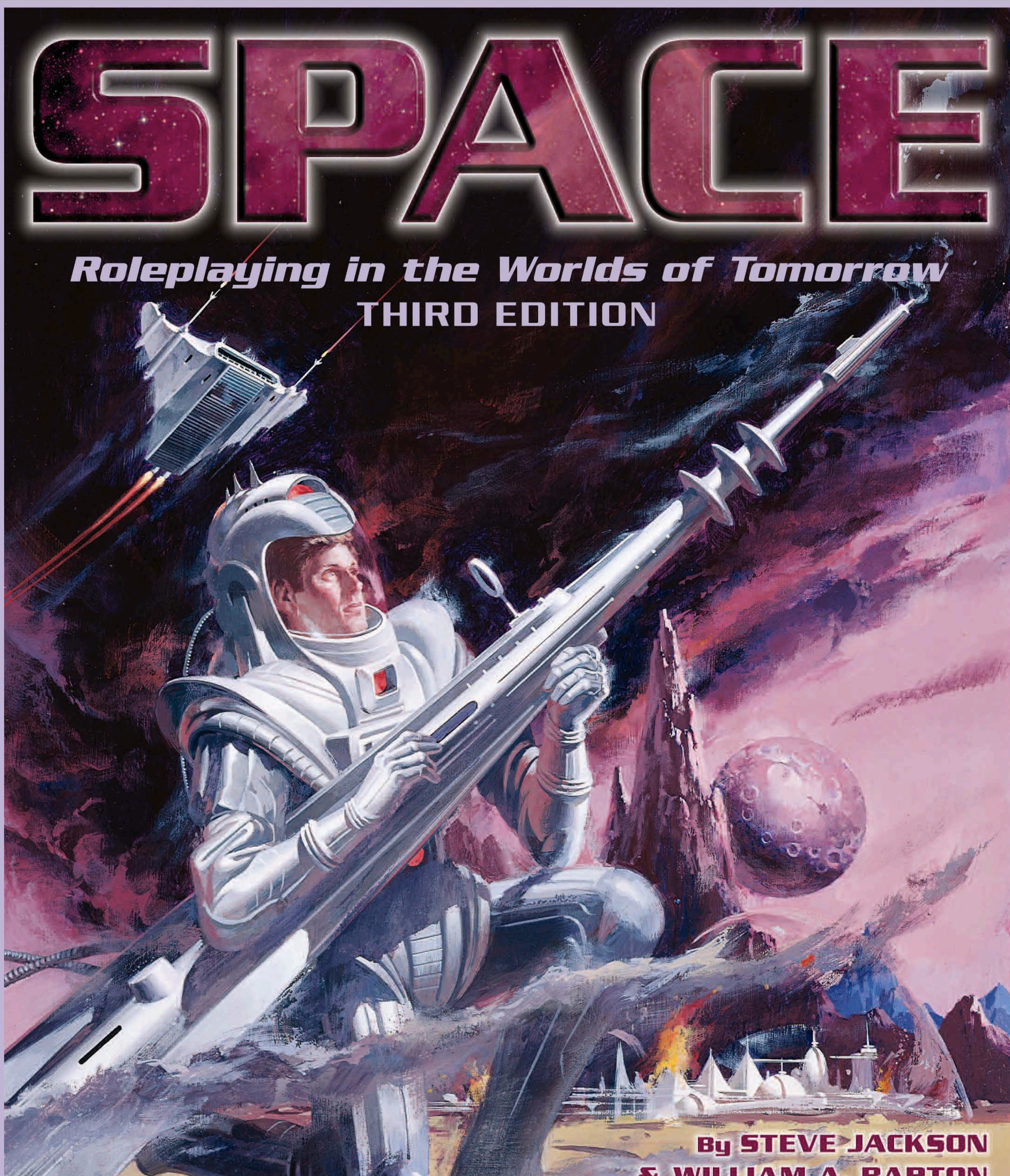
GURPS®

SPACE

Roleplaying in the Worlds of Tomorrow

THIRD EDITION



By STEVE JACKSON
& WILLIAM A. BARTON

Third Edition Revised by DAVID PULVER

STEVE JACKSON GAMES

The FUTURE Is YOURS!

GURPS Space is the star-spanning sourcebook for *GURPS* – now revised and expanded for its third edition. In the 160 pages of *GURPS Space*, you'll find:

- Scientifically accurate and *up-to-date* rules for creating star systems and planets . . . either randomly or to fit a specific campaign.
- Detailed guidelines for creating futuristic and alien governments and societies.
- An informed look at the technologies of tomorrow: what will be, what might be, and beyond!
- Character-creation resources for space campaigns, featuring 24 character types, three variant human races, and four alien races.
- A full science-fiction equipment list, including weapons, gadgets, and medical technology.
- Realistic treatments of the dangers of noxious atmospheres, crushing gravity, vacuum, radiation, and other hazards of space travel and exploration.
- A self-contained, ***GURPS Vehicles***-compatible starship construction system, covering TL8 (just around the corner) to TL13+ (superscience).
- Complete ship combat rules – no ship counters, just roleplaying – for playing out ship-to-ship battles.

GURPS Space does not tie your game to a single background. Rather, it is designed for the creative GM who wants to develop his *own* universe! This book presents a wide variety of choices and background information to let you recreate your favorite science-fiction background – or build your own.

Years in the making and now extensively revised and updated, *GURPS Space* is a survey of the whole space-adventure genre as it relates to roleplaying. If you're ready to create your own future . . . it's yours.

Winner of the Origins Award for Best Roleplaying Supplement of 1988!

GURPS Basic Set, *Third Edition Revised* and ***Compendium I: Character Creation*** are required to use this supplement in a *GURPS* campaign; however, *GURPS Space* can be used as a sourcebook for *any* science-fiction roleplaying campaign.

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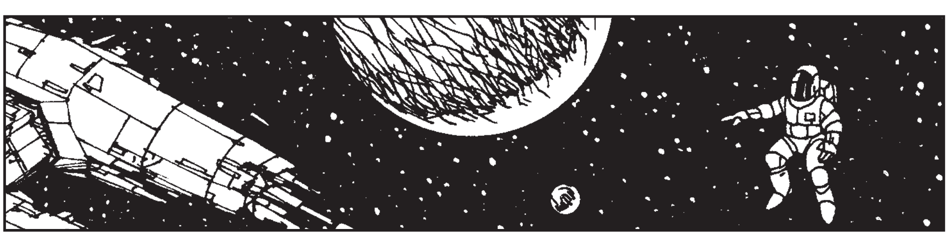


INTRODUCTION

There's this about space: It's big. Sometimes entirely *too* big. ***GURPS Space*** was tough and long-delayed, but when it hit the stores, it was worth it. When it was named Best Roleplaying Supplement at Origins 1989, we were overjoyed. And now it is in its third edition.

Each new edition of this book has seemed to take forever, because there was so *much* to cover and more was appearing every year. In fact, the first edition "spun off" several other projects. Bill's original manuscript included over 30 complete world descriptions, enough to be a book in their own right. We solved that problem by *giving* them their own book – the first of four ***Space Atlases.***

Several other subjects that got chapters in this book deserved full-length treatment, too. We now have separate books for high-tech gadgets – ***GURPS Ultra-Tech*** and ***Ultra-Tech 2*** – not to mention technological sourcebooks like ***Vehicles,*** which covers spaceships in even greater detail than ***Space,*** and ***Bio-Tech,*** which is an indispensable guide to designing non-human races.

One common question has been "Is ***GURPS Space*** hard SF or space opera?" Actually, it's both. We have *not* included a pregenerated universe background. Instead, the book tells you how to create your own. Want detailed, state-of-the-art scientific guidelines for building star systems? They're here. Want quick random tables that give believable results? They're here, too. Descriptions of zap guns and aliens? No problem.

In some chapters, we've given detailed information on (for instance) the way the Galactic Survey works, or the politics of an interstellar federation. But, again, this is resource material . . . suggestions. We don't expect the GM to feel locked into these names, or these details, for his own campaign.

Instead, we're doing whole worldbooks for specific SF backgrounds, like ***GURPS Autoduel, Cyberworld, Planet Krishna,*** and ***Traveller.*** But this book is something else: the (pardon the expression) generic rules. It's a *general* sourcebook. You can use it to adventure in your own SF universe, or that of your favorite SF author – or even that of the SFRPG you used to play (before switching to ***GURPS,*** of course).

We had a lot of fun developing the technical material – but reality testing had to go right out the viewport this time. Not too many blasters or stargate generators are available to test, even at Frederick's of Altair VI. So if you disagree with any of our specifications – change 'em. We've done our best to keep the science straight wherever *our* science applies, and we have updated it in each edition, but science evolves quickly and today's "facts" may be discredited next week. Until then, take it and run.

Where Credit Is Due

We were certainly influenced by previous efforts in SFRP gaming (good or bad), and even more by that vast body of SF literature that has accumulated since the golden age of the '30s.

Our own favorites include the work of authors such as Poul Anderson, Isaac Asimov, Iain M. Banks, C.J. Cherryh, Arthur C. Clarke, Philip José Farmer, Robert A. Heinlein, Larry Niven, Andre Norton, H. Beam Piper, Robert Silverberg, Jack Vance, Roger Zelazny, and many more. Overt influences from the SF gaming world would include that old favorite, GDW's ***Traveller*** (now adapted for ***GURPS***); the works of Don Rapp and Chuck Kallenbach of Paranoia Press (which published some of the best ***Traveller*** supplements); and Richard Tucholka, designer of the too-often overlooked ***FTL: 2448.***

And, finally, our sincerest thanks to the many who commented on the various stages of the manuscript. If this book holds together well, it is only because of the dedicated pickiness of all those rules-readers and playtesters. Whatever is missing is the fault of the authors . . . but let us know what you want, and we'll deal with it. After all, we've got a whole universe out there.

Hot jets!

About *GURPS*

Steve Jackson Games is committed to full support of the GURPS system. Our address is SJ Games, Box 18957, Austin, TX 78760. Please include a self-addressed, stamped envelope (SASE) any time you write us! Resources include:

Pyramid (**www.sjgames.com/pyramid**). Our online magazine includes new ***GURPS*** rules and articles. It also covers ***Dungeons & Dragons, Traveller, World of Darkness, Call of Cthulhu,*** and many more top games – and other Steve Jackson Games releases like ***In Nomine, Illuminati, Car Wars, Toon, Ogre Miniatures,*** and more. *Pyramid* subscribers also have access to playtest files online!

New supplements and adventures. ***GURPS*** continues to grow, and we'll be happy to let you know what's new. A current catalog is available for an SASE. Or check out our website (below).

Errata. Everyone makes mistakes, including us – but we do our best to fix our errors. Up-to-date errata sheets for all ***GURPS*** releases, including this book, are available from SJ Games; be sure to include an SASE. Or download them from the Web – see below.

Gamer input. We value your comments, for new products as well as updated printings of existing titles!

Internet. Visit us on the World Wide Web at **www.sjgames.com** for an online catalog, errata, updates, Q&A, and much more. ***GURPS*** has its own Usenet group, too: rec.games.frp.gurps.

GURPSnet. This e-mail list hosts much of the online discussion of ***GURPS***. To join, e-mail majordomo@io.com with "subscribe GURPSnet-L" in the body, or point your World Wide Web browser to: **gurpsnet.sjgames.com**.

The ***GURPS Space*** web page is at **www.sjgames.com/gurps/books/space/**.

Page References

Rules and statistics in this book are specifically for the ***GURPS Basic Set***, Third Edition. Any page reference that begins with a B refers to the ***GURPS Basic Set*** – e.g., p. B102 means p. 102 of the ***GURPS Basic Set***, *Third Edition*. Page references that begin with CI indicate ***GURPS Compendium I***. Other references are CII for ***Compendium II***, GT for ***GURPS Traveller***, T:BC for ***Traveller: Behind the Claw***, and so on. The abbreviation for this book is S. For a full list of abbreviations, see p. CI181 or the updated web list at **www.sjgames.com/gurps/abbrevs.html**.

CHAPTER 1 CREATING A UNIVERSE

A "universe" is the game background created by a GM. Much of the excitement of a star-spanning campaign comes from a detailed, believable background.

These rules are not tied to any single vision of the future. This worldbook is not intended to impose a background on the game; rather, it gives the creative GM the tools to develop *any* type of outer-space campaign.

Designing a complete space campaign involves five decisions:

Type. What will the players do in your campaign? Are they military officers, intrepid surveyors, or profit-hunting traders? Would they rather engage in combat or diplomacy?

Scope and FTL Technology. How much space does your campaign cover? Will it be set within a single star system, around a few dozen local stars, or in a whole spiral arm of the galaxy? This decision is tied to your choice of stardrives; the faster the drive, the more territory can be covered. Are habitable worlds rare, common, or innumerable? And how close are they in terms of *travel time?* The more quickly you can travel between worlds, the likelier they are to interact on a large scale – fighting wars, sharing governments, extraditing criminals, and so on.

Other Technology. What are the campaign's average and maximum tech levels? What sort of FTL communication, weaponry, etc., will be available?

Races. In your universe, are the "good guys" all human? Are there allied races? Are there "bad guy" races? What about vanished races?

Habitable Worlds and Society. Do your characters live in a massive empire, or a loose-knit alliance? Is the government restrictive? Are the police and military effective? Are there many societies, or just one large civilization? Note that this decision is tied to the scope of the campaign. Also, what interstellar organizations are important? And what is the *history* of interstellar civilization?

Campaign Type

What will your campaign be about? Will the characters be planetbound or space-faring? Good citizens or nefarious pirates? Are they after money, adventure, knowledge . . . or something else?

Strange New Worlds

The theme of the campaign is the search for new worlds – the thrill of discovery, and the adventure that it brings.

Character Roles: Characters can be private explorers or members of the Survey Service (p. 22), making contact with strange worlds. Scout crews include scientists and Rangers (p. 20), and diplomats and even merchant representatives might be present if the world is inhabited.

Things to Do: Scouts are expected not only to discover and survey worlds from orbit, but to land on the planet to discover any potential dangers to the colonists who may follow. There are dozens of things to find on an unfamiliar planet – strange, threatening animals or aliens, mysterious ruins, a lost human colony, an unsuspected pirate base, etc.

Campaign Advantages: PCs who work for a government or private survey organization will have a powerful Patron who supplies equipment and a ship. But they will often be in remote space – away from daily control by their superiors. The variety of new worlds provides campaign diversity. This campaign can be ideal for small groups – a scout crew can be as small as one person.

Campaign Disadvantages: If the PCs work for an interstellar survey service, space navy's exploration branch, or a private (probably mercantile) organization, they will likely explore worlds by assignment. On the other hand, they might be exploring on their own – in which case their ability to keep a starship fueled and supplied depends on finding profitable worlds. For the GM, a scout campaign means constantly generating new systems (and new surprises).

References: Rendezvous with Rama by Arthur C. Clarke; *Ringworld* by Larry Niven; the *Tschai* books by Jack Vance; the *Star Trek* television series.

Selling the Moon – Wholesale

The characters are merchants – free traders or employees of a merchant company. Profit is the name of the game.

Character Roles: PCs are merchant ship crew members. Some should have mercantile and shipboard skills; a few ex-military types might be handy.

Things to Do: This campaign is about getting cargo from origin to destination – despite the hazards of travel, competitors, and alien menaces. An added dimension comes if the merchants must develop their own markets: evaluating new worlds for profit potential, making deals with alien civilizations, finding new cargo and ways to sell it. They can ride the coattails of survey vessels – or even explore on their own. Variety can come from special charter runs or unusual passengers.

Campaign Advantages: If a merchant makes money, he may feel that the ends justify the means – players who can't do things "by the book" may enjoy this campaign. Free traders have many options on where to go and what to do, while company men may be allowed to break regulations if they turn a profit. Company men have a Patron in their employer.

Campaign Disadvantages: Free traders are on their own when it comes to equipment and a starship. They will constantly have to keep an eye on their finances and will be in big trouble if they run out of money. (Impoverished traders may try to skip out on their payments and go criminal . . . becoming pirates.) Company men may be restricted by regulations, specified trade runs, and other forms of corporate control.

References: Poul Anderson's "Van Rijn/Falkayn" stories; A. Bertram Chandler's *Commodore Grimes* series; C.J. Cherryh's *Chanur* and *Merchanter* series; Robert A. Heinlein's *Citizen of the Galaxy;* Andre Norton's *Solar Queen* novels; *Cascade Point* by Timothy Zahn.

Recommended References

Science References. A few good popular-astronomy books will be a tremendous aid in building a universe and filling in details on planets and stars. Many of these books have beautiful illustrations – both actual photos and artists' conceptions. This is a "must" for a pre-starflight campaign in our own solar system!

Rather than a technical book, look for something by one of the popular science authors. Isaac Asimov and Robert Forward have written several that are both entertaining and informative. Check out the astronomy or science section at your local bookstore or the public library.

Jerry Pournelle's *A Step Farther Out* is an excellent reference on TL7-8 space travel technology; so is *The Starflight Handbook* by E. Mallove and G. Matloff.

Star and Planetary Maps. If you're interested in running campaigns in areas within 15 parsecs of Sol, a good star map will be useful. It should tell you a star's spectral type, approximate location, and name. Such maps can often be found in the astronomy books or through special-order listings in magazines such as *Astronomy* and *Sky and Telescope.*

Planetary maps are available from many of the same sources. Fairly detailed maps of the Moon, Mars, and Venus exist, based on data from space probes, and these could easily be translated into the surfaces of other worlds.

Science Fiction Novels. These are obvious sourcebooks for a ***Space*** campaign. Series set in consistent universes can make excellent campaign backgrounds. Lesser-known works make good scenario inspirations; there's less chance that the players will have read them already. See *Campaign Type* (pp. 6-9) for many recommendations.

GURPS *Supplements.* ***Ultra-Tech*** and ***Ultra-Tech 2*** list TL8+ equipment of all kinds, while ***Bio-Tech*** covers advanced biotechnology, including variant humans and living spaceships. Four ***Space Atlas*** volumes were produced, listing inhabited or interesting worlds, and may still be found in some game stores.

Other ***GURPS*** *Worldbooks.* Plugs are in order for ***GURPS Traveller*** and its supplements – notably ***Far Trader,*** a comprehensive guide to merchant campaigns, and ***First In,*** a dedicated manual on scout campaigns. Several licensed SF backgrounds have been brought to ***GURPS*** as well: ***Lensman*** is an adaptation of E.E. "Doc" Smith's novels and a veritable textbook on space opera; ***Planet Krishna*** is based on the work of L. Sprague de Camp and shows how a low-TL society can fit into a high-TL space game; and ***GURPS Uplift,*** developed from David Brin's works, includes detailed rules for creating alien species in any environment.

Star Soldiers

Characters in a military campaign might be infantry, battlesuit troopers, mechanized troops (tanks, aircraft, mecha, etc.), or the crew of a warship or space station. They may be employed by a government, or they may work for a mercenary organization.

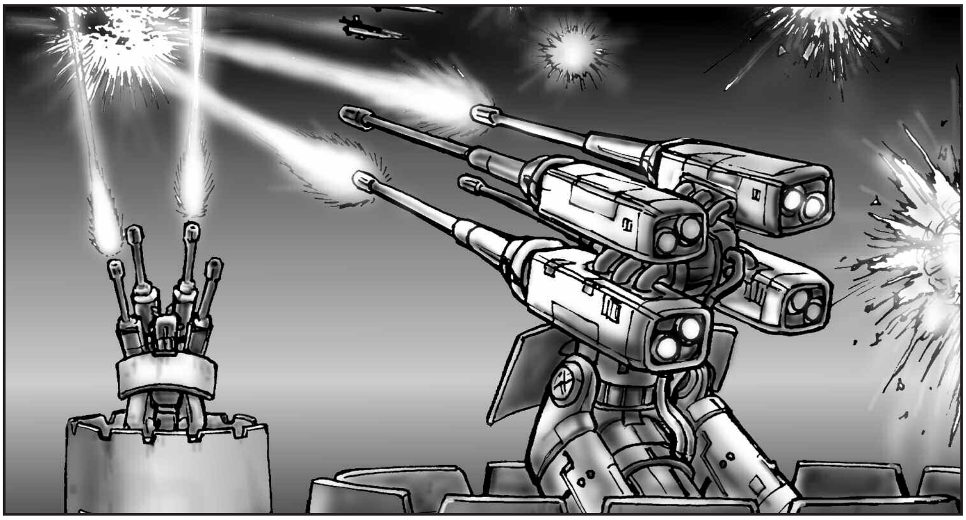
Character Roles: Characters should be part of the same organization – and usually the same unit. They should have the skills within their group to perform their unit's duties. They might be on the fighting end (in which case they will probably be enlisted men and junior officers), or they might be in command (senior officers and staff officers, with commands of their own).

Things to Do: In wartime, marines will be "bug hunting" in their battlesuits, while spacers are repelling boarding parties on their starships. Fighter pilots will scramble when they are given the signal, and officers will make life-or-death decisions. If the campaign is on the frontier, or if the interstellar government is weak, fighting can continue in peacetime – especially for mercenaries.

Campaign Advantages: Government troops don't have to buy their own equipment. Since the PCs must answer to a higher command, the GM can more easily direct the campaign.

Campaign Disadvantages: Military PCs have a Duty to their organization and its officers. Military regulations might be enforced. Unless the PCs include the captain of a crucial ship or starbase, or the elite squad that always performs the crucial assault, their individual actions will seldom influence entire battles and wars. If the GM isn't careful, all the battles may start to seem the same.

References: Lois McMaster Bujold's "Miles Vorkosigan" books; the *Faded Sun* series by C.J. Cherryh; *Hammer's Slammers* by David Drake; *The Forever War* by Joe Haldeman; *Starship Troopers* by Robert A. Heinlein; *The Mote In God's Eye* by Larry Niven and Jerry Pournelle; *Space Viking* by H. Beam Piper; the *Honor Harrington* series by David Weber; the *Cobra* and *Blackcollar* books by Timothy Zahn; the *Babylon 5* TV series.



Colony Alpha

The characters are colonists settling a newly discovered world or perhaps a newly built space habitat or asteroid belt. Another twist is to have the colonists be genetically engineered to exist in this new (and perhaps *strange*) environment – making them almost aliens to the rest of humanity.

Character Roles: The PCs *should* all be rugged survivors. Those with good Craft and Outdoor (or zero-gravity) skills will do best. However, colonists may also include political or religious refugees, criminals, and minorities – and not all of these will be survival types. Some specialists may be needed to operate equipment, exploration vehicles, or weapons. There might be a government representative.

Other Military Campaigns

There are several "sub-genres" of the military campaign, including:

Skull & Crossbones

Arrrr! The characters are the crew of a pirate vessel. This is ideal for those who enjoy space battles, boarding actions, and divvying up the loot afterward.

Character Roles: PCs must have the skills to operate their ship or base. Combat skills come in handy, as do mercantile abilities (to evaluate the booty). Disregard for danger – and the law – are musts. Scurvy old space dogs fit in well.

Things to Do: Pirates usually attack merchant ships or raid prosperous colonies. They may or may not have a hidden base, and they may pay visits to civilized worlds for rowdy R&R. In wartime, pirates may become privateers (privately owned warships), serving under *letters of marque*. Pirates have an Enemy in the Patrol (p. 21) – if their base is discovered, they may need to explore new worlds to find a safe hideout.

Campaign Advantages: PCs are under no obligation to obey the law. They're already wanted criminals, so anything goes.

Campaign Disadvantages: Pirate PCs must provide their own starship or start without one. The Patrol is their Enemy; other pirates may be hostile as well.

References: C.J. Cherryh's *Merchanter* novels; *Space Viking* by H. Beam Piper; E.E. Smith's *Lensman* books; the film *Ice Pirates.*

Rebels Against the Empire

The heroes are struggling to overthrow a government they dislike. This may be an oppressive galactic empire, or we might see the heroic Lunar, Martian, or Centauri colonists struggling to win their freedom from a bureaucratic Earth.

Character Roles: Characters are noble freedom fighters, or rogues with hearts of gold who decide to help when the chips are down. (Or Imperial double agents?) Or maybe they are the government or military of a colony that has *had enough* and broken away from its masters back home.

Things to Do: Raiding hostile bases and battle stations, brandishing force swords, and rescuing captured allies. Many operations will be covert spy or guerrilla missions rather than military operations. Rebel forces are often shorthanded – PCs might be star pilots one day and ground troops the next.

Campaign Advantages: A powerful rebel organization might be a Patron. PCs can have a great effect on the success of the rebellion, acting in military, espionage, and diplomatic operations all at once.

Continued on next page . . .

Other Military Campaigns

(Continued)

Campaign Disadvantages: Taking on the entire Imperial armed forces, often in nothing much more heavily armed than an interstellar garbage scow, is seldom safe.

References: F. M. Busby's *Star Rebel* and its sequels; Heinlein's *The Moon is a Harsh Mistress;* certain SF movies that take place a long time ago in a galaxy far, far away; the fourth season of the *Babylon 5* TV series.

Agents of Terra

The espionage campaign focuses on intrigue, covert operations, and double-dealing among the stars.

Character Roles: The PCs must be deadly and capable. They may be suave and sophisticated, or they may look and act like interstellar scum – it doesn't matter as long as they can work undercover and kill efficiently when necessary. They might also be "specialists," brought in when needed for specific assignments.

PCs don't have to be traditional "secret agents" – they might work for naval intelligence, the Patrol's covert office, a corporation's industrial intelligence bureau, or an obscure regulatory or law-enforcement agency. They might even work for the Other Side. Or they may be private detectives.

Things to Do: Spies work to preserve their organization and to cripple or destroy hostile spy networks. They infiltrate criminal or enemy organizations while eliminating moles and double agents in their own outfit. Important people and vital secrets must often be rescued, kidnapped or stolen. Most importantly, spies must discover and stop the latest insidious plot to take over the universe – and the Galactic Illuminati are everywhere.

Campaign Advantages: Spy agencies are often Patrons, providing specialized and expensive equipment. Friendly law-enforcement organizations may be cooperative (or jealous, or traitorous). Except when on assignment, PCs will usually be free to do what they wish. Many agents are paid well. This campaign works well for a small group.

Campaign Disadvantages: Spies have a Duty to their Patron, and will often be sent on dangerous missions. Both the individual PC and his Patron will have Enemies. There is also a lot of double-dealing – PCs might be sent on suicide missions, fingered by informers, or targeted by opposing assassins.

References: The *Flandry of Terra* novels by Poul Anderson; Iain Banks' *Culture* novels; the *Stainless Steel Rat* series by Harry Harrison; Keith Laumer's *Retief* stories.

Things to Do: The basic idea is to tame and settle a hostile environment. Many twists can be added – do the colonists have access to FTL drive, or are they "stranded," arriving by generation ship? Are they the first colonists, or the follow-up team? (If they are the follow-up team, are the original colonists still there when they arrive?) Are there hidden surprises, such as a bizarre ecosystem, unknown aliens, Precursor relics, or a smuggler base? Are the colonists unified, or is there strife between factions? Is this a peaceful colony, or an outpost in disputed territory? Are there menacing pirates, aliens, or hostile governments back home? The colonists may not have a world at all – they may be on a "lost" generation ship, perhaps with regressed technology.

Campaign Advantages: Colonists won't need a starship. The GM needs to design just one star system, although great detail will be required. Many players enjoy the challenge of organizing settlements and exploring the frontier. This campaign can work at TL8 or even lower, especially if the PCs arrived on a sublight "sleeper" ship.

Campaign Disadvantages: If the colony is isolated, there will be a limit on available equipment – and its use may be controlled by the colony's administrators. The GM also has the burden of keeping the campaign more interesting than "build another hut, explore another valley."

References: Tau Zero by Poul Anderson; *The Seedling Stars* by James Blish; *Hestia* and *Forty Thousand in Gehenna* by C.J. Cherryh; Harry Harrison's *Deathworld* series; *Farmer in the Sky* and *The Rolling Stones* by Robert A. Heinlein; *The World At The End Of Time* by Frederick Pohl; the *Alpha Centauri* computer game from Electronic Arts. See ***GURPS Bio-Tech*** for more on variant human colonists.

Stop In The Name Of The Law

The characters patrol the spacelanes, enforcing interstellar law and protecting civilians from human and alien menaces alike.

Character Roles: Patrolmen (p. 21) or Rangers (p. 20), probably assigned to a ship or frontier space station. They should have the skills to perform their duties; one may be the leader. Alternatively, the PCs could work for a peacekeeping force or an interstellar diplomatic agency.

Things to Do: Aside from patrolling interstellar borders and spacelanes, Patrolmen are interstellar policemen, investigators, rescuers, and the all-around do-gooders of the galaxy. If there are pirates to be fought, smugglers to be tracked down, an alien invasion to be blunted, a mystery to unlock, or a distress call to answer, the Patrol gets the call. In times of war, the Patrol and the Rangers are called to duty – whether on covert missions behind enemy lines, escorting convoys, or serving as light combat forces.

Campaign Advantages: The Patrol is a powerful Patron, providing equipment and a ship. Patrolmen also have a great range of adventures. This makes a wonderful "space opera" background.

Campaign Disadvantages: Patrol PCs have a Duty to their organization and its officers – and, depending on the campaign, they might operate under tight supervision. The Patrol represents interstellar law; it can't go around shooting indiscriminately. Patrolmen often have the privilege of dying in the line of duty.

References: Many! The archetypal Patrols are found in the *Lensman* series by E.E. Smith (see ***GURPS Lensman***) and in Andre Norton's SF novels. A more recent example are the Rangers of *Babylon 5.* A "peacetime" space navy may find itself performing Patrol-type functions, even if not specifically a law-enforcement body.

The Absurdist Campaign

If life on *Earth* is incomprehensible and sometimes blackly comic, how much worse might a galactic empire be? Absurdist SF is often satirical, but an absurdist space campaign is usually an excuse for straightforward humour, from simple silliness to more subtle bizarreness.

Character Roles: Innocents abroad – possibly highly capable on their own world, but in galactic society they are but motes caught up in chaos, not even able to go to the male mammalian biped's room without a guidebook. The being with an angle – someone who (thinks it) sees a profit to be made from the situation. Characters from other campaign types, twisted to suit.

Things to Do: Get home; rebuild home; buy a nice quiet planet; find out who's behind it all; make a documentary; become Emperor; find a decent cup of coffee; try to avoid trouble.

Campaign Advantages: Can go anywhere and take inspiration from anything (following classic clichés to absurd conclusions). The GM can rewrite galactic history and assign TLs to suit himself. Characters rarely die, except absurdly.

Campaign Disadvantages: Can go anywhere. Needs players and GM willing to improvise and not take any of it too seriously. Boring if drawn out, so best used as light relief between episodes of a serious campaign.

References: Douglas Adams' *The Hitchhiker's Guide to the Galaxy;* Harry Harrison's *Bill, The Galactic Hero* and *Stainless Steel Rat* series; Terry Pratchett's *Discworld* books, *The Dark Side of the Sun,* and *Strata*; almost anything by Robert Sheckley or Jack Vance; *Lost in Space; Red Dwarf;* the campiest episodes of *Star Trek* and *Dr Who.* See ***GURPS Discworld*** for a detailed discussion of comic roleplaying.

Races

Nothing affects the flavor of a science-fiction campaign as much as the presence (or absence) of alien races. Four sample races are described on pp. 56-58. Campaign possibilities include:

One Race

There is only one sentient race, and all characters must belong to that race. Widely variant forms are still possible, however. A human-only cosmos can still be diverse and exciting – especially if bioengineering is common! Many stories of galactic sweep, such as Herbert's *Dune* books and Asimov's *Foundation* series, have included no alien races.

A Few Races

There are only a handful of star-traveling life forms. Almost anyone will recognize each race and know the important facts about it.

Writing History

When you know what your present-day universe looks like, you should fill in some of its history, with special attention to the area the PCs will be operating in. These notes may be detailed or sketchy, but the players will certainly want information about what happened last month, last year, and last century.

Important points to cover in a future history:

First FTL drive. Who reached the stars first, and how?

First interplanetary colonies. Who discovered habitable planets of other stars? Who colonized them, and how? (If colonies were launched by generation ship or sleeper ship, then colonization could take place before the discovery of FTL travel.)

First contact with aliens or extrasolar humanity. And if the first contact was with humans from other planets, what were they doing out there?

Interstellar wars. Did they happen? When and why?

Advances in technology. Was the original FTL drive superseded by something later? When and why?

Formation and dissolution of interstellar nations and empires.

History of organizations to which the PCs are likely to belong.

History of important planets. Date of colonization; who colonized them, and why; subsequent development.

In some universes, of course, it may be impossible to answer all these questions. Perhaps humanity has populated the whole galaxy, interacting with hundreds or thousands of other races, and Earth itself is lost in the dim past. In this case, the important history will be that of the territory where the campaign is set . . . who are the friends and enemies, where does the money come from, and what are the politicians likely to do next.

Many Races

There are *many* intelligent races in the universe. Unless a race is dominant or exotic, only those with Area Knowledge of its region of space will recognize it on sight. The various races mingle, and there may be true interspecies civilizations. Races can be categorized as:

Dominant. One or more races may dominate others; their power may be military (conquerors or peace keepers) or economic (manufacturers, traders, or explorers). Dominant races are well-known near their regions of space. The opposite is *subordinate* races that are dominated by others.

Common. A race that is older, fast-breeding, or aggressive in exploration may be encountered often. Such races are also well-known in their localities, regardless of dominance. The opposite is *rare;* such races may be new to interstellar civilization, secretive, or slow-breeding.

Exotic. Races may be well-known because they have odd customs, bizarre reputations, unusual biology, or control of a particular technology.

Advanced. Some races might have a higher TL than the rest of the campaign – or they might monopolize a particular technology (perhaps a certain FTL drive). The opposite is *primitive,* a race that is technologically backward.

Precursor. Many SF novels have been written around the mysterious "Precursor" or "Forerunner" races: once-great civilizations which have disappeared, leaving only puzzling ruins and artifacts behind.

Subrace. A race may include several subspecies or offshoots. These may exist within a single society, perhaps with a caste system. Separate societies of subspecies might also exist; perhaps they separated millennia ago.

Descendant. A popular theme in SF literature is the "fallen" race, descended from a once-mighty civilization. Or space might contain several subraces, all descended from the original Precursors (or the splintered First Human Empire).

Unknown. The GM may create one or more races – potentially friendly or hostile – that are unknown to interstellar society at the start of the campaign.

Societies

SF literature describes dozens of different kinds of interstellar nations. (We'll use the term "nation" to mean any interstellar government, although "state" might be more appropriate in some cases.) The most important things about an interstellar nation are *size* and *political type.*

Size is largely determined by the speed of FTL travel and communications, which will be discussed in detail in Chapter 2. In general, the faster the ships can travel, the larger a coherent interstellar nation can be. Central control is difficult when the borders are more than a month's travel from the capital.

The most common political types are the *alliance, federation, corporate state,* and *empire,* as outlined on pp. 10-19. These can vary greatly. Look at the differences between the empire in Isaac Asimov's *Foundation* series and that in *Star Wars,* or the federations in *Star Trek* and Andre Norton's *Solar Queen* books.

Of course, names may vary greatly; we have provided some alternate names for each type of government to add variety to galactic maps. And governments, especially repressive ones, can have deceptive names – the iron-heeled empire that calls itself an alliance, the fragmented mini-state that puts on the title of "empire." After all, was the USSR *really* a union of republics?

Designing your interstellar government(s) is a great creative exercise, and shapes your whole campaign.

The Alliance

An alliance is a group of autonomous worlds. Its key feature is that its members are genuinely *self-governing.* The alliance controls only interstellar policy – primarily defense policy and foreign relations – and not any member's domestic affairs.

Languages

Any multi-species society will have to deal with the problem of language (see p. 48 for language skills). Some options:

Designate an official language. A common language ("Galactic Basic") may be designed, with a simple grammar and sounds that can be pronounced by the major races. If different races have widely different methods of communication, there will be several official languages. Of course, an empire may just require everyone to learn the rulers' language.

Develop a pidgin. Traders often devise a simplified "trade" language – a *pidgin* – where the most complex ideas that need to be conveyed are "What do you have to trade?" and "How much is it?" An interstellar pidgin may or may not use sounds; other encoding systems such as gestures or pulse codes may be used exclusively, or in addition to sound.

Find a technological solution. Species that have been in contact for some time will develop computer expert systems to translate for them (see p. 67). More radically, a universal translator based on psionics or superscience may be possible (see p. 64), in which case a common language isn't needed: communications are possible without it. Of course, such devices might be unreliable . . .

Whatever the translation system, it will work best with aliens whose thought processes are like ours, and worst with the *really alien* aliens.

The Precursors

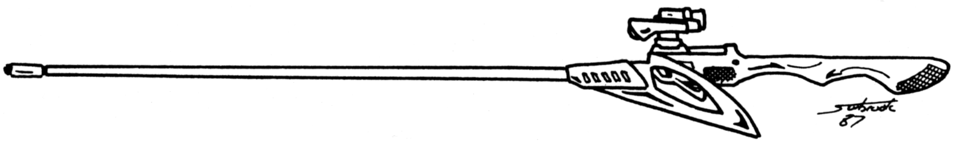
Many future histories incorporate Precursors – alien civilizations that died out before mankind reached the stars. Also known as Forerunners, Ancients, Elder Ones (or Gods), Progenitors, and Predecessors. Or they may be called by the name of a world on which their remains have been found. In most cases, who they were and why they disappeared is a mystery. There might have been a single race of Precursors, or dozens.

The discovery of new or different ruins or – especially – of working artifacts is a celebrated event. Study of Precursor technology might change a whole campaign's TL. (Or the poor Precursors might have had technology *inferior,* overall, to that of the campaign!)

Adventuring possibilities: A campaign might center around the search for Precursor artifacts, ruins or knowledge. A find can make the PCs rich beyond their wildest dreams – or hunted by half the galaxy. Precursor involvement can spice up any adventure (for instance, the pirate base might turn out to be a Precursor installation). The Holy Grail of the campaign would be the chance of finding the Precursors themselves or learning the Precursors' Secret.

Citizens have no direct influence on an alliance, but influence their world government which is represented on the Alliance Council.

H. Beam Piper's Sword-Worlds formed an Alliance (the individual worlds had feudal governments). The human worlds of Larry Niven's *Known Space* series might be considered a very loose alliance, at least in wartime.



Government

The governing body is a council made up of delegations from each member world. If a world has multiple governments, all must be represented in the delegation. In some cases, an alliance may give special power to important members – extra votes or veto power.

Normally, the Council may only pass laws affecting relations among its members, and seldom intrudes on its members' internal affairs. A majority of the Council – usually two-thirds – must favor any measure before it can be voted into law. A world can disregard alliance laws by seceding or by becoming an associate member – giving up its vote on the Council to gain full freedom in interstellar policy, yet retaining many benefits of membership.

The Council also acts as a court or mediator among member worlds.

When it comes to politics, an alliance is wide open. Member worlds can practice assassination, war among themselves, bribe alliance officials – and until the Council comes up with a two-thirds majority, the alliance will be powerless to stop it. Each member world, protective of its own sovereignty, is loathe to allow the extra police powers – including counterespionage or expanded military forces – that would allow the alliance to maintain order among its members. Only an outside threat is likely to unify the Council to legislate the needed action.

However, there won't be large interstellar rebellions fomenting in an alliance – there isn't that much to rebel against. Rebels are more likely to fight member worlds than the alliance, often covertly backed by other member worlds.

The Military

Alliances typically maintain a small interstellar navy, while member worlds maintain their own defense forces. If member worlds are stingy, the alliance military may be desperately underfunded until actual war breaks out; if not, they can be small but formidable forces.

Navy operations beyond routine patrols must be approved by the Council. Alliance military forces may not intervene in a member's internal affairs without permission from that member. In extreme cases – if conflict on a world or between member worlds is a clear threat to the alliance and its other members – the Council may send in a peacekeeping force.

During peacetime, planetary fleets usually restrict themselves to their own star systems. They may also take turns performing border patrols or other routine duties at the request of the alliance. In wartime, the Council can request members to mobilize their fleets to supplement the Alliance Navy. Even then, officers may challenge the nominal authority of the alliance admiral, especially when their homeworlds are threatened.

Ground combat forces might consist of a small core group – a "Marine Corps" or "Presidential Guard" – supplemented in wartime by member worlds' armies. Mercenary organizations thrive in the loosely regulated clime of an alliance, and are always available to aid with the defense . . . for a price.

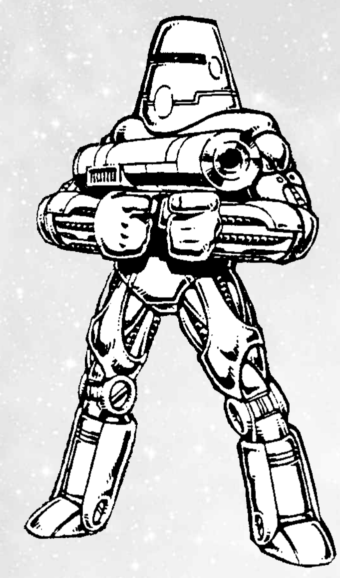
Alliances: Variant Forms

Hegemony. This is a society or group of societies in which one member controls the external affairs of the others, without interfering (much) with their internal policies. Otherwise, it is similar to an alliance – or, in its most restrictive forms, an empire. In a Terran Hegemony, for example, Mother Earth would be "first among equals," dominating the other member nations of the state. A hegemony may be repressive or benevolent.

Confederation. This may be just another name for the same political structure described for an alliance. It may also be a loose grouping of worlds for defensive purposes against an outside threat. Other than aid, assistance, and cooperation for the common defense, worlds within a confederation may have few ties. They are usually bound by a written defense treaty, and are otherwise self-governing.

Axis. An axis is a confederation of two or more worlds or societies built around a common philosophy. They coordinate foreign and military policies, usually seeking to draw under their sway dependent or supporting worlds. An axis is often expansionist and highly aggressive. Eventually, one of the worlds in the axis may come to dominate the others, forming an hegemony.

Concordance or Concordat. This type of society is formed when a group of worlds agrees to abide by the terms of ideals, laws, and principles for government expressed in a pact or *concordance.* Often, they will share no military forces and have no common laws; nevertheless, they may be very close allies.

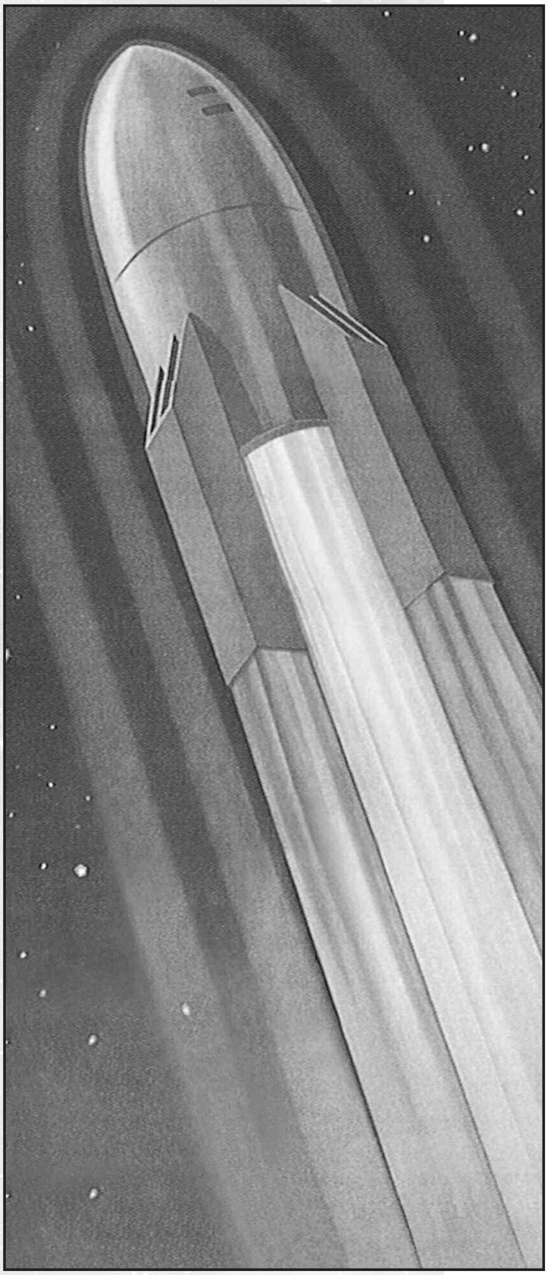


Federations: Variant Forms

Assembly. Just another name for a federation.

Protectorate. An expansionist federation might come to possess a large number of frontier sectors or colonies. Since the frontier sectors are not judged ready for self-rule, the federation government acts to protect and govern them. Such rule can range from benevolent, to mindlessly bureaucratic, to deliberately exploitative and repressive.

Union. Any state in which worlds have joined, willingly or unwillingly, into a single political entity may be called a union or a unity.



Law and Order

There will be an interstellar police force, usually called the Patrol (see p. 21). From a 20th-century perspective, the Patrol is a combination of state police and coast guard. It may be the only permanent armed space force an alliance maintains. The Patrol has full judicial and legal powers within the alliance and outside the member worlds' borders. Anyone arrested by the Patrol is tried in a Patrol court.

Since alliance laws deal only with interstellar matters, adventurers will not be bothered by alliance law except when operating in space. Within the political boundaries of a member world – which usually extend throughout its solar system – they are subject to local laws and ordinances, which can vary widely from member to member! One world could be a liberal democracy where citizens enjoy great personal freedom, while others might be dictatorial, tribal, theocratic, corporate . . .

Extradition of criminals from member worlds is possible, but never certain. Once a criminal is on a world, he is under its jurisdiction – the alliance legal system only has jurisdiction in interstellar space *between* member borders.

The Patrol seldom interferes in commerce between member worlds – restrictions are more likely to be imposed by the members themselves. Exceptions may be made if the Patrol is after terrorists or pirates, or if a ship is acting suspiciously, but the Patrol must be careful not to offend member worlds – and delaying cargoes or disturbing tourists is often offensive.

The Patrol exerts more control over travelers from beyond alliance borders. Patrol ships and border stations carefully screen incoming traffic, even if the destination worlds protest such scrutiny. Passengers are checked against lists of wanted criminals. Cargoes are checked for contraband, dangerous animals, or illegal weapon shipments, and routine tests are made for disease or pests. Leaving alliance territory, on the other hand, is usually simple.

Certain goods may be taxed or banned, either because they're dangerous or to protect the industry of member worlds. Enforcement is up to the Patrol.

Taxation of individuals is a power strictly held by member worlds, *not* by the alliance. The alliance is funded by tariffs, fines, and contributions from member worlds for protection and services. Payment may be made in kind rather than in cash. Worlds which cannot pay their "dues" may be subject to coercion by other worlds or by alliance forces.

Terrorist and fanatic groups may exist. If they do, the limited authority of the alliance may make them hard to root out. Member worlds might secretly shelter terrorist bases, letting them train beyond the reach of the Patrol.

Origin

Alliances may form in response to external threats, or from the weakening of a more controlled society. This is a natural first stage for interstellar government. Often, the original members have ties besides geography – common ancestry, trade ties, or similar histories.

Effects on the Campaign

Citizens of an alliance are free to do almost anything – even exploration is unregulated. Unless they violate one of the few alliance laws, they have little to fear from the Patrol.

Another benefit of adventuring in an alliance is its potential variety. *Any* sort of government or society can exist on a member world, as long as the world is reasonably stable in its dealings with other planets. However, this allows more chances for PCs to run into unexpected laws and taboos. And if they get in trouble on a member world, they can expect little help – the Patrol has no jurisdiction.

Resourceful types who are wary around repressive societies and who aren't averse to world-hopping when it's time to run may do quite well in an alliance.

The Federation

Federations and alliances share many features, but they differ in basic philosophy. In an alliance, the individual member worlds dominate the central government. In a federation, the opposite is true – the central government takes precedence over its component worlds. Federations usually take the form of republican democracies – that is, citizens elect the Federation President and local representatives to a Federation Congress. The typical federation is free but bureaucratic.

Federations are the ruling bodies in the *Star Trek* universe and Alan Dean Foster's *Humanx Commonwealth.*

Government

A federation is composed of administrative areas often called *sectors.* Each sector may encompass one or several star systems. There will be small differences (if any) in different sectors' laws. The sector governor is chosen by popular election; there is also a sector legislature.

The Federation President (or Elector) is selected in a federation-wide election, and serves for several years. He is responsible for administering the laws enacted by the legislature. He controls foreign relations with the advice and consent of a Senate. He may sign treaties and declare war. He is supreme commander of the federation military, and may use them without prior approval by the Senate – although the Senate may call on him to justify his actions.

A typical legislative body is a Federation Congress, elected by individual worlds (delegation size depends on world population); it is usually responsive to the will of the citizens.

There is a separate judicial branch. The Patrol is responsible for enforcing federation law, but offenders are tried by a federation court at the appropriate level.

When a world joins the federation, it agrees to abide by the federation charter. For this reason, sector government and law are much more homogeneous than those of an alliance's member worlds – divergence is prevented by swift federation action, including economic blockade and military invasion.

Secession usually isn't an option for members of a federation, unless several worlds secede at once or outside military protection is available. Planetary nationalists favoring secession may become rebels or terrorists. In rare cases, politics will allow a peaceful evolution to "special autonomous status" and finally independence.

There may also be *frontier districts.* These are similar to sectors, except that their populations are new (mainly colonists or the newly conquered) or scattered (a blighted region of space). The district government and officials are appointed by the federation, and there is no sector legislature.

The Military

Federation politics recognize that military and political power are linked. The Federation Navy is the only group authorized to have interstellar warcraft. Member worlds must surrender their navies upon joining. Hearkening back to the days of independence, however, naval vessels may be named after and manned by a particular world – the cruiser *Lotvik,* for instance, is crewed largely by native Lotvikians. Size of the fleet depends on the political will and wealth of its citizens. If the people will tolerate the cost of a major fleet, a federation can be as militant as any less-democratic society.

The Interstellar Marine Corps is the federation's military ground force. Planetary guard troops and draftees supplement the Marines in wartime, but it is the experienced, well-trained Marines who handle the dirty work – planetary invasions and defenses, commando raids, etc. If there is a continuing threat to the nation, federations may institute a draft, requiring young citizens to serve terms in the armed forces.

With federation permission, individual worlds may establish planetary guard units. These include ground troops and possibly atmospheric and sublight warcraft, but no significant armed starships.

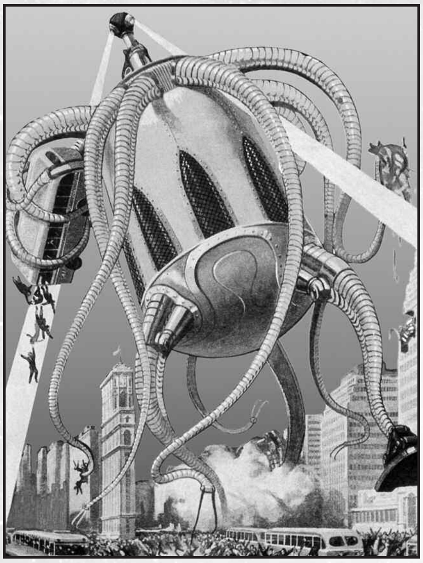
The Conquered/ Insignificant Terrans

In this type of universe, Earth has been conquered or absorbed by a technologically or numerically superior stellar state that was already in existence when Earthmen reached the stars. Earth may be one of many member (or subjugated) worlds, perhaps even considered a provincial backwater of little significance in the galactic scheme. Humans (or Earthmen at least, if the existing state is also dominated by humans) may be second-class citizens or worse – especially if Earth has been conquered by an alien-dominated federation or empire.

Even if Earth's absorption was peaceful and the rulers are benevolent, Earthmen may be considered children or primitives. This is especially likely if the overlords have superior technology. On the other hand, if the overlords are *too* civilized, Earthmen may be valued as warriors. (This might be a ploy on the part of the stellar rulers – a way to keep those pesky wolflings busy.)

If the rule of the master state is *too* heavy-handed, however, Earth might be in rebellion – possibly in confederation with other worlds or even other, smaller stellar societies.

The campaign then becomes military. PCs would be members of the rebel forces, fighting for Earth's destiny. Or, to pose a moral dilemma, the GM could make the PCs members of the overlord forces, preparing for a punitive campaign against one of those insignificant worlds bucking imperial rule. The world's name? Oh, Dirt, or Earth, or something like that. Won't matter once you launch those planetbusters, eh? What an honor!



Corporate States: Variant Forms

Cartel. Space is controlled not by a single megacorporation, but by a league of several competing corporations. Such a cartel is a hybrid of corporate state and alliance. There is no CEO, and the board of directors is replaced with a League Council whose members are delegates from the member corporations. The council selects a chairman, who has very limited authority – like an alliance, individual member corporations have more power than the central cartel government. Member corporations maintain private fleets, fight among each other militarily and economically, and spy on one another to obtain commercial secrets.

Enterprise. Citizens in this society follow the political doctrine of free enterprise – they want *everything* done by competing companies. The structure of corporate society remains the same at the upper levels, but everything at the middle or lower levels is contracted out; private companies bid for the contracts to run government services – including police, custom ports, welfare, and prisons. The military consists of hired mercenary and security companies. Competition is enforced and monopolies are illegal.

Association. A close brother to the corporate state, the association is formed of interdependent corporations. Each corporation performs a function of government – one is Commerce, one is Defense, one is Law Enforcement, etc. Such corporations compete over turf – for instance, there are redundant espionage branches in Defense, Commerce, and Law Enforcement – and some would like to establish predominance over the others. The Board of Directors is made up of delegates from the associated corporations; citizens usually own stock in the corporation that employs them.

Mercenary companies are rare except in frontier sectors, as the government distrusts independent military forces in central areas. In times of upheaval, mercs may be called in, but liaison officers will be assigned to ensure that they remain under strict control.

A federation may form its own legion of mercenaries. These troops are useful for prosecuting politically unpopular wars, especially if they are recruited solely from frontier or foreign worlds – which have no representation in Congress and cannot easily complain about combat losses.

Law and Order

Unlike an alliance, which is concerned with the rights of its member worlds, a federation guards the rights of its citizens. The necessities of reelection help to foster this. Federation laws are designed to protect the individual citizen and to provide security and unity for the society. On the whole, federation citizens get more benefits, services, and protection than citizens of an alliance.

Police functions may be handled by planetary or sector law-enforcement organizations or by the Patrol. The Patrol has full authority anywhere in federation territory, but must cooperate with planetary police – it cannot investigate and arrest independently of local authorities, unless they are obstructing justice.

Extradition of accused criminals between worlds is mandatory under federation law, provided the requesting world can guarantee a fair trial. Otherwise, the accused will be tried in a federation court. Federation authorities (such as the Patrol) carry out the extradition process.

Terrorists may be present, but bases must be well-hidden to survive. Any world known to be harboring terrorists can expect swift reprisals from the Marines.

Federations keep tabs on interstellar trade within their borders, routinely inspecting cargoes and travelers. Traffic entering and leaving the nation will be more restricted than that of an alliance. Passports will be required – especially if the federation has hostile neighbors – but the emphasis will be on the right of the average citizen to travel, limited by the security needs of the society.

The Patrol is on hand to combat pirates or terrorists and to conduct rescue operations when needed. It will also ensure that unscrupulous transport companies do not take advantage of citizens.

Interstellar trade involving federation worlds is regulated by the Interstellar Trade Commission (p. 19). Congress may ban some goods – usually harmful drugs, proscribed weapons, dangerous animals, etc. Tariffs and duties may exist to control imports that might harm world economies. This means there may be a lucrative business for smugglers in some areas, but that's what the Patrol is for. Customs offices are maintained at all starports in federation space. Starports are considered federation territory, and local police do not have jurisdiction there. The Patrol operates these ports, plus any additional posts needed at jump points or along trade routes.

Free news services thrive, restricted only in the name of federation security.

Taxes may be collected by federation, sector, and local governments. There may be a personal income tax, taxes on commerce, or both. Merchants and entrepreneurs will do their best to beat any such tax!

Origin

A federation often evolves when an alliance is forced by some threat to strengthen its central government. Federations last longer than alliances because their society can quickly meet and deal with external threats, and often has the power and authority to deal with internal ones as well.

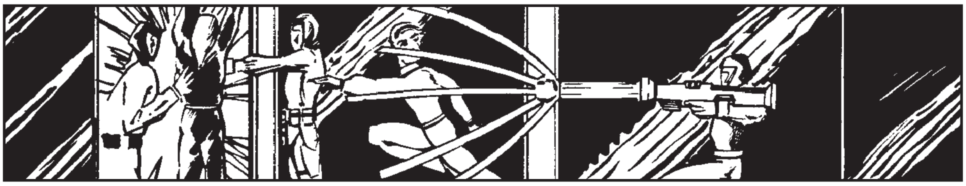
Effects on the Campaign

Campaigns set in a federation offer less freedom for those who play fast and loose with the law. Law-abiding types may find it the safest place of all – if they are federation citizens. PCs who run afoul of extremist planetary societies might find aid at the nearest Patrol office, unless the federation approves of the laws they broke.

The Corporate State

This is a society run by *big* business – a huge corporation that controls entire worlds, with a monopoly on commerce among them. Leadership is vested in a Board of Directors and a Chief Executive Officer (CEO).

Dictatorial corporate states are depicted in F.M. Busby's *Star Rebel* stories and (on one world) in *Sten,* by Allan Cole and Chris Bunch. Poul Anderson's Polesotechnic League is an alliance of (usually) fair and well-managed corporate states.



Government

A corporate state is "managed" rather than governed. Leadership follows standard business practice – the CEO directs day-to-day affairs, appointed and supervised by the Board of Directors. As long as the CEO has the support of the Board, he has dictatorial powers, and may hire and fire all other executive officers.

The Board of Directors is elected by the company stockholders. Directors have no responsibility for the day-to-day operation of the company, but act as a policy council to advise and direct the CEO. The directors elect one of their number as Chairman. The Chairman is the single most powerful person in the corporate state, though he operates behind the scenes.

Minor rules and regulations are set by corporate bureaucrats at all levels. Major policy decisions are made by the Board. The Board also decides the amount of stock available on the market, and possibly its current cost.

The relative benevolence of the corporate state depends on how the stockholders are organized. Citizenship is defined as owning stock in the company. Sometimes a stock certificate is issued along with a birth certificate; sometimes citizenship must be earned. More stock means more voting power; in a malevolent corporate state, the Board is dominated by a wealthy minority. But sometimes the "poor" stockholders can band together into "blocs" of common interest, similar to political parties in a democracy. If they have the numbers, they can vote their own representative to the Board.

Stock ownership is power. If a few wealthy magnates control the Board, society will be managed for their benefit and individual rights will suffer. If other voting blocs gain power on the Board, interests will be protected; as more blocs gain power, rights are gradually extended to all citizens.

Stockholders also receive dividends, as long as the corporation makes money. Militant stockholders may demand profits, steering CEOs away from long-term investments and toward short-term gains. After an unusually profitable period, the Board may declare a *jubilee year* – paying extra dividends and sponsoring celebrations.

Individual worlds are run by corporate middle managers, many of whom are working hard to show a profit and earn a promotion. Local management styles may vary from enlightened to dictatorial, and don't have to match overall corporate policy if the Board is far away.

The Military

The company has a monopoly on armed might, from local police to interstellar fleets. Local forces will be controlled by planetary directors. Major operations may be ordered by the CEO and must be approved by the Board. There may also be an elite security force – possibly a secret police in all but name – under the direct command of the Chairman of the Board.

The Long Night

No civilization is immortal – and when an interstellar nation falls, the disintegration will be profound. Natives will clash with colonists suddenly deprived of aid, armies will be left without pay and high command, money will become worthless, and the value of off-planet goods will skyrocket. Not a good time to live, perhaps, but a great time for adventure.

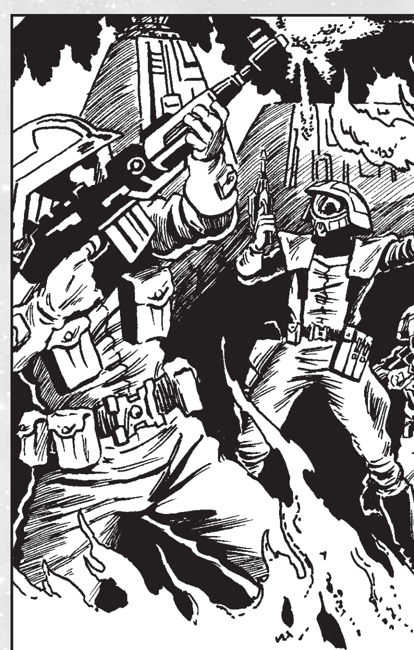
A period of turmoil and consolidation follows the collapse. Entire provinces and individual worlds become isolated. Systems or whole sectors may break off and become self-governing. With luck, the collapse ends at this level.

Otherwise, worlds may revert to barbarism, ruled by outlaws, raiders, or petty warlords. Technology may be lost – including the ability to travel from star to star. If a province or group of worlds is dependent on supplies from other areas – recently founded colonies, or settlements in hostile space – entire worlds may die.

This period of galactic history is known variously as "the Long Night," "the Dark Years," "the Interim," "the Aftermath," etc. It may last decades or centuries.

The Long Night is followed by reconstruction and consolidation. Any surviving kernel of the original civilization, plus strong new nations, will begin to expand outward again. Smaller states are likely to be absorbed. Eventually, the new government may reach the boundaries of the old one and start to expand again.

This cycle may be repeated many times. In a universe where man has been traveling the stars long enough, it may be that so many stellar empires have risen and fallen that Earth itself is only a legend, and no one knows the limits of human space.



Empires: Variant Forms

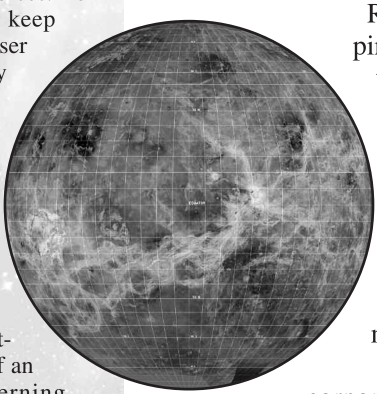
Realm. This is a more purely feudal system, with less centralized control. The local sector or planetary rulers – possibly known as lords or barons – control significant military forces of their own. The Emperor's military is probably the largest and best-equipped, but it is far outnumbered by the combined sector forces. For this reason, the Emperor must keep the good will of some of the lesser nobles, leading to a Privy Council: an advisory body of representatives from the major noble families. An Emperor who violates Council advice may find himself all alone on the day of battle.

Imperium. An imperium results when an autocracy grows too large to be effectively governed by one man using existing technology. The provinces of an imperium are large, self-governing areas. Provincial governors owe allegiance to the Emperor, but to the average citizen of the province, the province governor *is* the ruler and the Emperor is a vague, far-off figure. The Emperor retains control over the military, loaning imperial forces to the provincial governors – and fostering rivalry between his military and political leaders to prevent them from allying and taking the throne.

Theocracy. A society ruled by a church may closely resemble an empire, with the church's leader – the Prophet, Ayatollah, or whatever – substituting for the Emperor. This is true if the church rules autocratically; if it incorporates a form of democracy into its rule, it will resemble a corporate state (substituting the clergy or the faithful for the stockholders of the corporation). Theocracies tend to adhere to certain founding principles, which sometimes leads to an unhealthy inflexibility.

"Real" Empire. The technical definition of "empire" has nothing to do with one-man rule. It is a group of states among which one (the *metropole*) controls the internal and external affairs of the others (the *peripheries*).

In general, such a "real" empire can be treated like a federation in which one world or sector is dominant, pulling the strings of the others. The internal government of the dominant area can take any form. So can the peripheral governments – but whatever their form, they're puppets. A rebellion against such an empire is usually an effort by a peripheral state to take control of its own affairs.



Law and Order

Company regulations have the force of law. Many rules exist to insure that individuals put company concerns over any of their own.

Personal freedoms are often allowed only to the point where they interfere with job performance. Failure to follow regulations, meet quotas, or get along with one's supervisor can result in demotions and salary cuts (and loss of social status), criminal sentences, or firing. Firing is the ultimate punishment, since there is no other employer – shopping at the company store, banking and credit rights, and health benefits are lost along with employment.

Rebels aren't acknowledged as such. They are instead saboteurs, pirates, socialists, communists, or – worst of all – *unionists,* and are to be rooted out at all costs.

There is no judicial branch. Local executives conduct hearings and trials in their localities. There may be a "corporate ombudsman" to see that workers get fair treatment and fair trials. The power of the ombudsman depends on the stockholders. If the company is repressive, the ombudsman is helpless, or a pawn of management; in a benevolent society, the ombudsman has enough influence that middle management must respect his views.

Travel between worlds is controlled by the company. Travel for corporate reasons is easily arranged. Individual citizens are also free to travel, using their own time and money, though they may be "bumped" from scheduled flights by business travelers. Productive employees are often rewarded with paid vacations to pleasure worlds. Most employees, however, rarely get to leave the worlds of their employ – unless their skills are temporarily needed on another planet.

News is handled by the corporation's public relations or communications department, and reflects the company line. There are many stories about corporate success and happy employees. Failures are seldom reported.

Trade is company-regulated. Company employees must obtain all their goods at the local company store, paying whatever prices the company sets. With the company in control of all commerce, there's no competition and no chance of getting bargains somewhere else. Of course there's a black market, but it's grossly illegal.

Specific taxes in a corporate state are not necessary, since the company makes a "profit" on everything that is bought or sold. Occasionally, in a profitable year, the corporation will even pay bonuses to its workers.

Origin

A corporate state may evolve from the conflict between a super-corporation and a weak government, or when government gives too much authority to business.

If world colonization and exploitation is run by private enterprise, then single-company settlements may result. If corporate rule is unchecked by government, the corporation can expand its power base until it *is* the government on the colonies, while controlling trade with the mother world.

In a far-flung society, corporations may be allowed to form private fleets for defense in remote areas – similar to the East India merchant ships in Earth history. Such military power can allow total despotism in colonial regions, and may give the force needed (perhaps in alliance with other corporations) to secede from or take control of the society.

A corporation may also control a technology so valuable – FTL travel, for instance – that it can do whatever it likes!

Effects on the Campaign

Corporate societies can be dangerous; corporate security is watching all the time. The PCs might be security staff . . . or "evil" unionists! Good employees will keep their eyes on business, their shoulders to the wheel, and their noses to the grindstone – while watching their backs.

The Empire

An *autocracy* is a state in which one person is the final authority. Such states usually clothe themselves in the trappings of religion, feudalism, militarism, or all three. Fifty years of science fiction have popularized the term "empire" for this sort of structure, and we'll follow suit (but see *"Real" Empire*, p. 16).

Theoretically, all power comes from the autocrat, or Emperor – only by his grace does any lesser authority exist within the domain. Empires are *not* necessarily evil, or even totalitarian. An empire may be ruled by wise, fair people.

Empires are so common in science fiction that they're trite. Most (that of *Star Wars,* for instance) are dictatorial. Jerry Pournelle's CoDominium is heartless and bureaucratic. But the Empire of Man in *The Mote in God's Eye,* and the Imperium of ***Traveller,*** are basically benevolent.

Government

An empire may have a huge bureaucracy, or operate through a system of feudal lords (King of the Sirius System, Duke of Venus, Governor-General of Ishtar Terra Continent). But all authority essentially leads back to the Emperor.

Some imperial servitors have more authority than others. The Chancellor is the Emperor's officer for civil affairs, while his Adjutant General handles military affairs. There may be an Imperial Senate, elected by the people or selected by subject governments, but the Emperor is free to ignore them. Corruption is often widespread – the right bribe to the right person can work wonders.

The ruler may be selected in many ways. Typically, the Emperor rules for life. The next Emperor will be his eldest offspring or the closest surviving member of the imperial family if there is no child. The succession can be interrupted by rebellion – usually led by rival members of the imperial family – or by the death of a ruler without an heir. In this case, the next Emperor is chosen by an informal political process, heavily influenced by military power. Poison, assassination, and intrigue may be common at court at the best of times.

A bureaucratic empire will be divided into provinces, ruled by governors. They will be selected from among trusted military leaders and loyal, weak, or elderly civilians. An Emperor unsure of his power will forbid any governor to rule in one place for long, for fear he may become too popular with his citizens.

Individual worlds within an empire have whatever autonomy the Emperor chooses to grant them. Many worlds retain a semblance of their traditional government, and some even have limited independence. New territories are more cooperative when imperial interference is kept to a minimum.

But such freedoms are subject to the whim of the Emperor. At the first sign of disobedience, favored worlds may quickly find their governments deposed, replaced by an imperial ruler backed by the Imperial Guard. Other planets will quickly take the hint and toe the imperial line. Either that, or they swiftly find themselves with new rulers as well – and a permanent military occupation if they cause too much trouble.

Rebel activity is rife, no matter how hard the empire tries to stifle it – there is a lot to rebel against. Some rebels will want freedom; others will be part of conspiracies to seize the throne.

The Military

A militaristic empire can use its forces far more freely than other societies. Planetary police and security forces will report to provincial governors, but these forces will have little or no space-combat capability.

Conquest is the easiest way to expand an empire, using its inherent strength – a large military – rather than relying on exploration and colonization. Besides conquest, the armed might of the empire is geared toward keeping the populace pacified. In peacetime, much of the Imperial Navy will be dispersed throughout the empire; huge forces will drop in unexpectedly as a reminder of imperial power.

Why People Support Rotten Empires

It's nice to think that a government that Goes Too Far will eventually cause the citizens to rise in righteous wrath and throw the rascals out. It's also convenient when all the defenders of the Evil Empire wear uniforms (except for the occasional Secret Police spy). Unfortunately, we know from centuries of experience that it doesn't really work this way. The worst tyrannies imaginable have been enthusiastically supported by people no worse than you or me.

Without going deeply into psychology, here are some of the reasons why citizens support tyrannies. You can use these to make your fictional Evil Empire and its people something more than laser fodder:

Citizens fear the unknown will be worse than the known: a foreign philosophy, a strange religion, society breaking down to anarchy. They may fear and hate an enemy population, especially if they are a different religion or race. Let alone *species:* Do you hate the Bug soldiers because they are cruel and ruthless, or because bugs are icky? Many people fear that a new government would cost them their jobs or personal power; in a corrupt regime, they may have good reason to be afraid of justice. A clever regime's propaganda will play on all these fears, constantly portraying the foe as inhuman, the rebels as terrorist killers.

People who are used to obeying the law often have a hard time changing their habits when the law becomes oppressive. They still believe that "the police only arrest criminals; honest people have nothing to fear." When the rebels break into an armory to get guns, these people see only that a robbery was committed. Enough of this and patriotic citizens may volunteer for the army to fight the wicked rebels. Obviously, rebellions find more support on worlds that were free until the empire conquered them. But even there, some citizens may hate the occupier but doubt the rebels would be any better. You can fight for "freedom" – but once you win, you have to set up a government.

And people may be loyal to the idea, or to the ideals, of a nation or empire, even when the reality is tarnished. "My country, right or wrong . . . "

It is not evil, or even cowardly, to be afraid of starvation, torture and death. Any successful rebellion must overcome these fears . . . to convince the people that anything is better than slavery. Meanwhile, the government is telling them that anything is better than anarchy. Which is why rebellions have a hard time of it.

– John M. Ford

The Census Division

The Census Division is the least-glamorous arm of the Survey Service. These individuals – sometimes known as Census Takers, Enumerators, or, less formally, "bean-counters" – have the job of accurately recording the status and continuing history of all inhabited worlds in their territory. They also measure patterns of trade and communication, and may find themselves called on to document monopolies, hunt smugglers, and do other jobs that you'd normally expect the Patrol to draw.

Under a sufficiently repressive society, the Enumerators may spy on their fellow citizens.

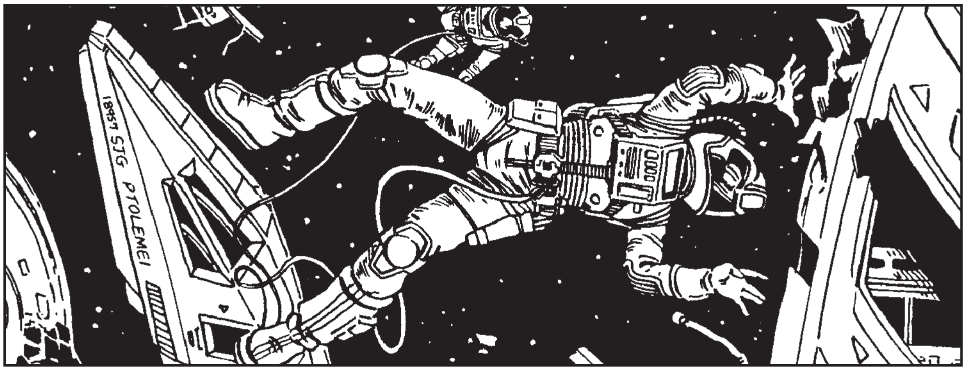
Being transferred to the Census Division is considered dire punishment by most scouts.

The Rebels

Every society has its dissidents, and when those dissidents take up arms, they become rebels. The character of the group depends on what it is rebelling *against* and *for.* A group rebelling against a repressive society, in favor of a democratic government, is probably heroic; a rebel movement to replace a king with a dictator is often less admirable.

In a far-flung imperium, rebels might seize several worlds successfully, while in a tightly held dictatorship, the Mind Police might thwart meetings of any kind.

Adventuring possibilities: The GM can easily build an adventure around the overthrow of a planetary government; toppling an entire interstellar society could be the focus of a whole campaign. Rebel movements of all types can spice up any adventure: PCs searching for Precursor relics on Epsilon VII may become embroiled in a slave uprising, for instance.



Even the Survey Service (p. 22) takes on military overtones. The scouts not only seek out new worlds, but also make initial judgments about the potential for hostility or conquest. The Patrol is also an arm of the military, as its police duties often involve light pacification and occupation missions.

Defense policy is typically "attack first." The empire cannot be expanded if it is constantly under attack. Therefore, strike at any enemy – or potential enemy – before he can strike at the empire. Besides, war keeps the masses busy, justifies the defense budget, and brings in new subjects.

Imperial citizens may be drafted into the armed forces at any time. Criminals and debtors are routinely sentenced to military service. The military-age population of a rebel world may be drafted *en masse.*

Mercenaries may be common. In times of political unrest, imperial officials may feel that mercenaries are more reliable than their own troops. Mercs may be hired to do the dirty work that the Imperial Marines consider themselves too good for, and they can be paid in "looting rights."

Law and Order

The word of the Emperor is law. Some Emperors rule by personal decree, but others are happy to let a huge bureaucracy make all the "boring" decisions. Imperial laws take precedence over all other laws.

Empires are restrictive by nature. Personal liberties are kept in check to ensure the security of the empire – otherwise, there will be unrest and rebellion. In general, nothing can be done without the proper licenses, permits, and orders: to use military force, to trade, to prove identity, to travel. Forgers will grow rich (or vanish suddenly).

The Patrol has police powers. Routine trials are held by local governors, or by the Patrol for offenses in space, but important matters must come before an Imperial Magistrate – an elite personal representative of the Emperor. Punishments include prison, forced-labor camps, slavery, torture, and impressed military service.

An autocrat may tolerate protest against his policies, but never against his rule. At the first hint of any actual threat, dissension is crushed.

Travel is tightly regulated and requires the right documents. Common citizens find it next to impossible to obtain permission to travel beyond the borders. One of the Patrol's duties is to police the borders for refugees attempting to escape.

Interstellar trade may still flourish, but heavy regulations and duties make it difficult to prosper without buying influence in the imperial court. Small traders may turn to smuggling to survive.

The empire will ban commerce it deems a threat, including military supplies; gunrunning to rebels carries an automatic death sentence. Traffic in drugs and vices may be prohibited by a puritanical Emperor or encouraged by a decadent one. But the Imperial Trade Commission is notoriously easy to bribe.

Taxes are numerous and burdensome. Citizens may pay a tax on everything they do, from travel taxes to restaurant taxes.

News will be censored by the Imperial Communications Bureau, and history itself may be rewritten in the imperial chronicles. From a totalitarian viewpoint, control – of travel, news, and ideas – is everything.

Origin

An autocratic empire may be founded when a society is faced with a crisis, from outside or within. Rule by one person, bypassing debate and election, may be appealing, since the autocrat can act far more swiftly than a democracy. This might happen during a war – especially as a desperation measure of a losing side – or an unhappy military might stage a coup. It could also happen in hard economic times, by popular election: citizens might believe a strongman's promise of forceful leadership. An empire could also evolve from a period of martial law – the military rulers just stay in power.

Social or economic conditions – overpopulation, food shortages, unemployment – may lead to restrictions and a loss of personal freedoms. A society which believes it must control its citizens may take on more and more of the characteristics of an empire – although it probably won't call itself by that name.

Effects on the Campaign

If the empire is perceived as corrupt, players will enjoy getting away with whatever they can. If the empire is firm but fair (it can certainly happen!) there will be honor to be won in its service.

Organizations

Any society will contain a number of important interstellar *organizations,* which make good building blocks for a campaign. Some organizations will be restricted to a single nation; others may extend through all of space. Organizations will include lots of NPCs – bosses, hirelings, foes, and spear-carriers. Most organizations make appropriate Patrons (or at least employers) for PCs, but membership may also carry responsibilities – Duty, Sense of Duty, or both.

Below is a representative collection of far-future organizations. The details given are only suggestions – the GM will want to modify them or use different organization names as he adapts them to his universe. None of these organizations *has* to exist – some may not be appropriate for some nations or races, and other nations may combine multiple functions into a single organization. All of these organizations can also exist in campaigns without interstellar travel – in that case, just replace references to "interstellar" with "interplanetary."

Government Organizations

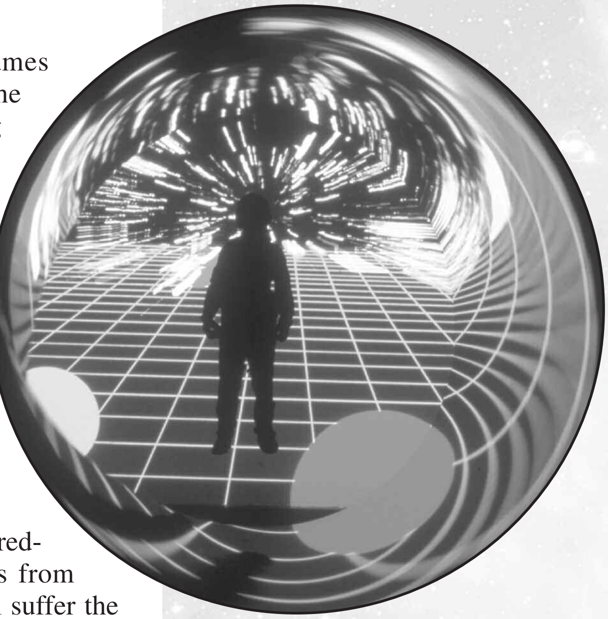
Interstellar governments have many branches. Their official names should suit the society; for instance, the Patrol might be known as the Alliance Patrol, the Imperial Patrol, the Interstellar Police, or something completely different like "the Federation Bureau of Investigation."

Interstellar Trade Commission

The ITC sets tariffs, duties, taxes, rules, and regulations for all merchant ships, both corporate and independent. All traders must be licensed by the ITC in order to conduct commerce within the nation. The commission may be charged with preventing monopolies in trade, especially by larger corporations, sometimes allying with the Special Justice Group (p. 22).

ITC agents operate the customs stations at all starports, and cooperate with the Patrol (p. 21) and the Census Division (p. 18) against interstellar smuggling.

Adventuring possibilities: Independent traders hate the ITC for its red-tape regulations and love it for the way it keeps big merchant outfits from putting them out of business. Corporations simply hate it. Everyone will suffer the indignities of going through customs. A shipful of ITC inspectors can poke their noses almost anywhere, making for a free-swinging campaign.



The Marines

Most interstellar wars are fought by starships. However, navies can only control space – it still takes ground soldiers to conquer a planet.

The Marines are assault troops, the ground arm of the navy. Their most dangerous jobs come in wartime – boarding enemy vessels (if technology permits) and establishing beachheads on hostile worlds. Marine contingents are present on all warships, acting as security forces.

During peacetime, Marines engage in war games, guard naval bases, train planetary defense forces, and aid in "police actions" – commando-style raids against pirate and criminal bases in cooperation with the Patrol. Under a repressive society, they have the job of crushing unrest and rebellion.

The toughest of the tough, the Marines live up to their reputation in combat and in peacetime. They get the dirty jobs – that's the way they like it. It isn't smart to mess with Marines.

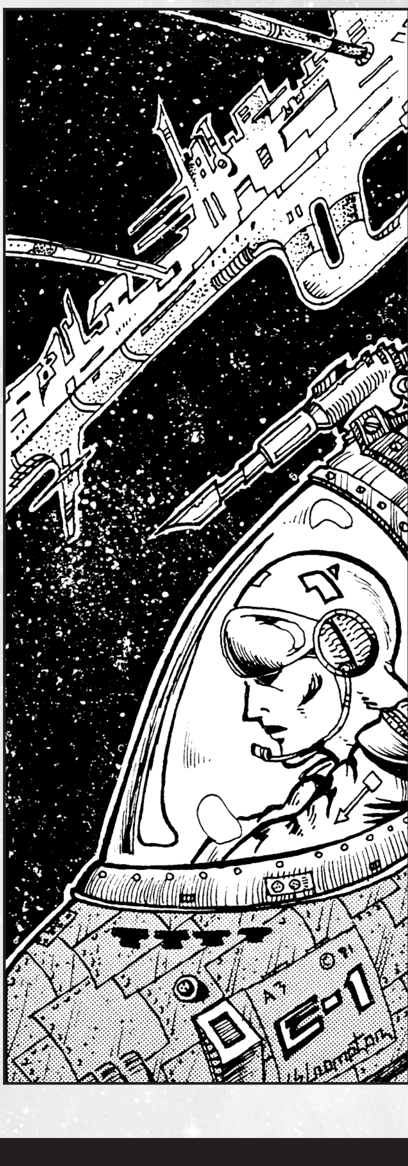
Adventuring possibilities: The most likely place to meet Marines is in a "liberty town" – a location where a company of Marines has been granted R&R. Rowdy, drunk Marines make interesting encounters. Former Marines make well-prepared adventurers, and may know secrets from their military days.

The Rangers

The Rangers (or Star Rangers) are a paramilitary force, trained for survival, rescue and combat on hazardous or untamed planets. They are practiced outdoorsmen and survival experts. Rangers also act as "sheriffs" on new colonies, under the direction of the Office of Colonial Affairs (p. 21), keeping law and order until the colonies become self-governing.

The Rangers are often called upon to rescue (or bodyguard) Survey expeditions, and occasionally join Patrol missions. There is a grudging mutual respect between the tough, free-swinging Rangers and the disciplined, spit-and-polish Patrol. In some campaigns, the Rangers may actually be an arm of the Patrol.

Adventuring possibilities: On the frontier, Rangers are the omnipresent law enforcers – PCs might even find themselves deputized during local emergencies. Ranger PCs can be fun, if the campaign restricts itself to the Rangers' assigned territory; a Ranger campaign is also possible.



Mercenary Regulatory Agency

If mercenaries are a big part of interstellar society, an organization like this may exist to set policies and directives for mercenary companies. Those that comply will receive licenses. Those that refuse must disband, or leave – or face the Marines.

Regulatory agencies almost always prohibit biological, chemical, or "dirty" nuclear warfare within the nation's borders. Clean tactical nukes are sometimes allowed. Mercs must not go to a troubled world unless hired by someone on the scene, and must leave when the fighting is over.

Unfair technological advantages are sometimes outlawed as well – merc companies may have to use weapons of the same TL as the world on which battle occurs. Some latitude may be allowed; outnumbered forces may be allowed a technological edge, for instance. See Andre Norton's *Star Guard* and Jerry Pournelle's "CoDominium" stories.

Regulators are assigned to each merc outfit. Some are self-righteous and obnoxious; some can be bought; some do their jobs.

The MRA is also a clearing house for licensed mercenary outfits seeking work. When contracts are negotiated, the employers place half the agreed payment on bond with the MRA. If there is a dispute later between the mercs and their boss, the MRA arbitrates – paying the mercenaries from the bond fund if necessary.

The MRA maintains a central office on the capital world. Other offices may be opened if local business makes it worthwhile.

Adventuring possibilities: The MRA is a natural opponent for merc outfits, whether on the trail of lawbreaking companies or acting as a nuisance for law-abiding ones. It is also a resource for out-of-work merc characters. In a non-merc campaign, adventurers may contact the MRA to demand action after being harassed by mercs – or the MRA may contact *them* if they tried to hire mercs for a questionable job.

Navy

The navy is the primary interstellar military force, defending against (or attacking) rival nations. During wartime, the navy's job is to defend the borders and vital inner systems while depriving the enemy of his ability to wage war. Between wars, the navy maintains readiness by carrying out mock battles – often in barren, remote systems where it can use live ammunition. The fleet may also pay "goodwill" visits to neighboring stellar states – allies *and* potential antagonists – to stave off war by impressing potential foes.

Large naval bases are maintained at strategic locations, often on airless moons or navy-controlled worlds. Small bases – mostly for refueling and repairs – are attached to many larger starports. The navy also has an intelligence branch, responsible for gathering current information on enemy military forces.

In an alliance or other loose society, the navy may be the professional core of the fleet, supplemented in wartime by regional forces of varying ability. Where the navy is the sole military arm, tight control must be maintained or the admirals may seize command and declare an empire.

Life as an average navy man can be boring – shore leave is the only high point, and even battle may only involve routine tasks. Officers enjoy status and authority; fighter pilots also have prestige. If interstellar communications are slow, a frontier base or starship captain may be granted great freedom of action, being as much ambassador as warrior.

Adventuring possibilities: Stumbling upon a secret war game can always be interesting, and in rare cases a naval squadron may pursue a noted villain. In most cases, however, the navy is the background threat – the intervention so awful no one risks it. Pirates and criminals avoid fighting the navy. On the other hand, in a turbulent frontier region, the navy is often the only authority for light years around. Playing the captain and command officers of a major warship or starbase assigned to an interesting sector of space can give great scope for players who want to make a difference.

Office of Colonial Affairs

The Office of Colonial Affairs oversees colony ventures and regulates the construction of colony ships. It may control new colonies until they are self-sustaining, appointing all administrators and governors. It may also work with the Ministry of Prisons to get involuntary colonists for harsh, mineral-rich worlds. The OCA has branches on any world that is likely to launch a colony effort, and administrative offices on sector capitals and throughout the frontier.

Adventuring possibilities: For colonist PCs, a friendly OCA may be their best friend . . . and a corrupt one will be their worst enemy. An OCA inspection team will encounter interesting situations.

Patrol

The primary responsibility of the Patrol is to police space. Peacetime duties include rescue work, escort for colony ships, routine space patrols, anti-piracy and anti-smuggling operations, starbase regulation and inspection, blockading restricted worlds, and perhaps mundane police duties on small colonies or space stations which lack their own local police force. They circulate a monthly list of the top "wanted" interstellar criminals to starports throughout the nation.

Patrol forces operate under naval command during wartime. Typically, the heaviest Patrol ship will be a light cruiser, but crews are likely to be elite. In a young or loosely knit society, or ones with no known foreign enemies, there may be no navy – in this case, the Patrol performs both military defense and law enforcement.

Patrol bases are attached to many starports; even minor starports are likely to have a Patrol office. The Patrol also has separate *operation bases,* away from the commercial starports, from which major anti-piracy and other missions are launched. The Patrol usually maintains a covert-operations office; its agents infiltrate criminal organizations. (In a repressive society, they are secret police.) The Patrol is known for rigorous adherence to the letter of the law and rigid interpretation of those laws. The ideal Patrolman is super-competent, incorruptible, and fearless.

Adventuring possibilities: Everyone encounters the Patrol, whether they run *to* it or *from* it when they're in trouble. PC Patrolmen will never lack for adventure.

Postal Authority

The Postal Authority is responsible for the mail. Mail between vital worlds is carried by official courier ships. Mail service for minor worlds is contracted out to private trade ships. This is profitable – many independent traders depend on mail runs for steady cash – but PA standards are high! Other interstellar communications may also be controlled by the Postal Authority, depending on technology.

Adventuring possibilities: Characters could be courier-ship pilots or private traders with a mail contract.

Security and Intelligence Agency

This shadowy, covert group is the national espionage and counterespionage arm. Agents are trained in intelligence gathering, overt and covert, as well as the "tricks of the trade," including infiltration, misinformation, code-breaking, social manipulation, and assassination. Counterespionage agents are responsible for identifying and neutralizing agents of foreign governments. There will usually be several different agencies, often with misleading names, who spend a great deal of their time spying on each other!

Advanced cosmetic surgery and clone technology allow agents to operate under cover in a variety of guises – different faces, sexes, and races. Potential recruits must have a wide variety of skills and abilities, including the more subtle combat arts.

Under a repressive society, intelligence agencies will spy on citizens while sending *agents provocateurs* to foment unrest in rival nations. Loosely knit societies may have no intelligence arm, but their member states might. In some societies, this may merge with the Survey Service and be responsible for covertly infiltrating alien or foreign societies, either to learn more about them or to alter their societies to make them ripe for assimilation or conquest.

Three Multistellar Corporations

Tri-Tachyon, Ltd.

This huge corporation is a leader in the manufacture of FTL drives. Subsidiary industries include computers, entertainment modules, and xenobiological research. It is rumored to be researching some sort of "trans-dimensional" travel. The Special Justice Group rates Tri-Tachyon as law-abiding – its legal transgressions have been minor, with fines correspondingly light.

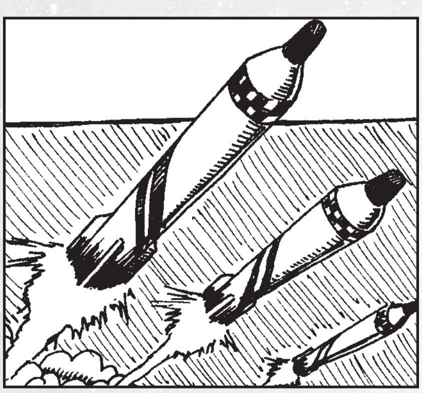
Trans-Sol Incorporated

Though Trans-Sol has dozens of subsidiaries, it is best-known for its advanced vehicles, ranging from cybertanks to personal flitters. Its designs are not innovative – proven designs and customer satisfaction keep Trans-Sol on top. Major diversification includes mining, android research, and consumer appliances. Trans-Sol is committed to maintaining its market share by any means necessary. It has a well-deserved reputation for ingenious forms of industrial espionage, computer sabotage, tax fraud, and similar offenses. However, the corporation seems to draw the line at violence.

Goliath Weaponry GmbH

This ruthless multistellar occupies the top of the Special Justice Group's watchdog list. It began as a cartel of weapons manufacturers, then grew rich through war profiteering – selling weapons to both sides, then collecting on debts to take economic control of entire war-exhausted systems.

The Special Justice Group has cited Goliath for more violations than the two next-worst offenders combined. Unfortunately, the company has been convicted on only minor infractions. Major violations – from sale of military secrets to hostile powers, to involvement in criminal and terrorist activities – remain unproven (evidence and witnesses frequently disappear). SJG agents have been unable to successfully infiltrate the company.



Planning Adventures

"It is the business of the future to be dangerous . . ."

– A.N. Whitehead

So you've got your campaign outlined. Now you need to find, or write, the first adventures with which you'll challenge your players.

Adventure in outer space often becomes a generic fantasy, with force blades standing in for magic swords, spaceships for horses, gadgets and psi for magic. Whether the task is to overthrow the wicked Emperor of the Universe or to preserve the peaceful Federation against slavering hordes of Space Mongols, it's the same old thing. Make the blasters into six-guns and it's a Western. Put sails on the space freighter and you're on the Spanish Main.

So what's different about science fiction? Isn't an adventure an adventure, no matter what the props?

Not quite. Science fiction offers something that humanity has almost lost: the chance to be *first* somewhere, to see something really new. And a space campaign, more than any other, can have infinite variety. In a galactic society, you can never run out of new people, places, and things. You can visit high-tech, low-tech, and everything in between . . . and you *can't* know it all. GMs should emphasize the effects of alien cultures and environments on the adventure – and on the adventurers!

Continued on next page . . .

Adventuring possibilities: Characters might find themselves on an intelligence mission – as unsuspecting dupes or working with agents. If they are part of an important organization, they may be infiltrated by agents of an enemy nation. An entire espionage campaign is also possible (see p. 8).

Special Justice Group

Formed as a watchdog agency over multistellar corporations, the SJG oversees corporate expansion and diversification, regulates free trade and stock sales, collects taxes and other government fees, inspects existing corporate facilities, and approves all new facilities. Its mission is to preserve society from domination by powerful business groups, while maintaining their financial health – realizing that the economy of the state is tied to corporate success. Covert agents infiltrate corporations to uncover assorted violations.

Adventuring possibilities: Characters hired as corporate employees or security forces might meet SJG agents – for good or bad. Obnoxious SJG officials make perfect opponents for ambitious corporate executives. Another possibility is a corporation-busting Special Justice campaign.

Survey Service

The Survey Service has two primary duties: To explore and chart the frontier, and to maintain accurate records of all worlds.

The Exploration Division of the Survey Service, frequently known as the Scout Service, works to fulfill the first goal. There are often two branches: first-in scouts and survey scouts.

First-in scouts are a quirky lot, solitary and temperamental. Often using one- or two-man craft, they visit unexplored systems. If they find a potentially habitable world, they make the best report they can, landing for close inspection if there are no apparent hazards. First-in scouts especially watch for signs of intelligent life. If an intelligent species is detected, they may *avoid* contact – that's a job for specialists.

When the first-in scouts make a favorable report on a new world, the survey scouts are sent in. A survey team may be a single ship or a full expedition; it includes xenobiologists, planetologists, xenoarchaeologists, and first-contact specialists. They begin by making an exhaustive orbital study, landing only when the planet is judged safe. Survey scouts certify worlds as suitable for colonization, and make recommendations about relations with new alien societies. Survey scouts are more intellectual than their first-in brethren, but they are still adventurous survivors.

Survey stations, manned by Exploration Division personnel, may be set up for the long-term scientific study of planets or interesting space phenomena (e.g., black holes) and major archaeological finds (like Precursor sites). Covert survey stations may be established if a planet has a low-TL native race deemed worthy of study but "unready" for contact. In an interplanetary campaign with no FTL travel, most worlds will have been explored already, so manning such projects may be the scouts' main role.

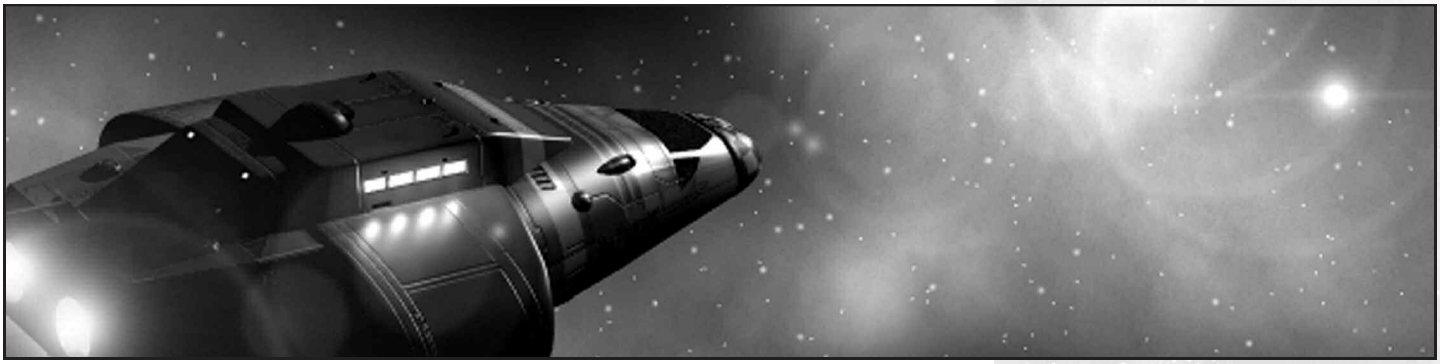
During wartime, scouts are attached to the navy. First-in scouts perform long-range reconnaissance, while survey scouts are attached to naval intelligence, often acting as fleet intelligence forces.

Adventuring possibilities: Anyone on the frontier is likely to encounter scouts, especially traders or corporate types interested in exploiting a newly discovered society or Precursor site. A dedicated scout campaign is also possible (see p. 6).

Private Organizations

Corporations

A multistellar corporation is a vast conglomerate of companies in hundreds of fields on dozens of worlds. Some multistellars control entire worlds and support vast armies of employees – corporate security forces can outnumber the local planetary defense forces (and may be better trained).



In many businesses, profits outweigh ethics. Some corporations use dummy companies and trusts to dodge government supervision, considering such high-profit, high-risk activities part of the corporate "game." When not cooperating against the Special Justice Group, the companies are spying on their competitors – bugging research centers, bribing employees to spill secrets, and planting misinformation about new worlds. Sometimes industrial espionage is a gentlemanly game; often, it's deadly.

Adventuring possibilities: Working for a corporation lets PCs be nasty without feeling responsible – they're only following "company orders." Corporations also make good Patrons. They make excellent bad guys, too – exploiters of defenseless aliens, ravagers of priceless Precursor sites, slave lords on remote company planets, and remorseless steamrollers in commerce and industry. Independent traders hate them.

Free Trade League

At first, it was little more than an association of independent traders that met at market worlds to swap information. As interstellar competition – and regulation – grew, the Free Trade League became a lobbying group for the rights of independent traders. It now has offices everywhere that traders gather.

The League is a clearinghouse for market information. An independent trader who has valuable information he can't use will pass it to the League – which brokers the data to other independents before the big corporations get the word. The original trader gets a 5-10% royalty; the League itself takes a percentage as well.

The League also arbitrates grievances among members and operates as a bank, facilitating transactions between races and cultures. Traders down on their luck can apply for a loan – but if they can't pay it back, they'll be pariahs in the trade community.

Adventuring possibilities: This brotherhood is the home organization for most trader PCs. Other nonmilitary PCs are likely to encounter independent traders, especially on the frontier – passenger rates are low, voyages are slow, and there's always a chance of adventure before journey's end.

Mercenary Companies

A mercenary company is a military outfit – usually ground troops, often with supporting ground vehicles and aircraft – which works for hire. Regulations and discipline remain under the control of the unit commander, not the employer.

Companies can be contracted for specific missions or hired by the month. "Honorable" merc outfits will fulfill their contracts so long as their employer deals honorably with them; other outfits may desert their employer for sufficient reward, sometimes even changing sides!

Organization varies, although it is always military in style. The commander may style himself by a variety of titles, including "general" and "commandant." There is a friendly rivalry among the best companies. However, licensed or "honorable" companies have a strong dislike for less-trustworthy outfits.

Adventuring possibilities: PCs who sign on with a merc outfit may see a variety of adventures in far places. Mercs also make good antagonists.

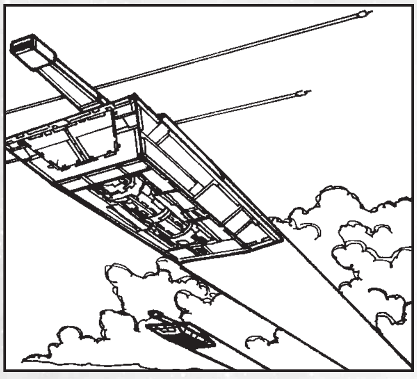
Planning Adventures (Continued)

Furthermore, *the future hasn't happened yet.* We know what life was like in the Middle Ages: poor, nasty, brutish, and short. If you were rich, it was a little better, but no money could buy more than the simplest medicine, and for every rich man there were thousands of suffering peasants. No magic swords; no magic, period.

Now, the future may be just as oppressive, or worse. But it doesn't *have* to be that way. Technology can take the place of peasantry. The resources of the solar system can make everyone wealthy – without dispossessing any natives. And the effects of high technology on humanity may seem literally miraculous. If anything, most science fiction is too *conservative.*

Science fiction – real science fiction, not space fantasy – is about solving human problems with the tools of the real world. Science fiction assumes there are no "mysteries" – only puzzles that haven't been solved yet. The universe is a dangerous place, but only for people who don't understand it and won't try to. Make the effort to learn and you can live anywhere and survive anything. The laws of physics can't be argued with – but they don't hate or love, lie or swindle, plot or hold grudges.

People do all those things, of course. And thereby hangs a tale. You, as the Game Master, can tell it. Keep reading . . .



Interstellar Trade

Star traders purchase goods from one world and sell them at another for a profit. This sidebar does *not* attempt to provide detailed rules for trade; the subject has been given a book of its own: ***GURPS Traveller: Far Trader.*** This is nothing more than a very general overview for the GM.

GMs may want to assign a *production score* to each world, reflecting that world's ability to market its product in interstellar commerce. Consumer goods are sold at any inhabited world, with the demand (and prices) related to the size of the population and the remoteness of the world; raw materials will be purchased by industrial worlds. Interstellar trade must be very cheap and efficient before it's worthwhile to move processed raw materials, let alone ore, between star systems.

If interstellar banking functions smoothly, then a planet's ability to buy goods is linked to its production score – if it is selling goods to other systems, it will have more credit with which to purchase new goods. If there is no working bank system, then worlds will use native, marketable goods to purchase goods from a trading ship. This leads to well-planned trade routes: a trade ship goes to Awwad to obtain brof fruit, which it takes to Boozer (where they make brof rum) in return for osmic ovens, which it takes to Cummerbund (where there is a housing boom, and every home needs an osmic oven) in exchange for rifles, which are then sold to the rebels back on Awwad for more brof fruit. These routes are subject to sudden change – if the housing boom on Cummerbund collapses, some trade ship will be left with a hold full of osmic ovens and no market.

Some worlds are trade centers. These are convenient for merchants, as goods and buyers are present in one location. However, trade centers usually charge fees (and high docking charges), and attract government inspectors and pirates. Without a competent Patrol, trade centers cannot survive long.

Startown

Almost every world with significant interstellar trade has a startown – or several of them. It's most likely to grow up around and in the starport or shuttle landing site.

Startown is the place where aliens don't get a second look . . . where almost anything can be bought and sold . . . where you can need both Streetwise and Savoir-Faire within five minutes.

Typically, the Control Rating of a startown area is at least one level less than that of the world it's on.

News Services

Space is big enough to hold a lot of news, and dozens of interstellar news services compete to get that news, explain it in an interesting fashion, and shoot it to the waiting tri-V watchers. Services will have large offices on major planets, one- or two-man operations on others, and stringer reporters and roving news teams on many more. Newshounds are among the first on the scene of any major event – the uncovering of Precursor ruins, a new stellar phenomenon, or the outbreak of interstellar war.

Adventuring possibilities: PCs can be a reporting team. A news service can also provide a meddlesome "third force" interfering in any adventure. For example: PC Patrolmen are about to assault a pirate base when a Starnews ship appears. Perhaps it will accidentally tip off the pirates about the Patrol's plan; perhaps it will be taken hostage by the pirates; perhaps the Starnews crew has information that will make the difference between success and failure, if the Patrol will only listen!

The Organization

The shadowy syndicate known as "the Organization" is the largest criminal empire ever to exist. Its influence stretches through nearly all interstellar nations. The Patrol is only beginning to realize that a single organization is behind centuries of crime. The "Big O" dominates interstellar drug trafficking, gunrunning, prostitution, the black market, and murder for hire.

On many worlds, criminal activities require the approval of the Organization – with a piece of the action going to the syndicate. And on *any* world with a population of more than a few hundred, there's an Organization contact. Organization VIPs live like royalty, often on syndicate-controlled worlds where crime bosses are feudal lords. The Organization also sponsors sanctuary worlds (see p. 170).

Should the PCs want to find an Organization contact on a new world, the best place is a startown or similar port area. Roll against Streetwise, *minus* the Control Rating of the local government (see p. 172). Each attempt takes two days of bar-hopping and hint-dropping. As a rule, about the time the searcher gives up, he'll be tapped on the shoulder and escorted to Mr. Big's office. A critical failure will lead to unwelcome interest by either the Organization or the local authorities.

Adventuring possibilities: The PCs may be surprised to discover that the crime they just foiled was part of a Big O operation . . . and now the Organization is on their trail. Or the PCs themselves could be interstellar criminals.

Psionic Studies Institute

On the surface, PSI is a research foundation dedicated to psionics. In reality, it is a secret psionic society that offers aid and training to psis. The Institute has branches on major worlds, particularly those with large universities.

Adventuring possibilities: The Institute might be either "good" or "bad." An evil Institute might take advantage of a PC with developing talents; a good Institute can help a psionic PC against persecution. Or PSI might be a red herring, staffed by crackpots – especially if psionics don't work in this campaign. And the GM doesn't *have* to tell the players whether psi powers are real or not!

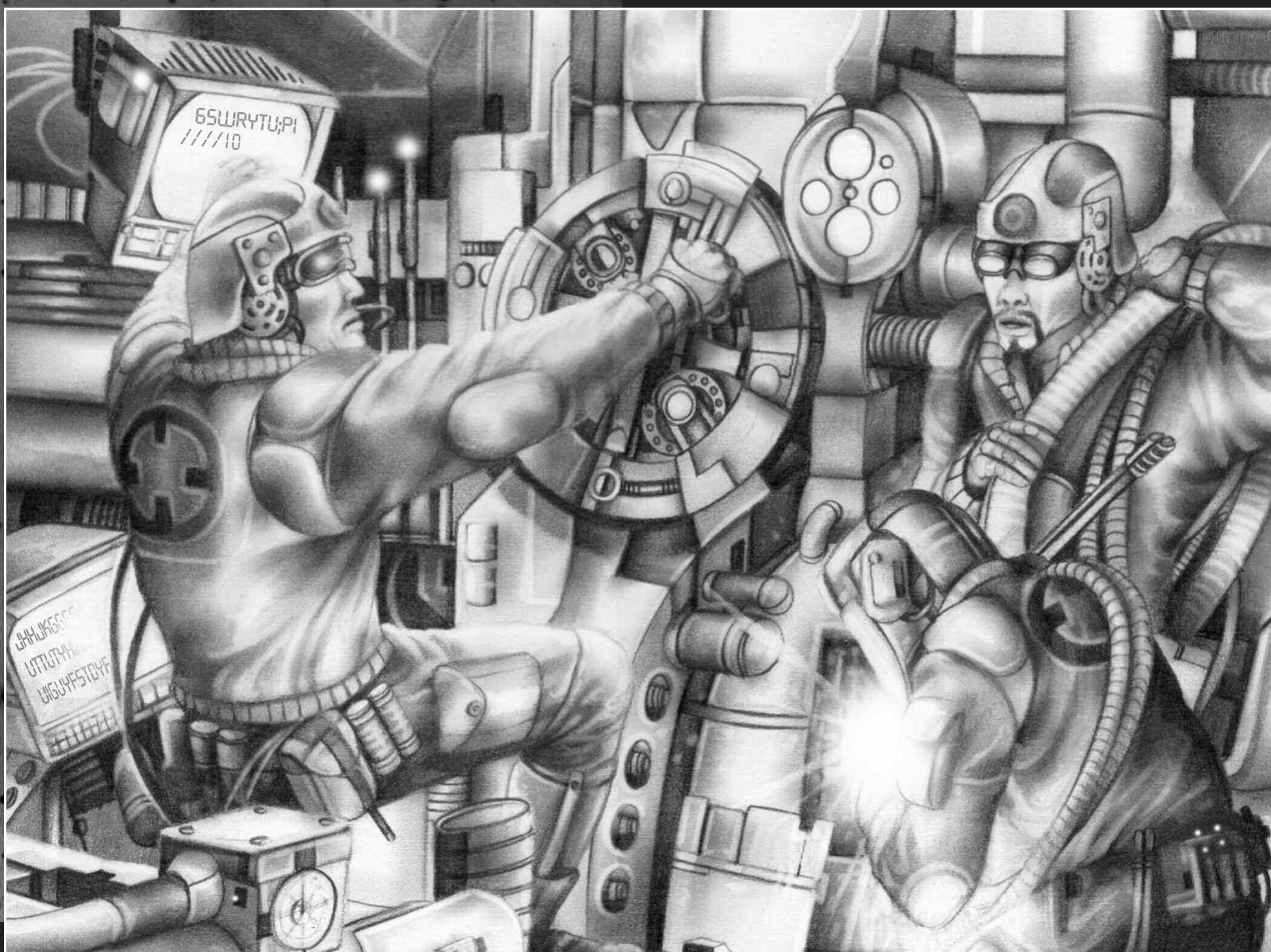
Universities and Scientific Foundations

Scholarly organizations can be huge and influential; they can dominate whole planets. Such groups can contain brilliant (and very peculiar) people. The political interplay within a university (over promotion, favorite theories, grant money, or just personalities) can be fierce, and rivalry between institutions can be bitter. Outsiders, expecting peaceful cloisters and ivory towers, are often numbed by the size of scholastic budgets and the fierceness of scholastic politics!

Adventuring possibilities: The PCs can be hired as part of a scholarly expedition; depending on skills, they may be guards, crew, or researchers. Unusual planetary conditions, strange and dangerous life forms, and Precursor artifacts are all obvious targets of scientific curiosity. And no pirate can match the disregard for danger shown by a dedicated researcher!

CHAPTER 2

CHOOSING TECHNOLOGY



As you set the social background of your universe, you must also choose the technological background. The GM sets the general tech level of the campaign (see sidebar, p. 26) and also makes some important decisions about which stardrives, weapons, communications technologies, and so on are available in *his* universe. These will affect the shipbuilding rules (Chapter 8) for that campaign; suggested statistics for hulls, stardrives, etc., are given in that section.

Superscience

Superscience technologies are those which violate physical laws – conservation of energy, relativity, etc. – as we currently understand them. By including superscience, the GM is saying that a new scientific revolution has occurred, changing our fundamental understanding of the universe. And if what we thought we knew about one thing is wrong, *all* of physics may have to be totally rebuilt! For instance, the same breakthrough that led to gravity generators might also lead to technologies like contragravity, FTL drives, and force fields.

By definition, no firm tech level can be set for superscience – we might discover workable FTL travel tomorrow, a thousand years from now, or never. For playability, though, a TL has been assigned to each superscience invention. Equipment TLs are always debatable, but superscience TLs are *arbitrary:* the GM should feel free to alter them in his campaign. Devices that rely on superscience have been noted as such in the text; if the GM wants a "harder-science" campaign, he should omit some or all of these devices.

Tech Levels

Star travelers may encounter worlds at any tech level, from Stone Age to miraculous. Here is a sample TL chart that incorporates both hard-SF and space-opera technologies:

0. Stone Age: fire, lever, language.
1. Bronze Age: wheel, writing, agriculture.
2. Iron Age: keystone arch.
3. Medieval: steel weapons, mathematics with zero.
4. Renaissance/Colonial: gunpowder, printing.
5. Industrial Revolution: mass production, steam power, telegraph.
6. Atomic: cars, airplanes, radio, rockets.
7. Nuclear: fission power, computer, laser, orbital travel.
8. Cybernetic: wearable computers, bionics, cloning, electromagnetic and beam weapons, power cells, lunar and space colonies, mobile robots, fission rockets, ion drives, nuclear pulse drives, and light sails.
9. Interplanetary: fusion rockets and reactors, star probes, artificial intelligence, variant humans, braintaping, automeds, suspended animation, blasters, crude terraforming, colonies on other planets, and possibly forced-growth clones, reactionless drives, and early FTL drives.
10. Interstellar: antimatter pion drives, sentient androids, X-ray lasers, and possibly artificial gravity and mature FTL drives.
11. Force: antimatter reactors, and possibly force screens, tractor beams, fast reactionless drives, and force swords.
12. Gravitic: pocket AI, antiparticle weapons, and possibly contragravity and flying cities.
13. Worldbuilding: advanced nanotechnology (chrysalis machines, human metamorphosis, living metal), full terraforming of planets (including moving orbits) and possibly personal force screens and grav belts.
14. Dysonian: construction of worlds, Dyson spheres, total conversion power plants.
15. MT: matter transmission, cosmic power, synthetic black holes, and possibly disintegrators.

16+. As you wish . . .

Cultures may be described in more detail by indicating about where they are within their tech level – e.g., "early Atomic" describes Earth during WWI. The atomic theory had been developed, but atomic power was still far away.

Power

Power generation is fundamental to modern civilization. In order for standard of living to keep pace with population growth, power-generation technology must also improve. A quick way to "peg" a civilization's tech level is to look at its most efficient power-generation technology.

Spaceship Power Plants

Most practical interplanetary and interstellar drives either require a great deal of power (like ion and reactionless drives) or are modifications of power plants (like fusion rockets). This means that power-plant technology is vital to space travel. Any spaceship power plant has to be able to operate without air; this rules out fossil fuels. Otherwise, power-plant designers look for safety, fuel efficiency (ideally, the plant should be able to operate for years at a time), and a high power-to-mass ratio.

The GM should decide what kinds of power plants are available for ships in the campaign. Power plants might be available in huge ground installations one TL before they are suitable for shipboard use. Examples include:

Solar Panels (TL7+): Produce power photoelectrically from starlight. Most useful for ships or space stations that operate in the inner reaches of a star system. Solar panels require no fuel, but are bulky and vulnerable, limiting their usefulness for military vessels.

Fission Reactor (TL7-10): A nuclear reactor that produces power by splitting the atom. At TL8, the heat vaporizes a liquid, producing steam which spins a turbine to generate electricity; at TL9+, the heat of fission is converted directly into electricity using thermoelectric materials (a simple design, +2 to repair). Fission plants are fueled by refined radioactives (often uranium) and can operate for about two years between refuelings. "Spent" fuel is still radioactive, and usable in weapons production.

Fusion Reactor (TL9-11): Produces power by fusing hydrogen nuclei to produce helium. A damaged fusion plant quits cold – there is no radiation hazard. Shipboard fusion reactors don't need refueling; a built-in hydrogen tank provides fuel for 200 years (longer than the plant's designers expect the plant to last).

Antimatter Reactor (TL11-13): Produces power through the mutual annihilation of minute quantities of matter and antimatter. TL13+ "pocket antimatter" plants are quite small due to advanced shielding. A plant operates for 2.5 years (TL11) or 5 years (TL12-13) between refuelings.

Total Conversion Reactor (TL14): Produces power by direct conversion of *minuscule* quantities of matter to energy. *Any* matter can be used as fuel, and in trivial amounts. Operates indefinitely. A large (say, 100 gigawatt) total conversion power plant may represent a stabilized miniature back hole.

Cosmic Power: (TL16): A "superscience" power source that generates power without any fuel at all – perhaps it drains energy from "zero point" vacuum fluctuations or another dimension.

Energy Banks

How do adventurers power their communicators, scanners, and laser pistols? There are several options, but they boil down to a choice between hard-science and superscience approaches:

Power Cells. The default for ***GURPS*** because it is easy and simple: small, very potent *power cells* exist that can run an electronic gadget for a few months or power an energy weapon for a few dozen shots. In order to do this, the energy densities of power cells must be impossibly high, making them a superscience technology.

Advanced Batteries. These are improved versions of present-day batteries, or possibly superconducting storage banks. They are reasonably realistic . . . but the notion of slapping a clip-sized energy cell into your blaster pistol goes out the window. At minimum, you'll need a bulky backpack-sized power source.

Rules for using both power cells and advanced batteries appear on p. 68.

Space Drives

One of the fundamental decisions that the GM has to make when designing a space campaign is the type of space-drive technology available. Obviously, if no FTL drive is available, then adventures will usually be limited to a single system; if a drive exists that can cross parsecs in seconds, then galaxy-spanning adventure awaits. The capabilities and limitations of any space drive will determine the extent and activities of a spacegoing culture. For example, if a drive depends on natural "jump points," the availability and location of these points will shape political geography and military strategy.

Cost is also an issue. If star travel is economical, one can imagine lots of merchant starships owned by small companies or private individuals hauling relatively low-value goods like grain or consumer electronics. Shipping surplus population to colonies becomes attractive; so does interstellar war. But if it costs millions of dollars to ship a few pounds from Earth to Alpha Centauri, starships would be rare, astronauts an elite corps, and only unique goods might be worth the price of physical transport. Instead of Earth's poor and huddled masses yearning to be free, a colony ship may carry self-replicating robot factories, artificial womb-tanks, and frozen fertilized eggs.

Space-drive technology falls into two main categories: *maneuver drives,* capable of slower-than-light speeds and usually used for interplanetary journeys, and *stardrives,* capable of faster-than-light interstellar travel.

Maneuver Drives

Maneuver drives range from realistic propulsion systems like ion and fusion rockets to superscience drives which appear to break physical laws but which are still limited by the speed of light.

The realistic maneuver drives we could theoretically build include solar sails, ion rockets, antimatter rockets, and pulsed nuclear propulsion. These are sufficient to support a "populated" solar system with far-flung planetary or space colonies at the Lagrange points, on the inner planets, and in the asteroid belt. Interplanetary journeys would take a few months. This sounds like a long time, but it is equivalent to ocean travel in the Age of Sail – an era where explorers, traders, colonists, and pirates all flourished.

Unless there is some breakthrough in fundamental physics, Man's first attempts at interstellar travel will probably be in slower-than-light ("STL" or "sublight") vessels using more advanced forms of these drives. Possible technology for such ships exists now (TL7). We *might* be able to send a star probe (or even a colony) out now, if a government, corporation, or consortium could afford the enormous cost in monetary terms and labor – see the sidebar.

A very fuel-efficient STL drive capable of approaching light speed *could* be used to colonize the galaxy . . . slowly. Relativistic time dilation (see p. 37) would mean that crewmen would live long enough to see many planets, even though their trips would take years from the point of view of groundside observers. F.M. Busby's *The Long View* is a good depiction of such a society. Even if FTL travel exists, STL drives may be necessary as auxiliary maneuver drives for starships. Some starships don't require a separate maneuver drive (but may have one as a backup). Others (hyperdrives, for instance) will. Maneuver drives include:

Reaction Drive

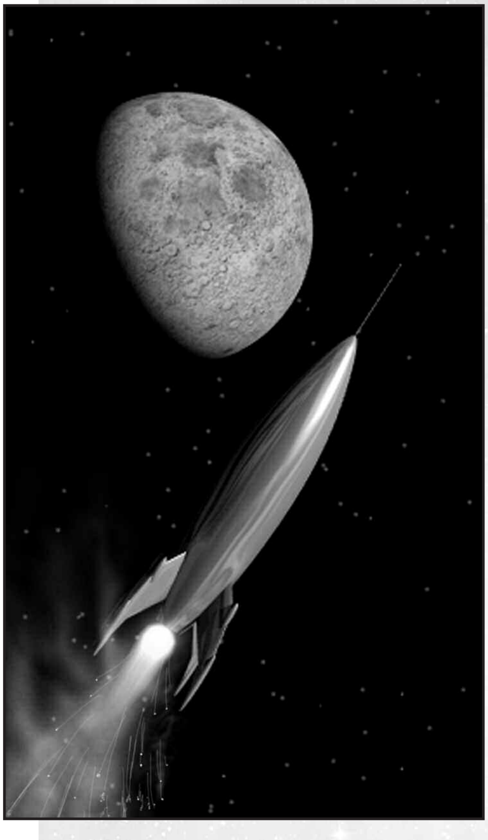
This is a general term for any drive that involves throwing something out the back of the ship to make it go forward. The limiting factor on reaction drives is *reaction mass* – the material ejected as exhaust. A drive that uses a lot of reaction mass has limited speed, since carrying the reaction mass itself slows down the ship. But a ship which uses little mass, or which can pick up more while traveling, could in time accelerate to speeds approaching light speed. Examples include:

Technology Paths

GMs should not let the tech level progression on p. 26 keep them from setting the exact technologies they want. The higher a culture's TL, the more likely it is to develop unevenly. A culture whose space travel is slower than light but which has full control of gravity may not seem to fit onto this progression – but it's *your* campaign. Invention is a dynamic process that depends as much on serendipity as it does on orderly research and development.

What this means is that the TLs here and in other ***GURPS*** technology books should be treated as guidelines, nothing more. The GM should feel free to adjust the TLs at which various technologies appear. After all, we have no crystal ball with which to see the future! Moreover, different cultures (human or alien) may develop certain technologies more rapidly than others.

GURPS Ultra-Tech 2 discusses the concept of "technology paths" in which certain categories of inventions appear in an order other than that suggested by the default TLs. For example, in a "cyberpunk" society, advances in computing, cybernetics, bionics, biotechnology, medicine, and neuroscience are two to four TLs more advanced. In contrast, a "retro-tech" setting that mimics 1940s and 50s sci-fi might have computers and cybernetics frozen at TL7 or TL8, but other technologies at anywhere from TL9 to TL15. Any combination is possible!



Civilization Levels

Russian astronomer Nikolai Karashev grouped advanced extraterrestrial civilizations into three levels, based on their energy usage (which could be detected via radio telescopes):

Type I civilizations use just about all the energy their planet can safely produce and have usually started to expand off-world. In ***GURPS*** terms, a planet with a population of several billion at TL10+ would qualify. A Type I civilization might reach Type II status if it continued to grow steadily for a thousand years while confined to a single solar system, but a Type I society that develops FTL travel may spread out too fast to reach Type II status – its energy may go into colonization rather than planetary and stellar engineering.

Type II civilizations use all the energy they can get from their star – about 10 billion times the amount used by Type I civilizations. To gather it, they may create a loose shell of solar collectors around their sun (a Dyson sphere). Finding a Type II civilization by telescope means looking for stellar-level infrared radiation sources that do not emit visible light. A mature Type II civilization may even be able to manipulate its star, altering or extending its life cycle, even moving it. Even if no "superscience" technologies exist for interstellar travel, a Type II civilization has enough energy capacity and stability to manage STL space colonization on a grand scale. A Type II civilization would probably be TL13-14.

Type III civilizations are galactic in scope, using the energy of thousands or millions of stars. A Type III civilization might tap energy from pulsars, black holes, or the galactic core. A Type III civilization would be TL15-16.

Technology Checklist

Use this list to make sure you've made all the necessary decisions about the technology for your campaign:

- Overall tech level.
- Sublight drive (maneuver drive) type(s).
- Sublight fuel consumption.
- Stardrive (FTL drive) type (s).
- FTL travel speed (and frequency of good worlds).
- FTL travel range and fuel consumption.
- Interesting side effects, if any, of FTL.
- Ease of FTL astrogation.
- Power plant type (s).
- FTL communications speed, range, and availability.
- Sensors (FTL and sublight).
- Weaponry (ship and personal).
- Medical technology.

Chemical Rockets. Fine for blasting off from a planetary surface or for maneuvering in orbit, these engines use too much reaction mass to be efficient for interplanetary travel. By TL8, they will most likely have been replaced by other kinds of space drive.

Ion Drive. Converts reaction mass (often argon or xenon, possibly cadmium) into a stream of ions (charged atoms or molecules) that form a high-speed exhaust. An ion-drive ship has low acceleration but good fuel efficiency – good enough for practical interplanetary (but not interstellar) voyages.

Fission Rocket. This kind of drive uses a built-in nuclear fission reactor to heat reaction mass, which is then expelled as a high-energy exhaust. Fission rockets are capable of higher accelerations but less fuel economy than ion drives, making them more suitable for TL8 warships or couriers.

Nuclear Pulse Drive. Detonates a nuclear explosion to propel the ship! Some versions ("Orion drive") use big external explosions and require a huge shock-absorbing pusher plate behind the vessel. More sophisticated designs use fusion "micro-explosions" inside the ship's drive chamber: small fusion fuel pellets are compressed by a ring of powerful lasers or ion beams until they detonate in a tiny nuclear explosion (about a ton of TNT). The plasma is then expelled to produce thrust. A variant of this design that is currently gaining favor detonates fissionable pellets using antiproton beams. Very little antimatter is needed for this – so little that it could all be provided by current technology. Nuclear pulse drives currently look like the best bet for high-thrust interplanetary (and maybe interstellar) travel; the main obstacles facing them are political rather than technological.

Fusion Drive. This drive uses a *controlled* fusion reaction to heat reaction mass to a plasma state and expel it for thrust. Its feasibility depends on being able to master fusion reactor technology (perhaps by TL9). If that is achieved, these drives offer nearly as good performance as nuclear pulse drives, but without the expense of specialized fuel pellets (or the risk of carrying hundreds of A-bombs).

Antimatter Thermal Rocket. A "fast" antimatter drive. When matter and antimatter mix, the result is mutual annihilation and a huge energy release. The antimatter thermal drive uses a small matter/antimatter reaction to heat up a much larger amount of conventional reaction mass, creating a plasma that is used for thrust. It allows for more efficient designs than most fusion drives, but relies on developing ways to produce and contain decent quantities of antimatter.

Antimatter Pion Drive. A "pure" antimatter drive, often seen as the ultimate form of realistic reaction engine. This mixes matter and antimatter in equal quantities, producing an exhaust composed of high-speed subatomic particles. The drive is *very* efficient, making it a good candidate for STL star travel, but it is not east to direct the exhaust or to store and contain that much antimatter!

Fusion and Antimatter "Torch" Drives. This kind of very high performance drive is typical of 1970s-era science fiction. It is a compromise in realism between reactionless drives and the somewhat harder-SF drives described above.

Total Conversion Drive. The ultimate in reaction engines! Converts fuel directly into energy (perhaps photons or gravity waves). Marginally "harder" science than a reactionless drive, since it does not violate the conservation of energy or momentum. It also requires the heroes to refuel once in a while.

Reactionless Drive

This is a general term for a superscience drive that seemingly violates Newton's laws . . . requiring a fundamental reworking of physics. Reactionless drives make the ship go forward *without* pushing anything else backward. A reactionless drive requires power but not reaction mass (though of course the power plant must be fueled). It makes ships much more efficient; such a drive would be a hugely valuable secret when first developed. A reactionless drive could approach light speed. Four categories of reactionless thrusters are provided, graded by relative performance:

Slow Thrusters. These have a poor thrust-to-mass ratio. High-gee accelerations will not be possible, and most ships will have accelerations between 0.01 G and 0.05 G.

Medium Thrusters. About twice as efficient. Most ships will average about 0.1 to 1 G, with ships capable of 3-5 Gs if they devote a lot of space to expensive drives.

Fast Thrusters. A quantum leap in technology – maybe a new principle. Accelerations of 1-3 Gs are easily obtained, and ships that are mostly drive can achieve tens of Gs.

Grav Drive. The ultimate reactionless drive! This generates a bubble of space-time with its own arbitrary gravity. As the bubble's occupants don't feel acceleration, grav-drive ships can safely pull *hundreds* of Gs, although the speed of light is still an absolute limit. Grav drives are similar in function to warp drives (p. 31); they may be precursors to or spin-offs from warp drive or contragravity technology.

The standard ***GURPS*** TL progression has slow thrusters at TL9, medium thrusters at TL10, fast thrusters at TL11, and grav drives at TL12-13. Optionally, instead of grav drives, "mega thrusters" (a high-thrust but expensive improvement on fast thrusters) may appear at TL13+. The GM is free to vary this progression.

Stardrives (FTL Drives)

The basic problem facing any FTL drive is Einsteinian theory, which makes the speed of light an absolute that nothing can exceed. This has not discouraged people from trying to find a way around it: a bewildering variety of FTL drives exist in scientific speculation and science fiction. The same name is often used to describe different methods of travel, but most science-fiction FTL drives – regardless of the "theory" on which they operate – fall within one of the following categories. Usually, only one type of FTL drive exists, but that does not have to be the case. It may be that one type has made the other(s) obsolete, or each type might have unique advantages and disadvantages, or appear at different TLs.

Hyperdrive

The theory behind hyperdrive is that there is another "dimension" where physical laws or topology allow the speed of light to be exceeded. The starship somehow enters hyperspace (or "subspace" or whatever), travels at speeds which seem faster than light from within our normal universe, and reenters "normal" space at its destination. Ships in hyperspace are wholly isolated from each other and the normal universe; they can perceive nothing, and cannot be perceived, until they emerge. A "slow" hyperdrive takes weeks or months to travel between the stars. If a hyperdrive is fast enough or the trip short enough, the ship simply pops from *here* to *there* – like a jump drive (below) that requires no special jump points.

Entering hyperspace usually takes a lot of energy, and the ship's course must be set ahead of time. If something happens to the drive or power plant during the voyage, the ship could emerge *anywhere.* Hyperdrive ships need maneuver drives unless the hyperdrive is *very* finely controllable.

Often, a rest time of some sort is required between hyperskips. This is automatic if the ship requires energy banks which must be recharged. Other reasons for the rest time might be to calculate the next skip, to let the crew recover from the unpleasant side effects of hyperspace, or to let local hyperspace itself relax from the stress of being crossed.

Hyperdrive alters space warfare dramatically. Battle lines don't exist. Any ship can escape battle if it has time to engage hyperdrive (so the amount of time this requires is a vital decision for the GM). Battles are not fought in deep space but around vital planets, when attackers appear to meet a defending fleet.

Variant forms of hyperdrive include:

Hypersails. What if hyperspace is like an ocean, with energy currents (and reefs, and storms) on which a starship can ride? Such a starship might need *hypersails* (perhaps energy fields rather than physical sails) to take advantage of the ether's flow.

Tachyon Drive. Tachyons are imaginary particles that always travel faster than light. A tachyon drive converts the starship into a beam of tachyons which then hurtles across space. A ship that is converted into tachyons might require a receiving station to restore it to its original condition.

Bussard Ramjets

One of the biggest problems with interstellar flight using any of the reaction drives described on pp. 27-28 is that accelerating to a decent fraction of light speed requires an incredible amount of reaction mass – and slowing down again takes more. The Bussard ramjet gets around this by not carrying any fuel. Interstellar space is not empty: there are stray atoms of hydrogen and other elements floating about. The Bussard ramjet uses a huge magnetic field – a "ram scoop" – to suck in interstellar hydrogen, which is used as fuel for the ship's fusion reactor, heated, and expelled for thrust.

When the Bussard Ramjet was first proposed (in the 1960s), it seemed to be *the answer* to interstellar travel. Much science fiction was written in which Bussard ramjets combined with relativistic time dilation allowed humanity to explore and colonize the galaxy or beyond (see Poul Anderson's *Tau Zero* and many stories by Larry Niven).

Sadly, more recent research suggests insurmountable technical problems exist with the concept. For example, the interstellar medium seems not to be as dense as had been first believed (especially in the vicinity of our solar system), making ram scoop sizes impractically large, while the necessary proton-proton fusion reactions that a ramjet would need to use appear to be difficult to achieve.

There are some situations where a fusion ram scoop system may be useful, though. One is for a culture operating in a region of space where the interstellar medium *is* dense – for instance, in a nebula or near the galactic core. As long as the starship kept to such areas, a fusion ramjet may be a practical (if very high-tech) form of STL starflight. Another is to use a ram scoop to augment a conventional fusion drive, effectively gathering extra reaction mass for it.

Despite real-life the problems with this technology, we have included two Bussard ramjet designs in Chapter 8 for those who like the idea – including a "super" model that reflects early, optimistic concepts.

Light Sails

A light sail is another means of space travel that tries to sidestep fuel and reaction mass requirements. It consists of a huge solar sail hundreds of square miles in area, made of plastic or ultra-thin metal, attached to the spaceship by a network of lightweight cables. For interplanetary travel, a light sail is propelled by light pressure from the sun, which is sufficient to provide a very slow but steady acceleration.

Will the future see stately lightjammers sailing between planets? On its own, a light sail is only effective in the inner solar system – say, between Mercury and Mars. More than a few AU from a star with the luminosity of Sol, light pressure drops below useful levels. This seems to make the light sail useless for interstellar travel – unless it is provided with an artificial light source, such as a powerful laser beam.

A single, extremely powerful laser (or a battery of many smaller ones) could be used to impart a steady thrust to a light sail. If the laser beam could be left on for weeks, months, or years, a ship could accelerate to a good fraction of light speed. This would give limited maneuverability, but by electrically charging the sail, interactions with the galaxy's magnetic field could be used to let the ship slowly turn or decelerate.

A laser light sail seems almost perfect for interstellar travel: there is no fuel to worry about and the "engine" is left at home. There are some problems, though. The first is that the lasers would require *enormous* power. Even a tiny probe massing a few kilograms would need lasers (or, in some concepts, microwave beams) with outputs in the hundreds of gigawatts. A sizable manned ship would require lasers with lenses many miles across, powered by solar collectors thousands of miles wide that would have to generate more than a thousand times the amount of power used by everyone on Earth today! Ignoring the question of whether building lasers that large would be feasible, it may be that a society would find different uses for that much power generating capability – for example, it might be better used to manufacture antimatter for an antimatter-drive ship.

Second, the ship's fate is in the hands of its home base. An interstellar journey would take decades. Could the planners be sure that things would remain stable back home?

Finally, whoever controlled the lasers would have a terribly powerful weapon, which could itself be the cause of conflict!

Communication-possible. Although a hypership cannot make physical contact with things in the real universe, perhaps messages can be sent, received, or both. This might even make hyperdrive sensors possible.

Maneuver-possible. Hyperspace is not just something you pass through. It's a real place (perhaps even with its own natives), although usually a very strange one – sensors rarely work properly, for example. Ships might be able to hover in hyperspace without going anywhere, and may even fight battles there!

Jump Drive

Jump drive assumes that space contains "jump points" connected by extra-dimensional "wormholes." A jump drive allows a starship to take advantage of these jump points, opening up and "tunneling" through the wormhole from one point to another without crossing the intervening space. Jump points must be found and mapped before they can be used. It is possible that each jump point leads to all the other points, to a few other points, or to just one other point.

Jump drives are usually instantaneous or nearly instantaneous, but getting to a jump point may be time-consuming, and requires a maneuver drive. And if there is no jump point near the place you want to visit . . . you can't get there. A bad jump or malfunctioning drive might send a ship to the wrong point, where it may be lost forever.

Jump ship battles will occur at or near jump points, because those are the only places ships can go and because jump points are such strategic locations. A rich planet near a jump point is a prize indeed! Variations on this theme include:

Natural Wormholes. There may be natural jump points in space, produced by unusual conditions (for example, near rotating black holes) or perhaps just left over from the Big Bang. It may be that they are very common but hard to detect without the right instruments. Wormholes may be large or stable enough that *any* ship can simply dive through them, even without a jump drive. On the other hand, current theory suggests a wormhole might collapse catastrophically as soon as something entered it – in which case a superscience jump drive may be needed to traverse it safely. And if wormholes are very small, a jump drive may be needed to widen them.

Stargates. A *stargate* is an artificial jump point, a space station (often ring-shaped) that serves as a wormhole gate. A ship which travels through the gate's focus reappears instantly at another stargate. The ship needs no FTL drive of its own. If this is the only FTL travel known, then an STL ship must travel to each new system to build a gate. But once it's there, any number of ships can go through. Stargates might all be compatible, or those of different owners might work differently.

Some serious suggestions have been advanced for manufacturing wormhole stargates that fall into the realm of fairly hard SF. One proposal suggests each end would require a ring of superdense neutronium massing about as much as the solar system and spun at nearly the speed of light. These requirements would seem to be beyond all but the most advanced of civilizations. Of course, stargates may be easier to build in a particular campaign, or use different principles than simply connecting wormhole jump points. Imagine a portal that sends ships to hyperspace, or which is packed with psionic adepts who mentally teleport ships. Such gates might not need a receiving gate; they could send a ship anywhere.

Jumpline Drive. Jump points are always connected in pairs. If a ship triggers its drive at one end of a jumpline, it moves to the other end. Lines are usually two-way. Many (but not all) stars have an associated jumpline. Stars without jumplines are inaccessible; jumplines without stars at both ends are of little use. Stars with several jumplines are valuable crossroads.

Psi Jump Drive. The "jump" is triggered psionically; only those with an appropriate psionic advantage (as determined by the GM) can activate the drive. Obviously, if this drive is used, the campaign includes psi powers.

Implosion. Space is stressed by multiple huge explosions (produced by colliding black holes?), creating a temporary wormhole that opens between two points, sucking the ship through. With practice, it is possible to aim such a jump, but ships will still need maneuver drives to make planetfall even if the aim is good. And bad aim could destroy a ship, or send it anywhere . . . Or any*when.*

Slow Jump. It takes hours, days, or weeks (maybe fixed, maybe depending on the distance) to travel "in jump" between points. During this time, ships are incommunicado, just as in hyperspace (p. 29).

Warp Drive

A warp-drive starship surrounds itself with an energy field – perhaps a ring of negative energy or a bubble of hyperspace – which lets it travel at FTL speeds. However, it can see and interact with things in normal space. If the drive malfunctions, the ship loses its FTL speed, keeping the STL velocity it had before warp drive was activated. It can fix the warp engines, or try to limp to a planet at STL speeds.

A warp ship may freely maneuver while traveling FTL, and may make the random turns needed in combat. Warp ships are likely to battle in deep space, when defending fleets intercept attackers. Possible variations include:

Inertialess Drive. First envisioned by E.E. Smith, an energy field allows FTL speeds by negating the inertial mass of the ship. The ship's maximum speed is now limited only by the strength of its engines and the friction of interstellar gas. No maneuver drives are needed – just good fractional controls on the engines. The ship can instantly stop or change its direction of motion – it can "turn on a dime" (as many UFOs reportedly can) and is immune to collision damage (it merely stops at the collision point, unhurt).

Blink-warp. Hyperspace exists but ships can only enter it very briefly. Every second, a starship makes hundreds of *short* skips; from a distance, it would simply seem to be moving very quickly. The GM must decide whether or not a blink-warp ship can use weapons while warping.

Acceleration Required. The ship must approach light speed on maneuver drives before it can go to warp.

Gravity-slowed. The drive is one of the above types, but only works at full function in deep space. In a solar system, its maximum speed drops below that of light. It either ceases to work or becomes a sublight warp drive.

Experimental FTL Drives

The first faster-than-light ships will probably be expensive, massive, fuel-hungry, risky, and totally unpredictable. In Chapter 8, it is assumed that most stardrives are TL10. An experimental drive may be available a TL sooner. For a first-steps-to-the-stars campaign, take any of the drives described above and add dangerous quirks!

Frequency of Habitable Worlds

Campaign scope is affected by the likelihood of finding earth-like planets. GMs may select the following degrees of probability (which affect the Life Roll described under *The Biosphere,* p. 160):

Common: Almost every suitable star has a habitable world; +3 or more to Life Rolls.

Likely: Most suitable stars have habitable worlds; +1 or +2 to Life Rolls. (This is a likely situation.)

Scattered: One must look for habitable worlds rather than just stumble across them; no modifier to Life Rolls. (This may also be realistic.)

Scarce: There are very few habitable worlds; -1 or -2 to Life Rolls.

Rare: There are almost no habitable worlds; -3 or worse to Life Rolls.

If useful worlds are common, then colonists will spread in all directions at once, often leapfrogging large areas in an effort to reach new territory. Worlds will often be overlooked, since there is no incentive to search every star system. Or a world may be inhabited and yet be so unimportant that the universe will forget about it. Worlds may even be owned by individuals!

But if good worlds are rare, then space will be explored one steppingstone at a time. Each colony will become a center of exploration for new worlds. "Unknown inhabited worlds" will be unlikely. Planets will never be private property, and races who use the same sort of planet may become bitter enemies. The finder of a useful world will become rich and famous.

FTL Travel Speed

The speed of FTL travel (see p. 32) affects the *apparent* frequency of usable worlds. If stardrives are fast enough, then all stars in an area can be checked in a short time. If you have to check a hundred stars to find a good planet . . . take a month and check a hundred stars.

But if travel is very slow, then worlds will seem far apart, even if earth-like planets are common, and voyages of exploration will be few and lengthy.

Stardrive Options

Once the drive type has been chosen, the GM may customize his system. These decisions are important; they provide much of the campaign's flavor.

Drive Reliability

Decide how much attention the engines need. They may be so reliable that a yacht owner need only order a checkup every few years – or so finicky that a specialist with a Scots accent has to roll against Engineering (Stardrive) at -4 after every use just to get them working again.

Drive Speed

Decide how fast the drive can go. This decision depends on how large an area the campaign covers and how fast you want the ships to get there.

Hyperdrives and warp drives can be given a speed in parsecs per day (or hour, or second . . .). For hyperdrives, there may also be a limit to the time or distance a ship can stay in hyperspace without emerging into normal space. Each separate trip is called a "skip," and the ship must wait a GM-set time between skips. For instance, maximum skip might be one parsec. If this is almost instantaneous, but the ship requires a day to recharge its energy banks, then effective speed is one parsec per day.

For jump drives, "speed" depends entirely on how far away the chosen jump point is through normal space. The important factors are endurance (which affects how *often* a ship can jump, with respect to refueling or maintenance) and normal-space time from one jump exit to the next entrance.

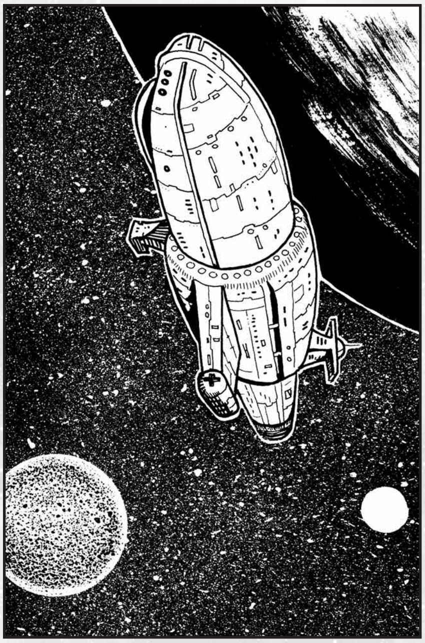
The following chart provides sample figures for distance, time and speed.

Speed	Alpha Centauri (1.3 pc)	Canopus (30 pc)	Across our galactic arm (2,000 pc)	To Sagittarian Arm (3,500 pc)	Galactic core (10,000 pc)
0.02 pc/dy	65 days	50 mon	270 yrs	480 yrs	14 cty
0.2 pc/dy	6.5 days	5 mon	27 yrs	48 yrs	1.4 cty
0.5 pc/dy	2.6 days	2 mon	11 yrs	19 yrs	55 yrs
1.5 pc/dy	21 hrs	3 wks	4 yrs	6 yrs	18 yrs
2.5 pc/dy	12 hrs	2 wks	2 yrs	4 yrs	11 yrs
7 pc/dy	4.5 hrs	4 days	9 mon	1.4 yrs	4 yrs
10 pc/dy	3.1 hrs	3 days	7 mon	1 yr	3 yrs
1 pc/hr	78 min	30 hrs	2.7 mon	4.8 mon	1 yr
4 pc/hr	19 min	8 hrs	3 wks	1 mon	3.4 mon
12 pc/hr	6.5 min	3 hrs	1 wk	1.5 wks	1 mon
20 pc/hr	4 min	1.5 hrs	4 days	1 wk	3 wks
1 pc/min	1.3 min	30 min	1.4 days	2.4 days	7 days
0.5 pc/sec	2.6 sec	1 min	1 hr	1.75 hrs	5.5 hrs

For instance, if your campaign centers around a galactic arm and you want the journey across it to take a year, then your starships should travel about 5 parsecs per day. At this speed, it will take two years to reach the Sagittarian Arm, and six years to reach the center of our Milky Way galaxy. Very long trips take longer, of course. Other galaxies in our group are some 700 kiloparsecs apart; the next group of 20-50 galaxies is about 1,500 kiloparsecs away.

Comparative Speed

With warp drives, ships will probably have different speeds, depending on mass and thrust. This can also be true with hyperdrives. Alternatively, all travel in hyperspace is automatically (for instance) at 0.2 parsecs/day – a drive is either powerful enough to boost a given mass into hyperspace or it isn't, with no middle ground.



Detecting Worlds

If FTL travel is possible, then the procedure for investigating a new system will nearly always be the same: jump in, look around, take notes, and get the word home. However, things may differ at lower TLs, or in settings without FTL travel.

Beginning at late TL7, *large* planets (like gas giants) can be detected indirectly from many parsecs away, provided they are both reasonably close to their star and quite massive. At TL8, astronomical techniques improve to allow detection of Earth-sized planets from several parsecs distant.

Long-range observations can reveal roughly how massive a planet is – whether it is a tiny rockball, an Earth-sized planet, or a huge gas giant. They can also show how far the planet is from its star and what its orbit is like, which gives a rough idea of whether it is too hot, too cold, or just right for life as we know it. Use of radio telescopes can determine whether it is pumping out electromagnetic signals. At TL8+, interferometry can even reveal details about atmospheric composition from several parsecs away (NASA's Terrestrial Planet Finder project claims a range of 15 pc).

At interstellar distances – unless *really good* FTL sensors are available – everything else is a mystery. To find out more, someone may want to visit the system and take a look, or at least send an unmanned probe. This may be a government job (Survey Service), or private enterprise. Or colonists may do their own world-hunting.

No matter how good your sensors and robots are, though, someone will have to "prove" a planet habitable by landing on it. This is always a chance for adventure.

Chapter 8 shows the relationship between mass and speed for each drive. With jump drives, point-to-point speed is likely to be the same for any ship, though one ship can still have better *maneuver* drives than another.

Maximum Range

How far can a ship go at a time? Ships which have to refuel often, or which require lengthy calculations before "going FTL," may have limits on the distance traveled before another jump or calculation is necessary. Possibilities:

Unlimited: The ship can go any distance, perhaps limited only by acquiring enough energy or suitable engines.

Great distances: A ship can travel a large number of parsecs (chosen by the GM) at a time. In fact, ships might not be capable of going small distances.

Small distances: A ship's maximum travel range is small relative to the distance between stars. For example, if the longest convenient trip is 2 parsecs without stopping, interstellar borders will be fairly easy to guard.

The distance traveled may also depend on other factors. For instance, very large ships might be able to jump farther than small ones (or vice versa) for reasons inherent in the drive system.

Effects on the Campaign: If ships can travel undetected through hyperspace for long distances, then interstellar nations cannot defend their borders – a hostile ship might warp in at any time. If ships can only travel short distances in FTL, or jump points are required and are easy to defend, then interstellar borders and border patrols become feasible. If the stops between voyage segments are long while energy banks are recharged, refueling is needed, or lengthy calculations are made, then borders become likely.

Fuel Consumption

Starships vary wildly in the amount of fuel they need. Sublight reaction drives need reaction mass (see pp. 118-119). Warp drives and hyperdrives must run continuously while the ship is in FTL mode. Jump drives operate for moments only, when jumping, but power requirements at that moment might be enormous. Drives consume either fuel or power from a separate power plant. And power plants don't create their power from nothing – they have fuel requirements of their own, although in some cases these are subsumed into the basic design ("a fusion plant has internal fuel for 200 years").

Some fuels are plentiful. A ship which uses hydrogen as reaction mass might dive through the outer atmosphere of a gas giant to "scoop" what it needs. A total-conversion power plant could burn *any* matter as fuel. Most restricted are ships which require processed or manufactured fuels, such as radioactives or antimatter; such ships must refuel at fueling stations or carry their own fuel-processing equipment.

A further possibility is that FTL drives require some crystal, rare earth, or other scarce material which wears out or is used up. Or they might require something that can be manufactured only at great difficulty or expense – like antimatter.

Effects on the Campaign: Availability of fuel will affect any strategic plans, military or otherwise. Ships must carry fuel or the means to get it. Starships with bad fuel economy must refuel frequently. Refueling points become strategically important, interstellar borders naturally expand around such points, and exploration depends on the location of new fuel sources. If hydrogen is the fuel, gas giants and cool stars become important specks of galactic real estate; for other fuels, other star or world types will dominate. A campaign where fuel is limited or expensive will be similar to the oil embargo situation of the 1970s, while limited fuel and bad endurance resembles the WWI strategic naval situation. When fuel is expensive, merchants will prefer to deal in low-weight, high-profit goods.

If fuel is free or ships are very fuel-efficient, travel becomes cheap. Conquerors might exile entire planetary populations, while merchants can afford to trade in bulky goods such as rice. If travel is both cheap and fast, tourism becomes an industry and the stars become melting pots of peoples and customs.

Campaign Scope and FTL Travel

The *scope* of a space campaign is the distance the characters can traverse regularly. This is tied closely to the type of space travel available to them. Possibilities include:

A single star system. Either there is no FTL travel or the adventurers don't have access to it.

A dozen star systems. The fastest travel is 0.1 parsec per day. (Unless habitable worlds are rare – see p. 31.)

All systems within a selected range of a homeworld. There are 150 stars within 10 parsecs of Sol, and 500 stars within 15 parsecs. This implies travel speeds of 0.2 to 2 pc per day.

A galactic arm, or part of one. A playable speed might be 2-30 pc per day.

A galaxy, or several galaxies. Instantaneous travel (stargates, for instance), or speeds of hundreds of pc per day.

If the campaign is based on a specific story or series, the scope is already defined. But even if the local civilization spans a galactic arm, the PCs may be concerned only with a few sectors on the frontier. Limiting the scope is easier for the beginning GM; the campaign can always be expanded later.

Speed vs. Acceleration

These rules give warp and hyperdrive FTL starships a *cruising speed* rather than an acceleration rating. The assumption, made both for playability and to conform with most fiction, is that there is *something* – an FTL friction factor, to give it a name – that requires hyperdrive or warp ships to constantly use energy to maintain speed. If this is true – and it is *much* easier to play if it is – then starships simply have a cruising speed (which can be "pushed" for a maximum speed) just as 20th-century automobiles do.

Map Obstacles

Where can a starship go when traveling in FTL mode? Are there limits on where it can begin its FTL voyage? Jump drives are limited to jump points. Many warp drives and hyperdrives also have limits. Options:

Gravity-limited. FTL travel might be impossible or dangerous within gravity fields of a certain minimum value (selected by the GM) – anything from distant orbit around a planet to dozens of AUs from any star. Planets are most defensible if starships cannot leave FTL travel within strong gravity wells.

Gravity-required. FTL jumps might be impossible except from *within* a strong gravity well – such as that within a few AU of a star or black hole.

Gas Density. Ships which travel in normal space – that is, warp ships – will be limited in speed by the density of gas present, traveling faster in low-density regions.

Nebulas and other gas clouds may be dark (like the Coalsack), lit by nearby stars (like the Pleiades, for instance), lit from within (like a nova shell), or glowing by their own ionized light (like the Hourglass Nebula). These regions may be up to 30 parsecs across. Dark dust lanes are sometimes found on a galactic scale. An uncharted nebula will (at best) slow a journey, and (at worst) be a ship-wrecking hazard. Ships may make long detours rather than pass through large gas clouds.

However, space between galaxies or clusters of galaxies will be very open, and travel will be faster. Rifts between a galaxy's spiral arms could become arteries of travel like terrestrial rivers. Journeys across a galaxy will arch above or below the galactic plane. Increasing speeds for low-density regions may also make otherwise long-distance travel possible.

FTL Astrogation

Once the GM decides how his drive system performs, the next question is: How easy is it to steer a course among the stars? This is where Astrogation skill comes into play. The GM decides what level of skill is required to set a course, and (very important) *how long it takes.* Possibilities include:

Straight-line. Point your ship toward your goal, engage engines, and you're gone. If you know where you are and where you're going, Astronomy or appropriate Area Knowledge skill can substitute for Astrogation.

Modified straight-line. The course must take into account a few major obstacles – stars, hyperspace currents, gas clouds – so safety requires some minimal course computation. However, with Astrogation skill, anyone can plot a course to any coordinate, perhaps stopping every so often to take a bearing.

Complex three-dimensional. The course must take into account the gravitational fields of intervening suns, hyperspace drift, or some other property that is relatively constant over time. A reliable course can only be computed if the astrogator has complete information about the region.

Four- (or more) dimensional. Astrogation simply cannot be learned by ordinary humans. The course must take into account time as well as space. A computed course is only good for the intended flight time – if there is a delay, the calculations must be redone. It may even be impossible to calculate a course in advance. An advanced computer could do these complex calculations very quickly, but hyperships might still have to wait an hour or more between skips to allow time for necessary *observations or measurements* beforehand.

Alternatively, courses may be plotted by mysterious "black boxes" supplied (or left behind) by alien civilizations – travelers may be able to set courses deliberately or they may have to push buttons until the ship "goes." Or the drive system could be experimental and unpredictable: PCs have no way of knowing what a "course" is – the same controls may not give the same destination twice.

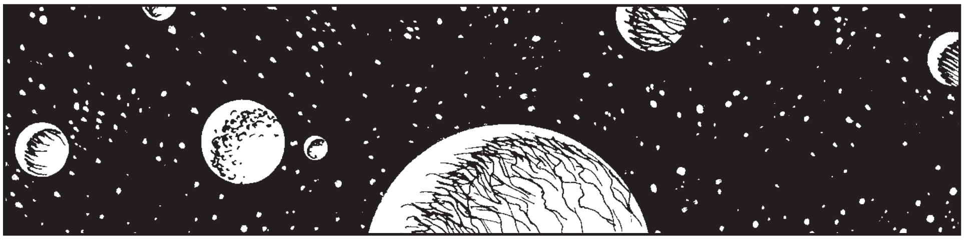
Elite astrogators. Perhaps astrogators must have unusual advantages (physical, mental, or psionic; natural or artificial) or use a particular substance (an addictive drug, for instance). Possible advantages required might be 3-D Spatial Sense (p. CI31), Intuitive Mathematician (p. CI26), or a particular psi power. Or it may be that the Astrogation skill is the secret of one organization. Breaking that monopoly will be dangerous but lucrative. Astrogators might be a powerful force – or valuable property.

Effects on the Campaign: When courses are simple, hotshot pilots can "guesstimate" and fly by the seat of their pants. Governments or merchant houses fight over the coordinates to valuable new worlds.

As astrogation becomes more complex, often-used courses can be kept on a computer, but each new one must be plotted from scratch. A proven course through uncharted space is valuable; coordinates may be useless without a working course. Voyages of exploration are made in short hops, not long leaps.

With very complex courses, ships must recompute before every jump. Lawbreakers may be caught by Patrol interceptors before they can break to light speed. Courses are no longer important, since they cannot be reused – what is vital now will be complete charts of space.

If navigation is unpredictable, only the desperate or the brave will chance a star voyage. Governments might recruit (or draft) criminals, political enemies, or the poor to serve as crew, possibly with brutal security measures.



Communications

Stellar nations are almost impossible to maintain over great distances without some sort of FTL communication, whether by "radio" or by courier ship. When the message lag between the capital and its frontiers is measured in months, the state is likely to break up, or at least abandon central government. If the campaign takes place in a large area relative to the speed of communication, there will be many stellar governments. If FTL communication exists, then larger areas can be governed – though FTL *travel* is still necessary for truly large empires.

If ships can cross the nation in a month, and FTL radio messages in a day, then it hardly matters whether the nation is 10 parsecs across or 1,000 (except that the latter allows a lot more room to hide!). The speeds of ship travel and "radio" communications (if any), *relative to the size of the area to be traveled,* will shape your interstellar culture.

Any organization with a monopoly on FTL communications will have a great deal of power – perhaps even enough to control the government.

No FTL Radio

At this stage, the speed of communications is that of the fastest starship. Fast courier ships will maintain contact between worlds, carrying mail, news, and government dispatches. Slower, independent ships – often those of free traders – contract for mail runs between less important worlds. The "Communications Fleet" is a vital branch of interstellar government. Without its services, communication – and perhaps even the nation itself – would soon break down. This is the "Pony Express" stage of interstellar communication. Invading fleets, escaping criminals, and similar menaces might be able to outrun the warning that they're coming.

Of course, if instantaneous jump drives or stargates exist, then news and mail delivery can be very fast indeed. Systems that aren't yet part of the stargate network will still have long waits for mail and news.

Interplanetary trade is risky when a trader doesn't know in advance what the market will be for his goods. A trader who guesses right can get rich; otherwise, he can go broke. People seldom travel far on the cosmic scale, the galactic capital seems remote, and citizens are more likely to be loyal to their provinces than to the nation.

If the nation needs a military fleet, it must be large in order to keep enough strength everywhere it might be required. Consider the huge British navy of the 17th century. Warfare will require careful planning, but captains (and frontier governors) will have great leeway when they are months from new orders; bravado and strategic skill will be very important.

Travel is always an adventure, because recent news of frontier areas is impossible to come by.

Slow FTL Radio

At this stage, simple messages can be sent at speeds two or three times that of the fastest starships. However, this is expensive. Routine messages must still be sent by courier. FTL communications might be a government monopoly. FTL transmitters may be so large or costly that many worlds must still rely on couriers. Ships in normal space can receive messages in mid-flight, but cannot send their own FTL messages. This can be considered the "telegraph" stage of FTL communications.

Traders who can afford access to FTL communications will have a big advantage over their rivals, except in frontier areas without FTL stations.

Space navies can be smaller, because fleets can be centrally located and called in time of need. This is also affected by the ships' own travel speed; most nations will want to be able to muster significant force on notice of not more than a day or two. But opponents will be able to muster large fleets more efficiently, too. Captains on patrol will have great autonomy, since they can't depend on getting up-to-date orders, but border worlds may be in close touch with headquarters.

Astrogational Errors

What happens when an astrogator miscalculates a course? Typically, if a jump-drive ship gets lost at all, it is *very* lost. Hyperdrives can go wildly off course, especially if the drive or power plant malfunctioned in hyperspace. Warp-drive ships aren't as likely to get totally lost, because they can see where they're going.

Roll against Astrogation skill, modified as the GM sees fit for the difficulty of astrogation (see p. 34). A hurriedly set course, relative to the time usually required, gives a penalty to skill. A successful roll means there was no error. The consequences of a failure depend on its magnitude.

This is the GM's chance to custom-build his own failure table, appropriate for the drive he has designed. Players should *not* be allowed to see this table, though they may be told what the general results of a *minor* error will be. If the penalties for miscalculating are low, then starships "on the run" will always take a quick-and-dirty FTL course. As penalties become more severe, snap courses become emergency measures.

Some possibilities include:

Nothing happens. Literally. If your calculations are wrong, you use up a lot of energy – and go nowhere. Especially appropriate for jump drives.

Off-position. This is more appropriate for hyperdrives than for jump drives. Deviation from the intended destination depends upon the amount by which the skill roll was missed, and may be minor (AUs) or major (parsecs). A ship might go in the correct direction but a different distance, or it could go the correct distance in the wrong direction.

Lost. The ship is sent to a wholly unexpected location – the worse the roll, the more lost it is. It may be a reasonable number of parsecs from the departure or destination point, or it might be random on a galactic or intergalactic scale. Astrogation rolls will be required just to locate the ship.

Time-lost. This is especially appropriate for hyperdrives. The ship moves a random distance forward or backward in time. Small time-movements are an interesting nuisance. Big displacements are catastrophic, and should be used to start new campaigns, or not at all. If ships can become "time-lost" predictably, the GM may find himself with a time-travel campaign.

Damage. The ship or drive takes a certain amount of damage – for example, the drive may burn out, or the ship may lose a percentage of its total hull hit points (e.g., 3d-2 × 5%).

Total disaster. The ship is destroyed. Not a good result for play balance.

Fast FTL Radio

At this stage, communication between nearby star systems is cheap and many times the speed of the fastest ship. Courier vessels are only necessary during the earliest stages of a planet's colonization, until an FTL com station can be built (even then, ships' FTL radios can be used), or when communications are too sensitive to be entrusted to the spacewaves at all. Ships and planets can communicate freely with each other, except for ships in hyperspace.

Trade becomes much safer, with fewer risks and rewards, when a trader can check the market at his destination before taking on cargo.

Fleets can be even smaller but still used efficiently, because warships can be scattered throughout the nation on patrol, yet quickly called together in an emergency. Captains will rarely take action without checking HQ for orders. An analogy would be the police cars of a 20th-century city.

However, even fast FTL radio has limitations. These are up to the GM to set. The point, of course, is to produce situations in which a call for help is impossible! Interesting possibilities include:

Limited range. Maximum range may be a few parsecs or thousands. Alternatively, a radio's range might vary depending on its quality and the power being used. The device may work only close to a gravity source – or only in deep space. It may be necessary to build repeater "beacons" at regular intervals, either ground or space based.

Static. Reception may decrease sharply, depending on the environment – stellar density, radiation, gravity wells, and so on. If FTL radios are sensitive to gravity, then each inhabited system may have to establish a communications relay in orbit about a main world, or even beyond the solar system.

Delay. Even if messages travel far faster than ships, there *will* be a delay when contacting someone far away. The GM should decide exactly how fast messages travel. (Perhaps a more expensive "radio" sends messages faster.)

Energy drain. The GM is free to modify the energy cost of the units given in Chapter 8. Conceivably, an FTL broadcast might require so much power than a ship cannot use its engines and radio simultaneously.

FTL blocking. FTL communicators might not operate, or might be seriously hampered, while the ship is in FTL travel. And hyperdrive ships, by definition, cannot contact the outside universe. If ships cannot communicate during FTL, that may be a direct reason for some voyages – military missions, for instance – to drop out of FTL and communicate with home base.

Astrogational Hazards

Theoretically, nothing can interfere with a jump-drive ship during its instantaneous flight. Warp ships and hyperships could be more vulnerable. A miscalculated course could encounter hazards; even a proper course might meet the unexpected.

As hazards increase, exploration becomes riskier, resulting in more "ghost ships" (human *and* alien) and "lost" worlds. Hazards also increase insurance rates and prices of interstellar goods, prompting research toward less hazardous travel.

Some of the astrographic features listed on pp. 147-151 are hazardous. Other possibilities include:

Normal Space

Debris. Warp ships may be vulnerable to large quantities of stellar dust, clouds of comets, fields of asteroids, or even ship wreckage. These might force the ship to suffer damage or go sublight.

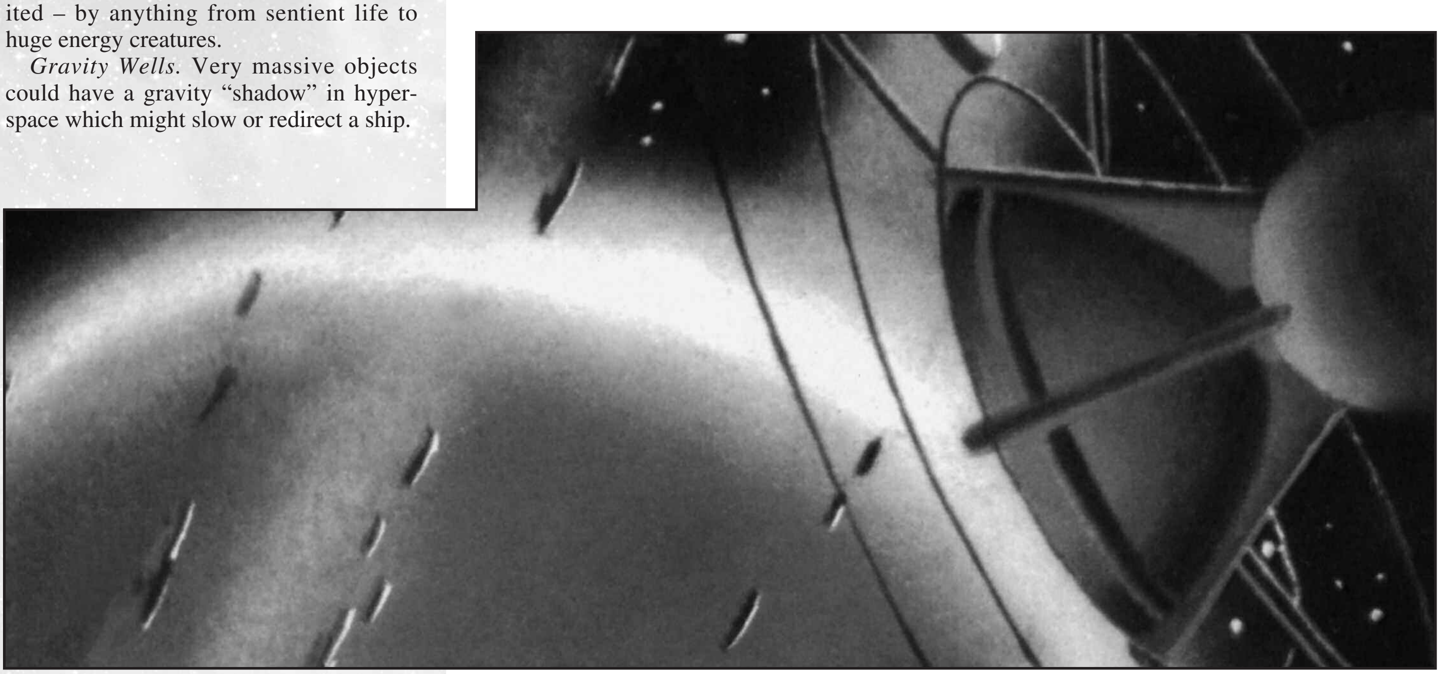
Uncharted large objects. Some very large items – including black holes, dwarf stars, protostars, and wandering planets – are difficult to detect, and might not be present on charts. A close encounter with an uncharted object could be an adventure in itself. The object could also affect a ship's course – for instance, a black hole might "hook" a warping ship, changing its course. These same comments apply to *charted* objects blundered into by miscalculating navigators or malfunctioning drives.

Hyperspace

Storms. "Space storms" in normal space are space opera, but they might exist in the unknown reaches of hyperspace.

Monsters. Hyperspace could be inhabited – by anything from sentient life to huge energy creatures.

Gravity Wells. Very massive objects could have a gravity "shadow" in hyperspace which might slow or redirect a ship.



Unlimited FTL Radio

Swift, unlimited communications create a universe similar to 20th-century America, where a great deal of information is available at the touch of a button – perhaps including surveillance of enemy forces (equivalent to our satellites today). Any vessel can be contacted at any time; the size of military fleets is governed only by the size of the opposing force and the speed with which trouble spots can be reached.

This is sometimes too much communication for an exciting campaign. Travel is less of an adventure when news from all over the galaxy can quickly reach any civilized world. And worlds may become more and more alike – everywhere begins to look like Galactic Prime (or California).

But it can still be exciting if the *ships* are comparatively very slow or the range of a ship's own system isn't too great. Thus, an exploring craft may be out of communication for long periods. Worse, it may be within range of unhelpful advice from the chair-warmers back at HQ.

"Survey Control, a mutant space amoeba just ate the stardrive! What do we do now?"

"Survey 1138, it will take about a month to route a rescue craft to you. Meanwhile, the scientific staff wants some information on that amoeba. Here's Dr. Gzint."

"Gzint here, Survey 1138. What color is that amoeba? Please send somebody out to take its temperature. Can you tell if it's carnivorous?"

Computers and Cybernetics

A straight-line extrapolation of existing trends indicates that computers will get faster and software will become more intelligent and more autonomous. By 2020, if not sooner, networked, sensor-using systems may anticipate many of our desires and, djinn-like, bring them into being almost before we can articulate them. With computers and sensors getting smaller, programs smarter, and networks larger, individuals with wearable computers should be able to call upon almost any kind of information in real time, augmenting or replacing many of their own skills with external knowledge. Near-future tech like camera-glasses linked to a computer running an optical recognition program could pop up data on whatever the wearer looks at, providing instant eidetic memory. More sophisticated versions may use brain implants or neural induction to load data directly into the user's brain.

This may be a nice world to live in, but it does create problems for the GM, with PCs' abilities being defined more by their pocketbooks ("How good a Geology expert system am I running?") than their personal skill levels. Of course, the GM does not have to feel bound by current trends. SF writers predicted robots, rocket ships, and nuclear power, but the invention of transistors and microchips caught most of them (along with everyone else) by surprise. Many famous SF settings conceived as late as the 1960s feature highly advanced physics but drastically inferior electronics. This isn't necessarily bad: it can make for a more exciting space-opera campaign. Without smart computers and advanced cybernetics, adventurers have to rely more on their own skills and less on those of their machines. GMs who want to de-emphasize computer capabilities can either create an "alternative history" where computer technology is retarded, or assume that social pressures limit the amount of autonomy that society is willing to give to machines.

Most spacefaring societies will likely make extensive use of robots in nearly every field; see ***GURPS Robots*** for detailed rules. The question is whether robots will replace people when it comes to the kinds of dangerous tasks that *adventurers* undertake, like combat or space exploration: Do humans go in harm's way, or do teleoperated drones or autonomous robots do the job? Will the galaxy be surveyed by manned ships or by robot probes?

Time Effects

Relativistic time dilation occurs aboard ships *approaching* the speed of light (c). The effects depend on the percentage of light speed achieved: a day at 0.9c would have far less effect than a day at 0.99c! It is relatively straightforward to compute this – see the Glossary (p. 175). In general, the GM is advised not to worry about the details. If a ship approaches light speed, assume a time ratio of 21:1 . . . three weeks pass in the universe for every day that passes aboard ship. This is appropriate to a speed of about 0.999c.

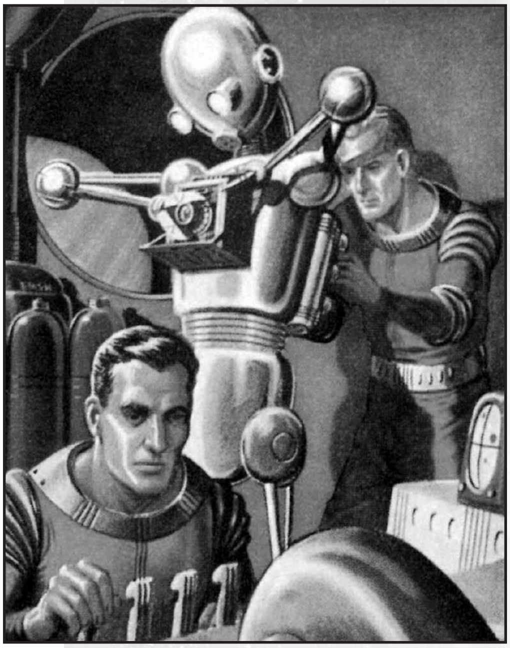
However, this effect applies only to sublight speeds. The effects of FTL travel on time are purely speculative, and are therefore up to the GM. Possibilities include:

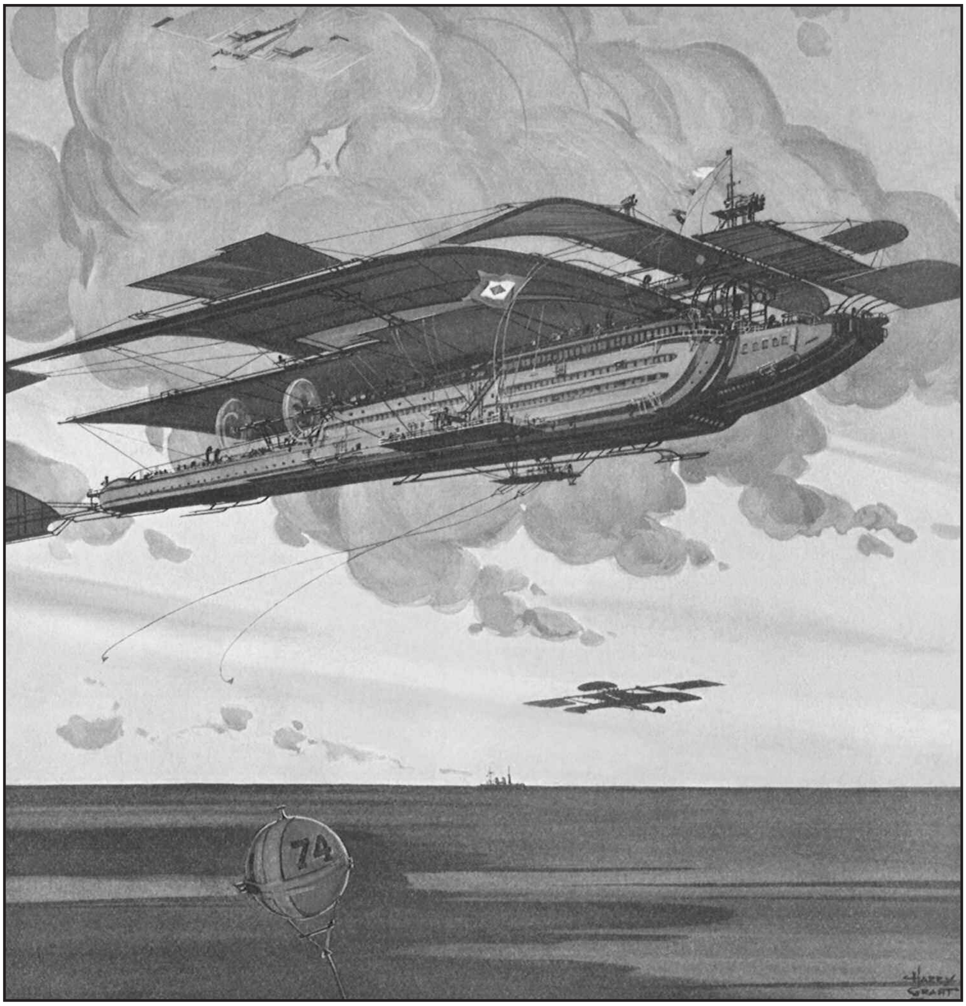
Instantaneous jump. No time passes, either on or off the ship, during FTL travel. This is the normal condition for jump ships.

No effect. The same time passes aboard ship as in the rest of the universe. This is the simplest method for the GM!

Time dilation. As described above, but with any time ratio set by the GM. For instance, 10:1 – meaning that ten hours will pass in the universe for every hour that passes aboard ship. If time dilation is large, then starmen, aging far slower than others, will feel distanced from the "groundhogs." This may result in the evolution of a separate starfaring society. It could also result in a sense of superiority – or hatred – leading to conflict.

Reverse dilation. The universe "freezes" while the voyage takes place. Time passes normally aboard ship. Crewmen may use freeze tubes (p. 91) to keep from aging too fast.





In some situations (like a low-tech colony), humans may be cheaper than imported machinery, but usually the high cost of training a skilled human means that drones or robots are a better solution . . . if they can be trusted. Fully autonomous machines may never truly be accepted, and as for drones, the crucial issue is communication. If communicators can be jammed or lag is an issue (see *Communications*), then humans will need to be somewhere on the scene to make vital decisions.

Different societies may find different answers, with social issues perhaps having more weight than technical ones. Things can get interesting if they collide with one another.

Gravity Manipulation

Gravity is one of the fundamental forces holding the universe together. It has also proven the hardest to manipulate. Today, the only known way to produce gravity is through piling up mass. There is as yet no workable method to "screen" against it to make an object weightless or even to reduce its weight. Gravity control ("gravitics" or "gravitonics") is very much a dream, and as such can be considered a superscience technology.

Physicists have had difficulty reconciling quantum theory (which describes the electromagnetic force and the weak and strong nuclear forces) and relativity (which describes gravity) in order to formulate an "unified field theory." Attempts to do so break down in odd places, like at the instant of the big bang or inside black holes. It may be that achieving this will yield surprising results – or vice versa; i.e., that investigation of gravity manipulation will result in a grand unified theory of some kind.

FTL Side Effects

The GM may specify side effects of FTL travel. These can be an interesting "balancing" factor in a campaign with two different stardrives. One is much faster – but unpleasant or even risky. These effects may vary from species to species – some races may make excellent space navigators, or use certain drives that others cannot!

Mechanical Effects

FTL effects may be severe enough to plague engineers. Options include:

Severe turbulence. Acceleration effects of FTL are the equivalent of high-G maneuvers. Ships must be built to withstand the level of acceleration, as determined by the GM. Equipment must be secured; people must be strapped down to protect against injury.

Temperature. Starships are subjected to unusual heat or cold. Ships might require extra life-support equipment, or – in extreme cases – costly temperature control gear for the entire ship.

Equipment disturbance. FTL travel causes certain devices to fail or to function erratically. Most commonly, this affects astrogational equipment, requiring ships to have living astrogators. Alternatively, only machines can withstand FTL and living creatures must travel in freeze.

Physical Effects

These effects might apply to everyone aboard, but if the navigator must take special drugs or link his mind to the ship's computer in order to pilot, it may only affect him.

Discomfort. Characters must roll vs. HT (either at transition, or at GM-chosen intervals during FTL travel) to avoid nausea or spacesickness. The effects might be so uncomfortable (or actually painful) that drugs are necessary.

Disorientation. Everyone has a DX penalty.

Illness. As for "Discomfort," except at a penalty to the HT roll, and critical failure means voyagers may *die.* Freeze equipment allows a bonus on the HT roll.

Death. Traveling at FTL is lethal. Humans may travel FTL only within freeze tubes, and are revived only when the ship returns to sublight speed. Or maybe a freeze tube isn't good enough – perhaps revival requires braintapes and cloning.

Continued on next page . . .

Artificial Gravity

If you want a spaceship or station with a 1-G gravity field, it would have to mass as much as the Earth. An artificial gravity generator is a way around this limitation. Somehow, it transforms power into gravity. This violates physical laws as they are currently understood.

Adding gravity generators to a campaign can have several consequences. It means that spaceships and space stations can be built in any shape desired; there is no need to design them with rotating sections, or shaped like rings or cylinders, to simulate gravity. It becomes easy to find real estate: people could easily live on comets, asteroids, or other bits of space junk. It also becomes less likely that variant human races (see p. 54) adapted to unusual gravities will be genetically engineered – although they might appear before artificial gravity technology is invented.

Contragravity

Contragravity (CG) is a means of "screening out" gravity – in effect, the reverse of artificial gravity.

The main use of contragravity is to allow things to fly without regard for aerodynamics and without noisy rotors or jet engines. Instead of being light and fragile like helicopters or jet planes, vehicles could be quite heavy, like "grav tanks," or even flying houses or cities. If CG generators can be made small enough, they also allow personal flying belts or carpets.

Cloud cities are dramatic and futuristic, which is the main reason to use contragrav. On the down side, if it's easy to fly, there isn't much point in sailing, driving, or walking. The more portable and simple flight technology is, the more likely adventurers will possess it. It's hard to get excited about a "man against nature" adventure where the heroes must cross a thousand miles of barren, monster-infested wilderness when they can just strap on their flight-belts and *fly.*

FTL Side Effects (Continued)

Mental Effects

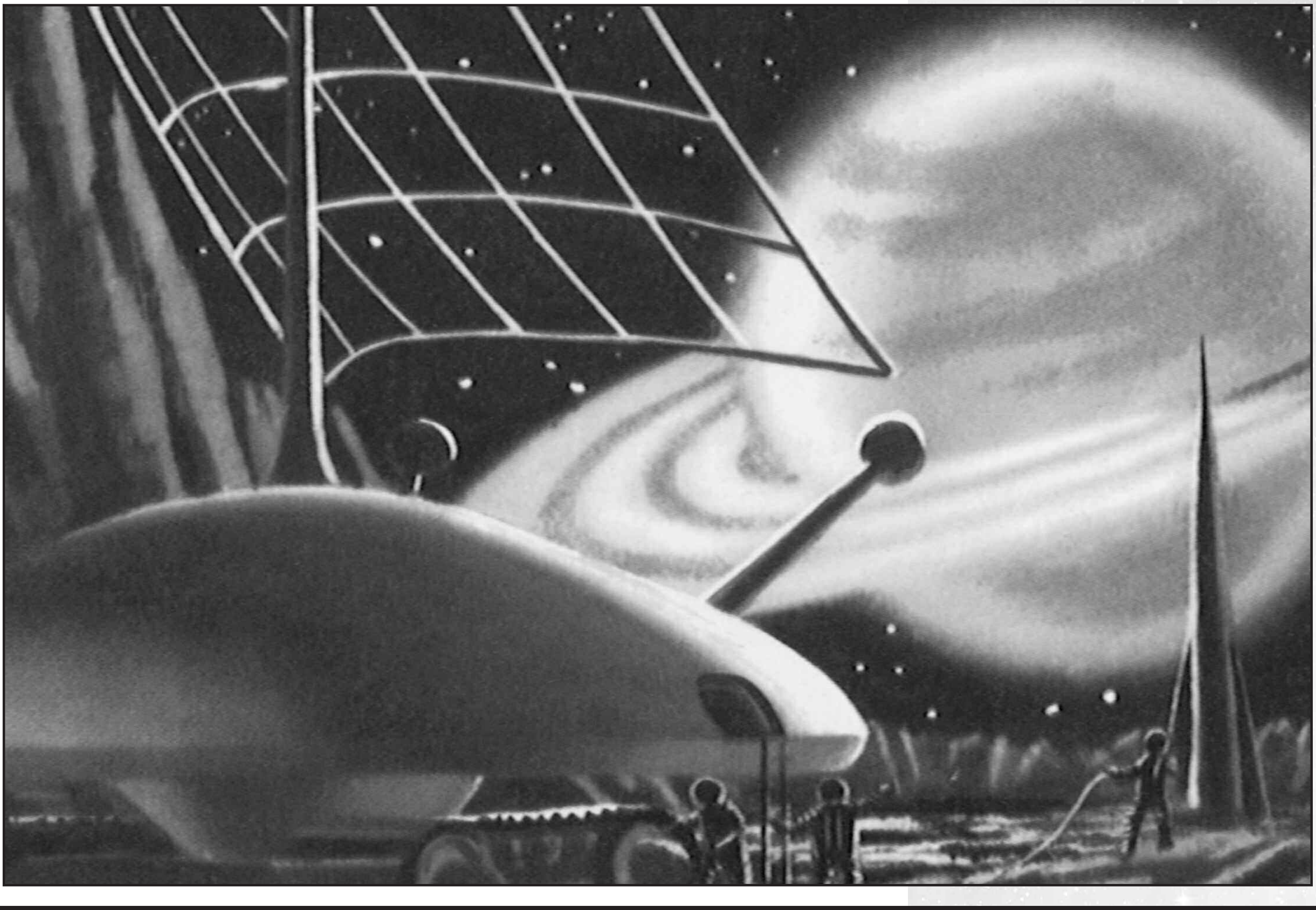
Mental distress. Those who miss their IQ rolls – attempted at GM-chosen time intervals during FTL travel – are plagued by nightmares or mild headaches. The result is -1 (or more) to IQ.

Psychic distress. Travelers must make IQ rolls to resist constant delusions and manic impulses. They may avoid this if heavily medicated or in freeze. If safe FTL travel requires crewmen to be incapacitated, adventures can be built around something that happens when the characters can't do anything about it.

Psionic benefits. During FTL, psionic abilities could be heightened, latent talents may blossom, and non-psis may have flashes of psi ability or prescient dreams.

Psionic snow. Psionic powers do not work during FTL, and psis may suffer nausea, headaches, or other results. Non-psis are unaffected.

Pleasure. The sensations of FTL travel are physically pleasurable. Frequent travelers (or navigators, if limited to FTL pilots) may acquire Obsession (Travel frequently) or Addiction. If drugs are required to navigate FTL space or to avoid its health problems, this may represent addiction to those drugs instead.



Sensors

What can a ship detect, and how far off? The detection rules in Chapter 9 address this question for star warriors, and the *Detecting Worlds* sidebar (p. 32) addresses it for searchers for new worlds, but the GM should consider the following as well:

Super-scanners: Do "superscience" sensors exist that allow long-range, instantaneous chemical and biological analysis, or are sensors limited to "realistic" types like radar, short-range biochemical sniffers, and infrared? See *Scanners* in Chapter 4 for some options.

FTL Sensors: Can a ship detect objects at FTL speeds? Without some sort of FTL sensors, FTL travel must rely on dead reckoning and charts – an astrogator cannot be sure that the space ahead of him is empty . . . only that it was empty some time ago. Having FTL sensors is most important in a game where warp drive exists and ships maneuver in "real space" – a setting that uses jump drive or hyperdrive does not really need them.

If FTL sensors exist, how accurate are they and do they have any limitations? For example, if warp drive does not work near a planet's gravity well, perhaps FTL sensors will share this limitation. If sensors are accurate but short-ranged, FTL combat is possible but parsecs-distant planetary scanning is not. If sensors are inaccurate but long-ranged, FTL combat is largely a matter of blind luck modified by volume of firepower, but a ship will have at least some idea of what a world is like long before arriving.

Special Sensor Types

The following special sensor types might be allowed in a campaign. Typically, their range would be much less than those of standard sensors, and the cost would be extra. Active devices send out a signal, which itself can be detected; passive devices only "listen," and cannot be detected:

Point detectors. These sensors are used to locate and pinpoint jump points or jumpline entries. Active.

FTL-scan detectors. These detect the radiation from an active point detector or a ship's regular sensor suite. Each will detect only one sensor type. Passive.

Hyperdrive emergence sensors. These detect the "ripples" caused when a vehicle leaves hyperspace and enters normal space. These ripples travel at about 10 times light speed (the speed of a slow FTL radio). Passive.

Hyperdrive wake sensors. These detect the "wake" of a vehicle in hyperdrive. These should only be allowed if communication with hyperspace is possible! Passive.

In terms of ship design, the existence of contragravity means, among other things, that a ship can enter atmosphere and land on a planet whether it is streamlined or not! Contragravity is not a drive per se, but a contragrav-equipped ship can reduce its weight to almost nothing, allowing it to take off or land with a very weak drive.

GMs who like the idea of contragravity but who do not want to see it overshadow all other forms of transportation can always add limitations. For example, the GM could rule that the minimum size of a CG unit increases from backpack-sized to truck engine-sized – or even house-sized. The former limits CG to vehicles, the latter to large ships or buildings.

Weapons and Defenses

Man's ingenuity in developing weapons is exceeded only by his ability to invent imaginary ones. Some "generic" starship weapons for various TLs are described in Chapter 8; personal weapons appear in Chapter 5. The GM can choose from these . . . or use them as inspiration for his own creations!

It is up to the GM to decide what weaponry is available in a setting. Just because something is possible does not mean it is in current use. If a campaign is going to involve a lot of combat, choosing what personal weapons exist is quite important for its tone.

For instance, in a cinematic space-opera campaign, protagonists typically wear little armor and a skilled warrior can defeat many opponents. It is hard to retain this feel if most combatants are armed with automatic weapons or wearing battlesuits. If the GM wants a cinematic feel, then it is a good idea to emphasize single-shot or melee weapons with high armor divisors but relatively low damage, as well as stun weapons. (Tight-beam blasters, electrolasers, and vibroblades are good examples of this; see Chapter 5.) That way, if the villains are unsporting enough to wear combat armor, our heroes can still take them down – but a dashing hero in ordinary clothing won't necessarily be reduced to a greasy spot on the floor when the Imperial Troopers open fire.

Armor

Any spacegoing society should be able to make good armor. The same advanced alloys and composites used to make strong, lightweight spaceship hulls or solar sails can also be used to make superior ship, vehicle, and body protection.

One thing to consider is whether any kind of "super armor" exists. The standard assumption in this book is that armor materials will get about 30-50% tougher for each TL. However, some science fiction assumes the existence – at moderately low TLs – of armor that can withstand very heavy attacks. This is often defined as some form of collapsed matter. It may be an outgrowth of gravity manipulation (pp. 38-40), nanotechnology (p. 41), or just a lucky discovery.

GMs also should consider whether battlesuits (or "powered armor") are available. There is little question that any sufficiently advanced technology *could* make powered armor, but it represents a large enough investment in the individual soldier that not all societies would bother with it. Moreover, it does a good job of making a man's equipment more important than his skills, something that GMs of more humanistic space-opera games may wish to avoid.

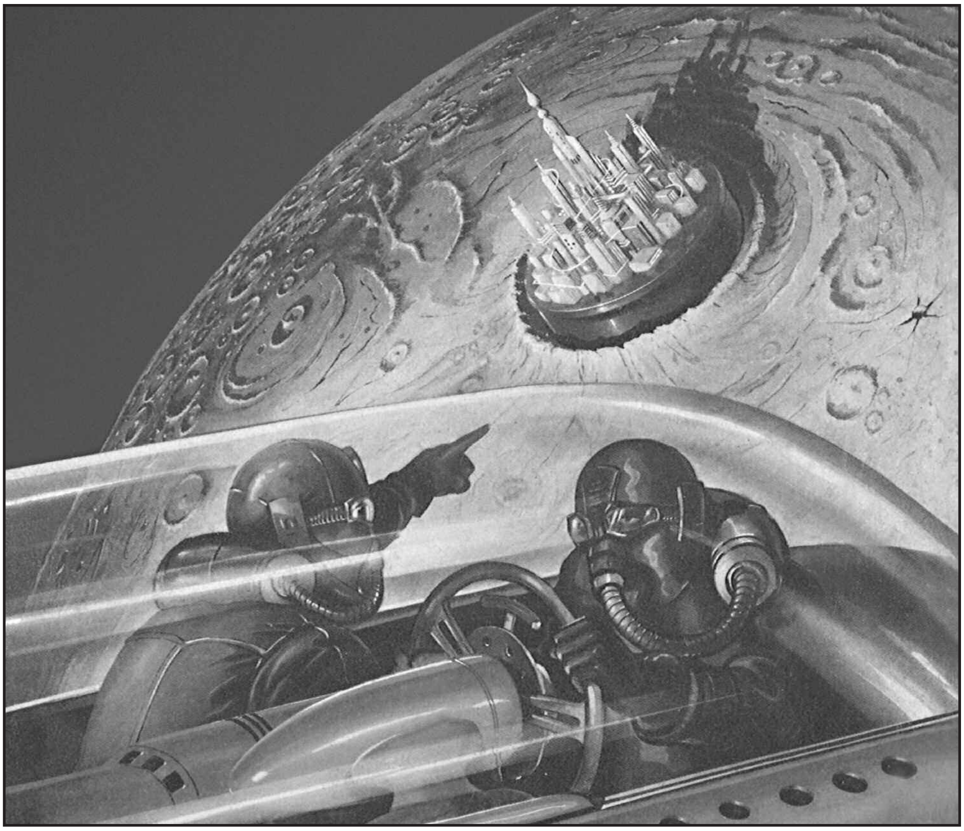
Force Fields

Defensive energy screens are a staple of space opera, but there does not seem to be any real-world basis for them. They are perhaps best explained by pointing to the same technology used for FTL drives: something that warps space or shunts energy into another dimension. The fact that we have no idea how force fields work means that GMs have a great deal of freedom when defining them – which makes them a valuable tool for designing a space-opera setting.

But why have force fields in the campaign at all?

First, they allow individuals or vehicles to *look* unprotected but in fact be well shielded against either enemy fire or hostile environments. You could have a summer cottage on the hellish surface of Venus, and a tiny shield belt is so much more *elegant* than a bulky armored suit.

Second, they allow the GM to explain what kinds of weapons are and are not in use simply by stating that force fields are more or less effective against particular attacks. For a "swords and starships" campaign, just rule that force screens will block fast-moving projectiles or energy beams but are ineffective against slow hand weapons. To "ban the bomb," rule that force screens provide 1,000 times their normal DR against nuclear weapons. Want to limit teleportation technology? Rule that a teleporter cannot reach through a screen. Frank Herbert's *Dune* illustrates well how force screens can shape military technology and thus alter society.



The standard ***GURPS*** force screen is assumed to project an invisible energy field around the generator grid that protects against all forms of attack but which can be gradually overloaded by successive hits of sufficient power (see p. 140). Some other options for force screens:

Huge Power Consumption: The screen drains so much energy that it can only be raised for a brief period. For example, if the drain were 60 times greater, a personal force screen (p. 86) would be good for only 15 *seconds.*

Rigid Screen: The screen cannot be overloaded. It works just like armor DR as long as the power operates.

Swashbuckler Option: Force screens are only effective vs. attacks moving at relatively high speeds. Thrown weapons and hand weapon attacks ignore their DR (the GM must decide whether this includes *energy* hand weapons like force swords), but explosions, missiles, bullets, and beams are affected by it normally.

Visible Screen: A screen is visible or audible; it may be a faint shimmer around the wearer, a hum, or even a solid black sphere! If the screen obscures its user, the GM should decide what sensors, if any, can penetrate it.

Window of Vulnerability: The screen's DR is ignored by a particular class of weapons (e.g., laser beams).

Nanotechnology

Nanotechnology is speculative technology that uses cell-sized or smaller machines to assemble, repair, or disassemble structures on the molecular level. This allows chemical or biological engineering on a scale far more precise than "top-down" methods can achieve.

Nanotechnology is fundamentally an industrial process: nanomachine assemblers build things people use, making them lighter, stronger, and cheaper. In addition, nanomachines may be capable of effects that ordinary technology cannot duplicate. For example, as they work on a molecular scale, nanomachines may construct microscopic sensors and motors inside objects, allowing them to vary their configuration in response to stimuli. Clothing built this way might alter its shape so as to better fit their wearer, or change color; a vehicle could do the same to improve aerodynamics; buildings, roads and sidewalks could flex to absorb sound.

On a biological level, nanomachines promise the ability to perform radical repairs, housekeeping, and modification to living things. Tiny medical robots, smaller than cells, could cruise through the bloodstream, eradicating cancers, cleaning arteries, fixing cellular damage, or reviving a frozen body from suspended animation. Nanomachines could also be deadly weapons: imagine a robot virus or a self-replicating plague that dismantles everything in its path, reducing it to "gray goo." A nanofactory could rapidly build conventional weapons, allowing a seemingly harmless state to transform itself into a superpower in a matter of weeks.

If nanotechnology exists, it will change many long-cherished SF assumptions. People often define themselves through their jobs . . . but nanotech may transform or eliminate numerous occupations. Why have farms – or agricultural colonies – when you can manufacture food? Instead of a new frontier colony importing high-tech goods in exchange for raw materials, it just brings in a few nanofacs, they replicate, and soon the colony is industrialized. Starving on an alien world? No problem! Bring your survival food processor, shovel in the local plant life, and it will turn local flora into hamburger.

Does Nanotech Exist in the Campaign? This is up to the GM. Estimates for nanotechnology range from "in 20 years" to "never." Nanotech can justify exotic gadgetry, as well as explain things like the rapid terraforming of worlds or ubiquitous biological engineering.

The classic reference book for nanotechnology is Eric Drexler's *Engines of Creation.* For more on nanotechnology and statistics for nanofactories and molecular nanomachines, see ***GURPS Ultra-Tech 2.*** For medical and bio-nanotechnology, see ***Bio-Tech.***

Teleportation

The development of teleportation – instantaneous travel from one place to another – will replace many other forms of transportation, depending on just how cheap it is. (For an excellent article on this, see Larry Niven's "Exercise in Speculation: The Theory and Practice of Teleportation," in his collection *All the Myriad Ways.* This should be required reading for anyone planning to invent teleportation.)

Three interesting possibilities:

Short range, low cost. Teleportation booths are only useful on the surface of a planet (or within large ships). You can go from any booth to any other booth within (say) 20 miles, for $1 per jump, deducted from your credcard. This reduces travel time in civilized areas to near zero, but doesn't affect the rest of the campaign very much.

Very long range, very high cost. This is like a stargate (pp. 30-31), but much more so. Once a teleportation station is established on a new planet, anyone can go there instantly. But it's *very* expensive . . . thousands of dollars per *pound* of matter transmitted. It won't replace starships, but if the filthy rich have to go somewhere fast, they can. News will travel instantly with this system. Or colonists can spend their life savings to reach a new planet.

Medium range, one booth needed. The classic, open-platform "beam me down/beam me up" teleportation system. A single booth can send things to or pick things up from a location without a booth. With good range (a few thousand miles) and some way of handling the energy differential, such a "teleport projector" can replace all ground-orbit transport. Mounted on a spaceship, it allows characters to quickly get into adventures. . . but to get out of them just as fast, since it can snatch objects or kidnap people, teleport bombs into enemy control rooms, and other tricky things. GMs introducing such systems should come up with a wide range of limits and countermeasures (e.g., "precise coordinates are needed" and "teleporting does not work through force fields") and be aware that it gives a teleport projector-using culture a *huge* advantage over any culture that lacks such technology.

Teleportation is probably at the "miracle" level . . . TL15 or above . . . but as with other superscience, the GM can introduce it at any level.

Stealth and Invisibility

The art of camouflage predates warfare and recorded history; just ask the chameleon. In any kind of hard-SF setting, the ability to deceive enemy sensors and smart weapons will probably be more important than physical armor. There is considerable debate as to how easy it is for spaceships to conceal themselves from sensors, however. Space is *big* – spotting something as small as a ship may be tricky. But space is also *dark* and *cold:* the energy used to operate a ship (if only to provide life support) has to go somewhere, making it stand out nicely against such a background . . . and the flare of a rocket exhaust will act as a beacon to everyone in the area. Yet advances in ECM and stealth could be such that battles must be fought at or near visual range; examples of such advances are offered below. The GM should modify the detection rules in Chapter 9 to reflect his own prejudices.

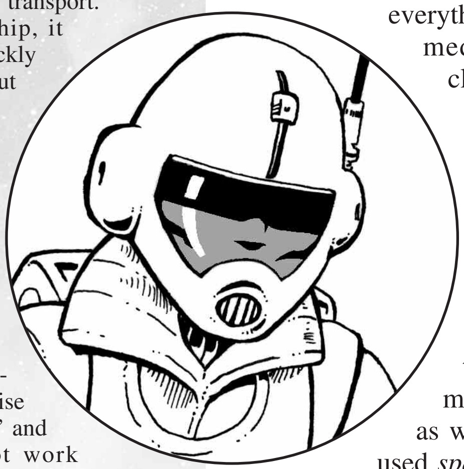
Chameleon Systems. Sophisticated "smart" materials with integrated computers may allow the development of surfaces that allow vehicles or individuals to effectively disappear. See the *chameleon suit* on p. 72 for an example. This sort of technology is likely if nanotechnology and cybernetics are advanced, much less so if they are retarded.

Cloaking Devices. There may be superscience "invisibility fields" which can render a ship invisible to both sensors and the naked eye, or disguise it as something else. They may have limiting disadvantages, or it may be that space battles are fought like World War II submarine actions, between opponents who are nearly undetectable to one another until they give away their position by firing.

When using any superscience technology, the GM can fudge detection one way or another – reactionless drives may produce waste heat, or a unique property of the drive or force screens may be to render the ship harder to detect.

Other Technology

The choices you make for FTL travel and communication will help define the general tech level of your universe. Routine interstellar travel means at least TL9 in transportation. But whatever the overall TL of the campaign, there will probably be worlds with lower TLs – and maybe a few higher!



Also, just because you've reached TL9 in star travel doesn't mean that everything else has kept up. You may be using TL8 fission power, and medical knowledge may be limited to organ transplants, with cloning still in the future.

Once you set the basic TL, you must decide which items of lower TLs are still in use, and which higher-TL items have become available. Study the equipment in Chapters 4, 5, 6, and 8 and choose what to allow. Some classic SF novels have introduced odd combinations. In H. Beam Piper's *Space Viking,* ships used hyperdrive and contragravity, but fought with atomic missiles, while handguns fired lead bullets.

Be careful what technologies you introduce. Many innovations – particularly in the fields of mind control and man-machine interfacing – could lead to a society where "adventuring" as we know it is impossible. If potentially dangerous technology is used *sparingly,* as braintapes are in the ***Autoduel*** universe, explain how it is kept under control. If the limiting laws, embargoes, or religions break down, an adventure is beginning!

Many writers simply assume that the future will be just like the present, except with spaceships, blasters and computers. But it seems likely that society, and humanity itself, will change more in the next hundred years than in all previous history. To try to predict all these changes isn't practical in this book . . . or in your campaign. And it's your universe. If you want something (or a lot of things) to be just like today, go right ahead.

CHAPTER 3 CHARACTERS

Certain character-design options are especially appropriate in a science-fiction universe. The GM should fill out the *Space Campaign Plan* (p. 59) and distribute copies to the players so that they will know which character types and abilities are appropriate and which are undesirable.

Power Level: Player characters should usually be built on 100 character points, with a general limit of 40 points of disadvantages and 5 quirks. In some backgrounds, such as heroic space opera or settings where people are commonly biologically or cybernetically augmented, the GM may select a higher point total. *Racial* disadvantages don't count against the 40-point limit.

Character Types

The literature of science fiction is so diverse that dozens of character types are available for a *Space* campaign. We discuss some of these below. Detailed character templates for many character types can be found on pp. 87-105 of ***GURPS Traveller.***

Starship Crew

Crew positions include Captain, First Officer, Pilot (or Helmsman), Astrogator, Engineer, Surgeon, Technician, Cargomaster, Steward, Gunner (or Weapons Officer), and Communications, Science, and Security Officers. On smaller ships, each crewman holds several positions; larger ships have several crew for every position but Captain and First Officer.

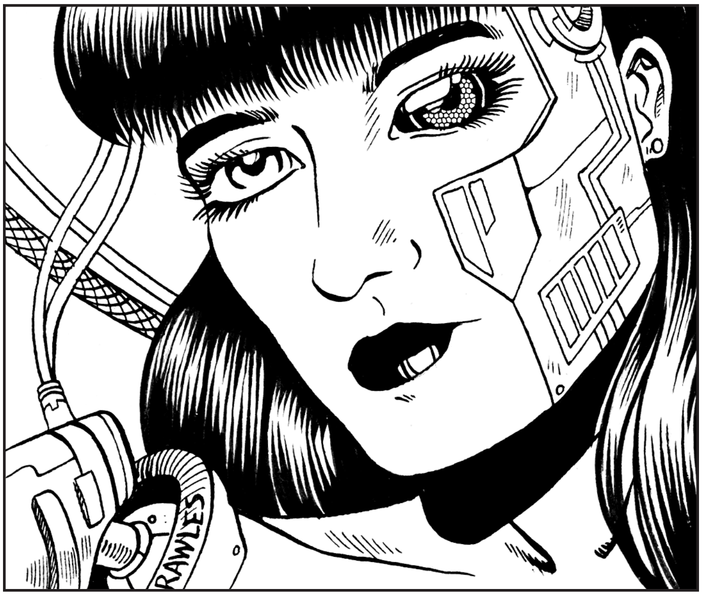
Skills of special value to starship crew include Armoury (Spaceship Weaponry or Spaceship Armor), Astrogation, Computer Operation, Electronics and Electronics Operation (Communications, Force Shields, Medical, or Sensors), Engineer (any space specialty), Free Fall, Freight Handling, Gunner (any spaceship weapon), Mechanic (any space specialty), Piloting (any spaceship or auxiliary craft), and Vacc Suit.

Merchant

An interstellar trader who cruises the spaceways, buying and selling. Merchant, Fast-Talk, and Diplomacy skills are a must. Unless he's a full-time trade specialist, he'll also need crew skills – especially on a small trading vessel.

Navy

Crew on a regular military vessel. *Marines* are ground troops transported via starship; see *Trooper* (p. 46). Savoir-Faire (Military) skill is required, and officers should have Leadership and Tactics. Military Rank is useful, unless you want to be a private all your life.



Patrolman

A member of the Patrol (see p. 21) or equivalent interplanetary agency, combining the skills of a police investigator with those of a soldier to keep the spacelanes safe. Sense of Duty is a must.

Pirate/Smuggler

The most celebrated interstellar criminals. Smugglers run contraband from world to world – anything from guns to drugs to slaves – slipping past the Patrol in fast, well-protected ships. They can use any of the Thief/Spy skills. Pirates are the scourges of the spacelanes, attacking freighters, liners, lightly guarded colonies, low-tech worlds, prospectors, and other prey. Some may be slavers. Combat/Weapon skills and Odious Personal Habits are appropriate.

Scout

Scouts (see p. 22) find and explore new worlds. They might specialize in one or more sciences, or be "general specialists." Useful skills include Cartography, Electronics Operation (Sensors), Planetology, Survival, and Xenobiology.

Other Starfarers

These may be found either groundside or as starship passengers. They may have their own ships but not crew skills, relying on hired crew.

Assassin

The killer for hire or for a cause. Skilled in many weapons (especially silent ones), stealth, and disguise, interstellar assassins are among the most dangerous characters in space. All the Thief/Spy skills, appropriate Combat/Weapon skills, and a good cover skill will be needed.

Bounty Hunter

Adventurers who make their living tracking down criminals, traitors, spies, and pirates. They often go where official lawmen, like the Patrol, cannot – by treaty, by convention, or because the risk isn't worth the prize. They are often solitary, though teams also exist: the catch is easier but the bounty must be split. Their methods may be questionable, but they often get results when the law can't. Some bounty hunters specialize in particular targets: runaway androids, spaceship thieves, etc. Thief/Spy skills, especially Streetwise, will help.

Colonist

The hardy folk who carve new lives out of the wilderness of a virgin planet. They may be part of a religious or ethnic group, sponsored by a government, part of a commercial venture, or on their own. Survival is the most important skill here.

Dilettante

Wealthy folk who travel because they've seen everything at home. Many have an Ally Group in their entourage (bodyguards, servants, etc.). High Status is appropriate; so is Savoir-Faire skill, if the dilettante bothers to use it.

Diplomat

The silver-tongued negotiators who keep rival worlds cordial – or at least on speaking terms. They are assigned to newly discovered civilizations, often accompanying survey crews when a new world is known to have a sapient species. They also serve on embassies to other starfaring nations or races. They are usually government employees, though some are skilled independent negotiators . . . or spies. A public-relations official for a multistellar could fall into this category as well. Bard, Diplomacy, and Savoir-Faire are musts; Language skills and Xenology are useful.

Escort

Tough, competent characters, hired to guide and protect more peaceable starfarers. They may be individual guides or hired guns, small freelance teams or corporate employees. Scientists, journalists, and diplomats are especially likely to need their services. Streetwise, Survival, and most Combat/Weapon and Vehicle skills will be useful.

Esper

Psi adepts, skilled in the powers of the mind. They may use their abilities openly or hide them, depending on the prevailing attitude toward their kind. Espers can often find useful employment in intelligence services, as assassins, or with survey crews, depending on their exact skills.

Fighter Jock

The elite warriors who pilot fighter craft – starfighters, aircraft, or both – assuming such things exist. In anime-influenced settings, this includes mecha jocks who operate giant robots. They have Military Rank, high levels of Piloting and Gunner skill, and probably Acceleration Tolerance or 3D Spatial Sense.

Intelligence Agent

Freelancers, government agents, or even corporate spies whose talents range from information gathering to assassination. They usually operate under a cover identity – often as a diplomat, but potentially in any role. They need Thief/Spy skills and a mundane skill to make their cover believable.

Interstellar Journalist

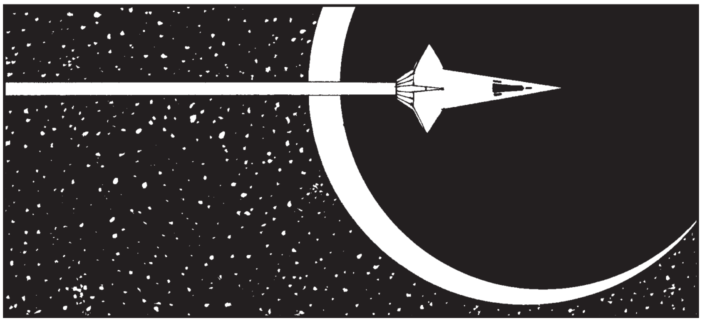
The news-gatherers of the galaxy, traveling from world to world in search of a great story. They may belong to a roving news team or be solitary investigative reporters, operating overtly or covertly. They could work for a news service (see p. 24) or as freelancers, selling their scoops to the highest bidder. This is a good (and common) cover for agents and assassins. Writing skill is a must; useful skills include Bard, Detect Lies, Fast-Talk, Photography, Research, Video Production, and Xenology.

Missionary/Chaplain

Spacegoing missionaries may be found along the frontiers, spreading their faith to newly discovered societies or caring for the spiritual needs of colonies and frontier outposts. Some may be found aboard large naval vessels or at military bases. Others might be con men hiding behind the cloth. Many will be fanatic proponents of new cults or religions. Bard, Fast-Talk, and Theology are all appropriate.

Primitive

Many natives of low-tech worlds have access to the spaceways. They may be descendants of a colony that has lost its technology or members of an "underdeveloped" race. Many tramp-spacer crewmen are from a primitive background. They are often prized as hunters, naturalists, beast masters, woodsmen, and craftsmen on more "civilized" worlds. Any low-tech skills are appropriate; high-tech ones are forbidden if you take the Primitive disadvantage.



Prospector/Belter

The crusty, colorful characters who exploit planets or asteroids for their mineral resources. They may work alone, be affiliated with mining corporations, or be part of a freelance team. *Belters* operate specialized prospector ships and mine asteroids in free space. Prospecting skill is required; Electronics Operation (Sensors), Engineer (Mining), Geology, and Planetology are all useful. Survival is handy for planetside prospectors, while belters need Astronomy, Free Fall, Piloting, and Vacc Suit.

Riffraff

You can see them around any spaceport . . . tough, street-smart types, hoping for a break that will get them off planet. Some are elderly; others are just kids. All of them look like bums to starmen. Some are; some aren't. Fast-Talk, Scrounging, and Streetwise are all vital skills. Either Running or a Combat/Weapon skill will be good life insurance.

Rogue

Riffraff who manage to get into space and survive for a few years may develop into rogues. Smuggler, scavenger, blaster-for-hire . . . a rogue will do anything for fun or for money. His first ambition is to get a ship; his next ambition is to keep it. Almost *any* Combat/Weapon, Social, or Thief/Spy skill suits some rogue somewhere!

Scientist

Affiliated with corporations, institutes, or universities, scientists are sent to the ends of the universe to collect data and to test theories. All have Scientific skills. Some are stereotypically absent-minded. Others use their skills practically, sometimes bettering themselves first and mankind second; this type can use Fast-Talk, Merchant, and Streetwise skills.

Terrorist/Rebel

One planet's terrorists may be another's valiant rebels. As a rule, though, terrorists are more indiscriminate than rebels, striking at random and often deliberately harming civilians. Rebels usually limit operations to strikes on military or government installations. Combat/Weapon and Thief/Spy skills are all useful. Politics skill is also helpful!

Tourist

Tourists prefer Real Life to the virtual-reality vacation, saving every spare credit for a once-in-a-lifetime holiday Out There. And they're not going to let little things like primitives, local wildlife, space pirates, or supernovae spoil it for them. Most have mundane job skills; many suffer from the Clueless disadvantage.

Trooper

Ground fighters – either infantry or armored. Might be a member of a mercenary unit or the Marines. Most mercenaries work as full-fledged military companies, often with established base camps, but small groups may act as roving soldiers of fortune. Military Rank and any appropriate Combat/Weapon or Military skills will be useful.

Advantages

Certain advantages in ***GURPS Basic Set*** and ***Compendium I*** deserve special attention in a ***Space*** campaign:

Acceleration Tolerance — see p. CI19

Useful for the crew of high-performance spacecraft if gravity compensation is unavailable.

Bionics — see p. 92

This covers a wide range of artificial body parts; see Chapter 6. If a bionic part enhances normal human function, it will cost character points – whether the character starts with it or adds it later. If it functions exactly like a lost limb or organ, there is no point cost (although there will likely be a cash cost).

G-Experience — see p. CI25

Useful for scouts and spacers, who frequently have to operate outside their home gravity.

Improved G-Tolerance — see p. CI26

Another useful advantage for adventurers who must deal with a wide range of gravity fields.

Military Rank — see p. B22

The Patrol and Survey generally follow navy ranks; mercenaries and the Marines follow army ranks.

Patrons — see p.B24

Patrons in an SF universe may include government and military organizations, merchants, or multistellar organizations. Remember that an employer is not automatically a Patron; the Federation Navy may be far more powerful than a tramp merchant vessel, but it's much less likely to come to the aid of a single crewman in difficulties.

Status — see p. B18

It is possible for a character to have Status in his home culture but to get little or no benefit from it during the campaign because that culture is far away. To reflect this, the GM may choose to modify the cost of Status in the same way as Reputation (p. B17).

3D Spatial Sense — see p. C31

Almost indispensable for astrogators and fighter jocks who must deal with the confusing, three-dimensional world of space navigation.

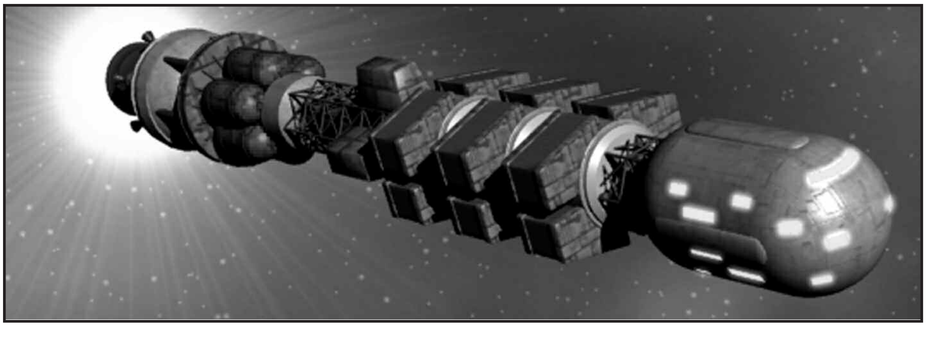
New Advantages

Ship Owner — Variable

This variation on *Trading Points for Equipment* (p. CI17) is used when a character wishes to start with a spaceship. Unlike points traded for equipment, Ship Owner is an advantage that remains on the character sheet. It is also far more efficient, which is intended to reflect the fact that ships are large, hard to sell, expensive to maintain, risky to operate, and subject to strict regulations.

The point cost has two parts: a base cost and an additional variable amount.

Base cost depends on the buyer's wealth level (p. B16): 15 points at Average or below, 10 at Comfortable, 5 at



Wealthy, and 0 at Very Wealthy or above. This gives a basic $300,000 to put toward the purchase of a ship *in lieu of normal starting wealth.* No more than 20% of this amount ($60,000) can be taken as cash.

After the base cost is paid, each point buys an additional $150,000 investment. *None* of this may be taken as cash. The GM determines how many additional points a starting character can spend; a suggested limit is 30 points (an extra M$4.5).

Filthy Rich characters multiply their total investment (but *not* their cash) by 5; each level of Multimillionaire further multiplies this by 10.

Example: A Filthy Rich merchant pays a base 0 points for Ship Owner, giving him a M$1.5 investment. Each additional point increases his investment by $750,000. He cannot take more than $60,000 as cash, however.

Characters *are* allowed to pool their investments. If they cannot afford the full cost of their ship, they may finance the difference with a bank loan. See *Finances* (p. 113) for rules governing loans. Starting points in Ship Owner reflect existing equity in the ship. A fraction of each payment made (½ to 2/3) is applied to the outstanding cost of the ship and buys more equity (requiring additional points in Ship Owner). The remainder of each payment (½ to ⅓) pays interest and is "lost." Selling stock in a company is another financing option; see ***GURPS Traveller: Far Trader.***

Ship Owners receive a free level of Status, *not* cumulative with that gained from Rank or Wealth, and free Courtesy Rank 5 (see p. CI23) as the "Captain."

Ship Patron — Variable

You have a Patron – see *Getting a Ship Without Buying It* (p. 114) for possibilities – who provides you with a ship. You have full use of this ship (except when the real owner is aboard), but you cannot sell it or dispose of it because it doesn't belong to you.

Point cost for a ship suitable for PC use is *X* × the ship's cost in M$, with a minimum cost of 15 points. The GM should set *X* to fit his universe; it may be as low as 0.25 in a cinematic space-opera setting where everyone has a starfighter, or as high as 1.5 in a "hard-SF" or money-oriented campaign where ship ownership is the sole campaign goal (*X* is about 1.25 in ***GURPS Traveller***). As with any Patron, the cost of Ship Patron may be offset with a Duty.

"Suitable" ships may or may not be armed, depending on the universe. Ship Patron is not recommended for huge ships (what "huge" means depends on the universe); PCs may crew such craft, but probably should not own them. Ship Patron does *not* apply to military ships; for that, take Military Rank. Military officers cannot use "their" ship as they please!

Characters with this advantage receive *free* Rank at a level commensurate with their position aboard ship. This Rank is of a type appropriate to the wealth and reach of their Patron. If Ship Patron is ever lost, though, this free Rank and all of its benefits are lost as well.

PCs are not allowed to split the cost of Ship Patron (unlike Ship Owner, above). Everyone who enjoys the full benefit of the advantage should pay for it separately.

Disadvantages

Some disadvantages in ***Basic Set*** and ***Compendium I*** are especially limiting in a ***Space*** campaign, including Acceleration Weakness (p. CI79), G-Intolerance (p. CI81), Motion Sickness (p. CI82), Space Sickness (p. CI84), Xenophilia (p. CI95), and Xenophobia (p. B36).

Dependents — see p. B38

A member of an egg-laying race may have an *egg* as a Dependent! Of course, the egg would only count as a Dependent if the character really was concerned about it and personally responsible for it. An egg is helpless; such a dependent egg is a disadvantage worth a base of 16 points.

Skills

Certain skills are particularly important to spacers. A ship crewed by skilled people is far likelier to succeed. Shipboard computers (p. 64) can be used for some skill rolls, if necessary – but a skilled operator has more ability than a computer.

Armoury — see p. B53

Useful specialties in a space campaign include Beam Handguns, Body Armor, Spaceship Armor, Spaceship Weaponry (the GM may require different versions for energy and projectile weapons), Vehicular Armor, and Vehicular Weaponry. Roll at -5 without appropriate tools (p. 72).

Astrogation — see p. B59

This is a vital skill for star travel. Rolls are required to plot a course, find the ship's position if it gets lost, or to determine likely routes for another ship that is being followed. Modifiers and failure results are up to the GM, since this skill can be defined very differently for different universes (see p. 34).

Beam Weapons — see p. B49

Many beam weapons are described in Chapter 5. Specialties include:

Blaster: Weapons which fire particle beams or plasma bolts (rather than streams of plasma), such as blasters and particle-beam rifles.

Electrolaser: Weapons which damage using bolts of electricity, such as electrolasers.

Laser: Weapons which fire coherent electromagnetic radiation (light, microwaves, X-rays, or gamma rays), such as disruptors, lasers, X-ray lasers, and grasers.

Neural: Weapons which fire beams that affect the nervous system, such as neural blasters.

Sonic: Weapons which damage or disable using amplified, focused sound, such as stunners.

Driving — see p. B68, p. CI123

Specialize in a vehicle type. In high-tech societies, these include the specialties mentioned on p. B68 and p. CI123, as well as Hovercraft for air-cushion vehicles. Contragrav vehicles require Piloting skill, not Driving skill.

Force Shield — see p. B50

This skill is required to use the force shields described on p. 86.

Force Sword — see p. B50

The skill of using the force sword described on p. 83.

Free Fall — see p. B48

A very important skill for spacers. A Free Fall roll is necessary to perform many actions in microgravity (pp. 99-100) and zero gravity (p. 100), and often replaces DX.

Gunner — see p. B50

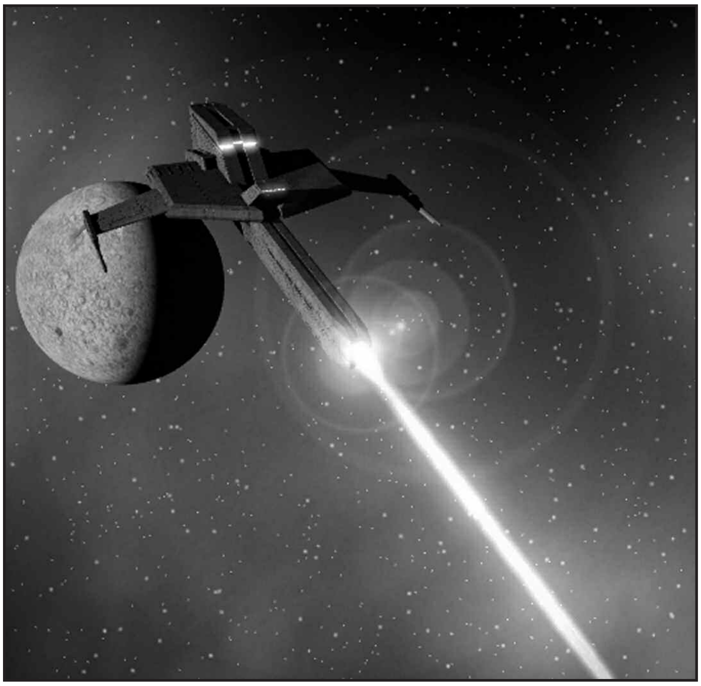
The ability to fire vehicle- and tripod-mounted weaponry, including weapons built into battlesuits and spaceships. Specialties include:

Beams: Directed-energy weapons, including laser cannon and particle beams.

Cannon: Medium- to high-velocity, large-caliber conventional (chemical-propellent) guns like autocannon, naval guns, and tank guns (but not mortars or grenade launchers).

Gauss Gun: Small-caliber electromagnetic guns, regardless of rate of fire.

Grenade Launcher: Large-caliber (up to 40mm), low- or very low-powered conventional or electromag guns.



Guided Missile: Self-guided missiles that require significant gunner input prior to launch.

Machine Gun: Small-caliber conventional guns fired in bursts.

Mortar: Large-caliber, low-powered conventional or electromag artillery intended for indirect fire (but not cannon, railguns, or grenade launchers).

Railgun: Large-caliber, high-velocity electromag guns (but not mortars or grenade launchers).

"Small caliber" traditionally means projectiles under 20mm in diameter, while "large caliber" is 20mm or larger.

Guns — see p. B51, p. CI121

In many future settings, beam weapons do not displace guns as handheld weapons! Specialties include:

Grenade Launcher: Short-barreled, low-velocity conventional or electromag weapons that fire large-bore (20-40mm) projectiles.

Light Automatic: Conventional long arms fired in bursts (RoF 4+), such as assault rifles and submachine guns (SMGs), as well as machine guns not mounted on tripods.

Machine Pistol: Conventional handguns fired in bursts (RoF 4+), including SMGs with folded stocks.

Needler: Any small-caliber electromag, gas, or spring-powered weapon, including Gauss guns, needlers, etc.

Pistol: Conventional handguns firing single shots (up to RoF 3~).

Rifle: Conventional long arms (guns with shoulder stocks) firing single shots (up to RoF 3~).

Tangler: Gas-propelled weapons firing sticky goo (see p. 79).

Language Skills — see p. B54

Each language is a separate skill. Alien languages do not default to one another unless they somehow derive from the same parent tongue (i.e., languages spoken by descendant cultures). Difficulty of typical starfaring languages:

Easy: Most pidgins.

Average: Any language designed to be pronounced *by the character's race.*

Hard: Alien languages which can be pronounced using the character's natural vocal equipment or with the aid of simple mechanical devices.

Very Hard: Alien languages which cannot be pronounced with a character's natural vocal equipment or simple mechanical aids.

Dialects. If FTL communications are limited and civilization vast, a common language may have hundreds of dialects. Treat a dialect as defaulting to the base language or another dialect at whatever penalty the GM sets; see p. B54 for suggestions.

Mechanic — see p. B54

Each type of maneuver drive, stardrive, power plant, or energy bank is its own specialization, as is each class of ultra-tech vehicle (e.g., Mechanic (Contragrav)). Mechanic (Robotics) covers battlesuits and mecha. Roll at -5 without appropriate tools (p. 72).

Piloting *see p. B69*

Piloting rolls are required for takeoff, landing, and docking. For routine situations involving skilled characters familiar with their craft, a failure usually means a delay, and even a critical failure only means a *potential* disaster (make a second skill roll to avoid it). Serious risks are only likely in bad weather, in combat, if the ship is badly damaged or under computer control, when landing in rough terrain, etc. If so, failure means damage and critical failure means catastrophe.

For ships that don't land or dock, a Piloting roll is required to enter standard planetary orbit. A failed roll just means a possible navigational violation; a critical failure means a potentially dangerous orbit. Piloting rolls can also affect combat (see Chapter 9).

Appropriate Piloting specialties include:

Aerospace: Flying vehicles with a top speed of 3,000 mph or more, as well as any spacecraft making a winged or lifting-body reentry or flight to orbit. Defaults to High-Performance Airplane (p. VE144) at -2, other Piloting at -4.

Contragravity: All vehicles that fly mainly via antigravity lift, regardless of propulsion type, while flying in a gravity field. Defaults to Vertol (p. VE144) at -3, other Piloting at -5.

High-Performance Spacecraft: All spacecraft with an sAccel of 0.1 G or more – or warp drive – maneuvering in space. Defaults to Low-Performance Spacecraft at -2, Aerospace at -4.

Low-Performance Spacecraft: All spacecraft with an sAccel under 0.1 G while maneuvering in space. Defaults to High-Performance Spacecraft at -2, Aerospace at -4.

Few characters will learn to pilot a spacecraft without also learning the Free Fall and Vacc Suit skills.

Psionic Skills *see pp. B167-176*

Psi powers are common in many SF universes. GMs may permit "espers" if they like, using the rules from Chapter 20 of ***GURPS Basic Set*** or from ***Psionics.***

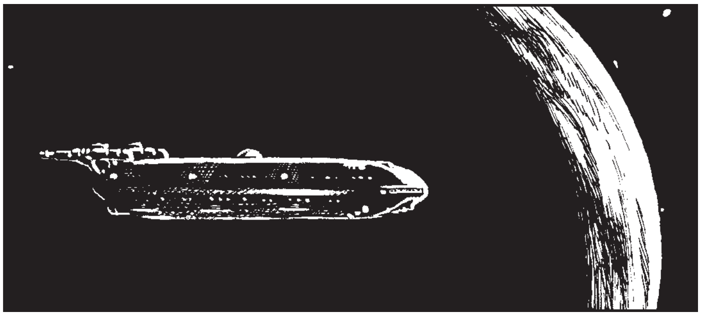
Shipbuilding (Starship) *see p. CI137*

The skill of assembling diverse components (designed using Engineer or Electronics) and building a hull around them to make a ship.

Heroic Performance

The GM may wish to let characters risk themselves and their equipment to "push the envelope" and improve technological performance. Successful skill rolls, at appropriate penalties, may let any system exceed its parameters. In general, this is limited only by the cleverness of the players and the generosity of the GM. Time required is left to the GM's discretion. The effects of a successful heroic effort are usually temporary – a turn, a space-combat round, or the duration of a particular voyage – governed more by dramatic necessity than anything else.

Boosting the performance of equipment usually involves operating it past its rated design limits. The GM should decide whether the players can just "roll and pray" or if extra work is needed. In some cases, a simple "I switch to manual and override the safety interlocks!" may fit the story; in other situations, this would not be realistic – an improvement might require the character to open up an access panel and fiddle with the double-talk generators. In the former case, the appropriate skill is an "operation" one, like Piloting or Electronics Operation. In the latter case, the necessary skill should be Electronics, Engineer, or Mechanic.



Before allowing a "heroic performance" skill roll, the GM should decide on the difficulty, reward, and cost of failure. At least some of this information should be conveyed to the players so that they can decide whether or not to chance it: decision-making is the core of roleplaying! The GM should also determine whether the enhancement can be repeated again if it succeeds, or if it is a one-shot attempt ("Okay, you can decouple the coolant system and double the super-laser's RoF this turn, but after that it will burn out – and that's if you succeed. If you fail, the coolant system will rupture and spray liquid nitrogen through the control room. Don't even ask what a critical failure might do. Do you still want to try?").

Success usually improves some statistic – weapon damage, communicator range, acceleration, FTL speed, the DR of a force screen – by a given percentage, or reduces the time required or the consumption of fuel, life support, or other consumables by a similar margin.

The GM can base the effect on the margin of success ("You succeeded by four, so you can jump 20% further!") or he can assign a skill penalty based on what the character wants to achieve ("Jump an extra two parsecs? That's 20% over your rated jump, so I'll make it -4 to Astrogation."). A good rule of thumb is to allow an increase in performance of about 1% times the margin of success or penalty for tasks that are reasonably "cost free," and 5-15% times the margin or penalty for tasks that are extremely dangerous or which cause breakdowns even if successful.

Failure should usually reduce performance by twice the amount that a success would have increased it. Critical failures in emergency situations should always be disastrous. Aboard ship, the GM might instead apply generalized damage to hull hit points, or even reduce the ship's overall HT. An alternative to damaging the system is to apply injury to the characters, or to describe a worse problem that prompt action can fix ("The fuel pump ruptured – liquid hydrogen is washing into the corridors – unless someone gets in there and seals the valve, we're doomed!").

In very cinematic campaigns, the GM may even let the characters try to make equipment do things that it was never designed for. Such field improvisations will be unreliable at best:

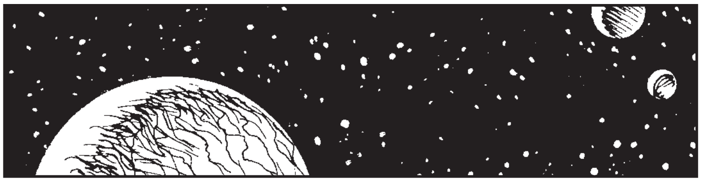
Player: "We have two days before the attack. You said that the Argosian invisibility field was an inversion of the force screen. I have those Argosian technical manuals we captured – now I want to reverse the polarity of our own force screens to work as a cloaking device. My character has Engineering-25."

GM: "In 48 hours? Okay, roll at -15. If you succeed, you have two rounds of cloaking before it burns out – and it won't work as a force screen while you are invisible. If you fail, the ship's force screen will be damaged and at -5% DR per point of failure . . . "

Another type of heroic performance is the "super-fast repair." The captain asks how long until the force screen is rebuilt, the chief engineer says "two hours," and the reply is "make it five minutes." A slavish interpretation of the guidelines above would be that this is -95% to time, so the GM should apply a penalty of about -19, but the GM can always allow players to trade risk for time. "Jury rigs" may be possible, but last only for the time spent on them times the margin of success; e.g., spend two minutes on a repair, succeed by five, and with luck it lasts 10 minutes. Characters may also be permitted to push the envelope *far* past the usual limits in exchange for much greater personal danger. For example, if the characters want their crippled main reactor to be fixed in minutes rather than hours, the GM may choose to allow it at a hefty penalty – but only if the engineering crew are willing to work alongside the automated systems *inside the reactor core,* receiving a dose of *x* rads per attempt!

Home Gravity

This is an item of "personal information" that becomes important in a ***Space*** campaign. The "native" gravity of each character must be recorded on the character sheet. If no gravity is recorded, the character's home gravity is assumed to be that of the race's native world; e.g., 1 G for Earthmen.



Economics, Jobs, and Wealth

"Average" starting wealth in an interstellar society is $15,000. For most PCs, 80% of this will be tied up in home equity, furniture, clothing, etc., leaving only $3,000 available to spend on adventuring gear. Of course, the Wealth advantage will increase both a PC's liquid cash *and* the quality of his home.

GMs may vary this starting wealth as required by the campaign. In general, set starting wealth equal to 30 times the monthly cost of living for a person of Status 0.

Colonist characters, setting down on a strange planet, are assumed to have put everything they own into their venture. Therefore, a colonist PC may spend his entire wealth on adventuring goods. If a colonist is part of a cooperative venture, with access to community equipment (such as a bulldozer to clear land), then *half* of his wealth may be spent on adventuring goods and the other half represents his share of the colony's equipment.

Starships are *very* expensive; see *Ship Owner* (pp. 46-47) for special rules governing their purchase.

Social Status and Cost of Living

Status (p. B18) reflects your position in interstellar society. Examples are listed below. Immediate family of individuals with Status 1+ have the same Status; more distant relatives have Status reduced by 1 or 2, but never to less than they would have on their own.

Level		**Monthly Cost of Living**
-1	Spaceport scum	$200
0	Ordinary citizen	$500
1	Ship's officer	$1,000
2	City/county administrator*; merchant ship owner	$2,000
3	Owner of a merchant fleet	$4,000
4	Planetary administrator*	$8,000
5	System administrator*	$15,000
6	Interstellar bureaucrat, senator, etc.	$30,000
7	Interstellar administrator*	$50,000

* Includes corporate executives, government officials, and Organization bosses.

Buying and Selling

The basic unit of interstellar currency in many SF universes is the *credit* (names vary, of course). For simplicity's sake, we will assume that one credit is roughly equal in buying power to one 1990 dollar. A sample price table is given below. The symbol for the credit is "$" – the old Terran symbol for the dollar. Amounts in millions of credits are often expressed as *megacredits* (M$).

On newly colonized worlds, barter may be necessary, and Economics and Merchant skills may prove vital.

On advanced worlds, financial transactions are handled through electronic transfer rather than physical cash. Some variation of a credit card or debit card is likely. Personal computers may be equipped to record and transmit transactions, sending them to the local bank or credit office for its records. Credcards or debit cards may incorporate some kind of digital encryption, which will have to be as powerful as the available computer technology can support to minimize the chance of fraud. They may also use passwords, or be coded to the owner's fingerprints, retina patterns, or – at higher TLs – DNA or brain-wave patterns, making them nearly worthless to a thief.

If FTL communications are limited or unavailable, there can be long waits for credit verification when the buyer is from a different planet; in this case, a traveler may have to carry hard cash or valuables in order to open a local account. Within the borders of a single economic region (state, empire, or trade confederation), letters of credit will usually be used instead, taking the form of a read-once credcard protected by the security measures described above.

Outside the borders of the issuing nation, though, credcards and cash may be less acceptable (although mercantile organizations may have their own systems for credit and secure financial transfers). Other nations will have other units of currency. These may have different bases and vastly differing values. In most campaigns, exchange rates should be simple; e.g., one Imperial Credit equals two Bolaski Pulg-Notes. More complex systems should be reserved for interstellar trading scenarios (traders *have* to be able to deal with different currencies) or for those rare scenarios in which financial confusion is the crux of the adventure.

But when complexity and confusion are the order of the day, the GM can be creative. Different races can use different forms of credit and value different goods. Treasure could be in the form of bars of plutonium, hand-drawn art circulating as money, or optical chips recording letters of credit. Really alien races may make funny faces as a medium of exchange, offer change in viral cultures, or trade their goods on the basis of personal intimidation. Some forms of "treasure" may be inconvenient, illegal, or *dangerous* to carry. Nobody said it was easy to be a star trader!

GMs who desire an extremely involved treatment of interstellar trade should consider using the rules presented in ***GURPS Traveller: Far Trader.***

Price Variations

The GM may wish to vary prices from world to world. To determine randomly how much a price may vary on a specific planet, roll 1d to determine whether the price is greater or less than list; in general, 1-2 equals a lower price, 3-4 equals normal, 5-6 equals higher. Then roll 1 die and multiply by 10% to determine the percent difference. Thus, a roll of 1, then a roll of 4 means the item costs 40% less than list on this world.

Generally, everything is more costly on remote or frontier worlds (+1 to the random variability roll), *especially* high-tech items. Merchant skills may allow bargaining for a better price. Black-market goods are always expensive (see p. 172).

Prices

Hotels, per night

Sleeper Cube	$6
Startown Low	$25
Starport Average	$50
Starport Deluxe	$200

Food, Drink, Etc.

Meal (Synthetic)	$5
Meal (Real Food, TL8+)	$10
Meal (Real Food, Imported)	$40
Soft Drink (Okrakola), per bottle	$0.50
Synthebeer (Rethay Lite), per mug or bottle	$1
Happy Stick (Leary Tube), per stick	$1
Mixed Drink (Naval Snoot), per drink	$3
Algae Wine (Bex-X), per bottle	$5

Medical Expenses See pp. 88-96

Communications/Information

Computer Net Data Time, per hour	$1
Comm & Data Net Hookup, per month	$20
Long-Distance Call, per minute (planetary)	$1
Interplanetary Call, per minute (in-system)	$5
Interstellar Call	depends on FTL radio technology!
Interstellar Mail, per ounce, per parsec	$0.20

Planetary Transportation

Ballistic Liner (transcontinental hop)	$200
Bullet Tube (per 1,000 miles)	$200
Hover Cab Service (per person per 10 miles)	$20

Ship Operations

Starport Docking Fees (per 500 cf per day)	$100
Starship/Spacecraft Fuel	See p. 116
Ship Insurance (against loss or damage)	10% of vessel cost per year
Ship Charter (including insurance)	
per day	0.1% of vessel cost*
per month	3% of vessel cost*

*Crew salaries and operating expense are not included.

Interstellar and Interplanetary Passage

If interstellar travel is routine, starfarers don't have to have their own ship. Passenger vessels ply regular routes, and freighters will carry a few passengers wherever they go. Costs given below are for interstellar travel, starport to starport. Inter*planetary* passages are 40% of these rates.

Luxury: $2,500/day. This is for the very wealthy. Travelers in luxury passage sections enjoy large suites, gourmet food, and a variety of other pleasures. Includes 250 cubic feet of luggage. This means single occupancy of a luxury cabin.

First Class: $500/day. Respectably spacious private cabins, first-class food, and good service. Includes 50 cubic feet of luggage. This means single occupancy of a cabin, or double occupancy of a luxury cabin.

Standard: $250/day. Usual accommodations on interstellar liners. Passengers usually share with another passenger. Food is adequate; services are limited. Includes 25 cubic feet of luggage. This means double occupancy of a cabin.

Steerage: $150/day. The lowest class of interstellar travel for conscious, aware passage. At best, travelers may be put in a bunk room. They are often given hammocks in the cargo hold or a storeroom (ship's life support must have adequate extra capacity for this). Food may be synthesized in the mess, or it may be concentrated rations; sometimes, it costs extra. Steerage travelers may have to put up with unexpected detours and delays, and may find themselves displaced in favor of higher-paying passengers (or even cargo), until the next ship comes along. Includes 10 cubic feet of luggage.

Freeze Passage: $50/day. Passengers who opt for freeze passage are usually those so down on their luck that they can't afford any other method of travel. They spend the entire voyage in suspended animation in freeze tubes (p. 91). Includes 10 cubic feet of luggage.

Not everyone can be revived successfully. Success is automatic if overseen by someone with Physician or Electronics Operation (Medical) at 10+, but this costs five times normal. Otherwise roll against HT: on a failure, the occupant receives 1d injury; 3d on critical failure (or the tube malfunctions and kills the sleeper). Sleepers must sign releases exonerating the ship owners from responsibility.

Working Passage: A negotiated arrangement by which a qualified traveler receives free passage in exchange for serving on the crew during the flight. Accommodations depend on the job. A stand-in for a missing pilot might get quarters equivalent to first class; a cook/steward would be lucky to have standard digs. Working passage is usually offered only by the smaller lines and by independent vessels, such as free traders, who may have difficulty finding last-minute crew replacements.

Luggage: In addition to their standard luggage allotments, travelers may carry whatever they can stow in their rooms (if they have any) and may purchase additional cargo space at $0.50 per cubic foot per day.

Job Table

On "civilized" worlds, PCs may find jobs to provide income while they are not in play. Jobs can help cover the PC's cost of living, as required by his Status. See p. B192 for general job rules.

The Job Table lists a number of jobs; the GM may add others, and not every job is available on every world. Some have skill or experience prerequisites (default values don't count here; you must have at least a half-point invested in the skill).

Remember that if a character's time spent adventuring is part of his job (e.g., for a starfighter pilot), his success should depend mainly on regular play, not job rolls.

Critical Failure Key

"LJ" stands for Lost Job – you were fired, demoted, or lost the client. The "d" indicates dice of damage ("3d" is 3 dice of damage; "10d" is 10 dice, etc.) – you were in an accident, fight, etc. The "i" indicates a lost month's income ("-2i" means losing 2 months' income) – you were fined, forced to pay for damages, had to replace equipment, etc. If there are two entries separated by a "/", use the second result *only* when a natural 18 is rolled.

Note that for some dangerous jobs, the result of a critical failure can be serious injury. The GM may choose to play out these episodes to give the PC a fighting chance.

Job (Required Skills), Monthly Income	Success Roll	Critical Failure
Poor Jobs		
Involuntary Colonist (no qualifications), negligible	8	1d/4d
Starport Bum* (no qualifications), $250	Scrounging or Streetwise	-1i/3d
Welfare Recipient (no qualifications), $300	10	-1i/dropped from rolls, reapply in 6 months
Struggling Jobs		
Actor or Actress* (Acting 10+), $50 × skill	PR	-3i/LJ, 1d
Colonist* (Any useful Craft or Outdoor skill 10+, Survival 11+), $50 × best PR	Best PR	-2i, 1d/-4i, 4d
Driver/Chauffeur (Appropriate Vehicle skill 12+), $60 × skill	PR	-2i, 1d/LJ, 3d
Laborer (ST 10+), $550	ST	LJ/5d
Shop Clerk (Merchant 10+), $600	IQ+Reaction	LJ
Average Jobs		
Bounty Hunter* (Beam Weapons 12+, Survival 10+, Tracking 13+), $100 × worst PR	Worst PR-2	LJ, 2d/LJ, 6d
Courtesan* (Sex Appeal 13+), $100 × skill	PR+Appearance	-2i/-4i, 2d
Criminal Enforcer* (ST 12+, Beam Weapons or Guns 12+, Brawling, Judo or Karate 12+), $90 × IQ	Best PR-4	LJ, 3d/8d
Interstellar Missionary* (Bard 10+, Occultism or Theology 11+, Clerical Investment), $75 × best PR	Best PR	-2i/LJ, 2d
Journalist* (Research 12+, Bard, Photography or Writing 12+), $70 × best skill + $500 per +1 general Reputation	Best PR	-3i, 1d/LJ, 3d
Lab Assistant (Computer Operation 10+, Research 11+, any science skill 10+), $100 × (worst PR-6)	Worst PR	-2i/LJ, 3d
Pirate (Beam Weapons or Force Sword 11+, Free Fall 11+, any shipboard skill 12+), $120 × IQ	10+|Reputation|	-3i, 4d/2d, imprisoned
Private Detective* (Criminology 12+, Law or Streetwise 12+), $75 × best PR	Worst PR	-3i, 2d/LJ, 4d
Prospector/Belter* (Prospecting 10+), $100 × skill	PR	-3i, 1d/LJ, 3d
Starship Crew (Status 0+, appropriate shipboard skill 10+), $80 × best appropriate skill + $200 × (Rank or Status)	Specific job's PR	LJ, 2d/LJ, 8d
Trooper (Status -1+, appropriate combat skill 10+), $1,000 + ($200 × Rank)	Best PR-2	-2i, 2d/-5i, LJ
Comfortable Jobs		
Assassin* (Beam Weapons, Crossbow or Guns 12+, Stealth 12+), $300 × worst PR	Worst PR	-4i, 4d/8d
Computer Programmer* (Computer Programming 14+, Electronics Operation (Computers) 12+), $250 × worst PR	Worst PR	-3i/LJ
Corporate Executive (Administration 13+, business experience 5+ years, Status 0+), $3,000	PR	-2i/-4i, LJ
Corporate Spy* (Acting 12+, Stealth 10+), $300 × worst PR	Worst PR	LJ, 1d/LJ, 4d
Diplomat* (Diplomacy 12+, Administration 10+, Status 1+), $1,000 × (Diplomacy-11)	Worst PR	-2i, LJ/LJ, 2d
Free Trader* (Merchant 12+, any shipboard skill), $1,000 + normal for shipboard position	Merchant	-3i, 1d/LJ, 4d
Major University Professor (Any academic specialty 13+, Teaching 11+, Status 1+), $1,000 × (specialty-12)	Specialty	-3i/-5i, LJ
Science Officer (Computer Programming 12+, Electronics Operation (Sensors) 11+, any science skill 10+, Status 0+), $400 × (Status + Rank + best PR-12)	Worst PR	-1i, 1d/LJ, 3d
Scientist* (Computer Operation 12+, Research 13+, any science skill 14+), $300 × best Science skill	Worst PR	-3i/LJ, 3d
Ship's Captain* (Leadership 12+, Tactics 12+, Status 0+), $500 × (Status + Rank + Leadership-12)	Worst PR	-3i, 2d/LJ, 4d
Smuggler* (Holdout 12+, Streetwise 12+), $3,000	Worst PR	-2i, 1d/-2i imprisoned, 3d
Wealthy Jobs		
Corporate Chief Exec (Administration 13+, Leadership 12+, business experience 10+ years, Status 3+), $5,500	Worst PR	-4i/-5i, LJ
Corporate Research Scientist (Research 12+, any practical science skill or Engineer 13+, Status 1+), $2,000 × (Research-12)	Worst PR	-3i/LJ, 2d
Doctor/Surgeon* (Diagnosis 12+, Electronics Operation (Medical) 10+, Physician or Surgery 13+, Status 0+), $650 × best PR	Worst PR	-3i/-10i, lose license
Holo-Vid Star* (Acting, Bard, Musical Instrument or Singing 12+, Status 1+), $500 × (best PR + reaction bonus)	Best PR	-5i/LJ, 1d
Idle Rich/Noble (Status 3+), $3,000 × (Status-2)	IQ	-4i, 1d/-12i, loss of title
Planet/System Govt. Administrator (Administration 12+, Status 1+), $5,000 if minor system, $10,000 if major system	PR	-3i, LJ/LJ, imprisoned
Sector Administrator (Administration 13+, Status 2+), $2,000 × (Administration + Status - 13)	PR	-4i, LJ/LJ, imprisoned

Variant Human Races

In a universe in which mankind has been starfaring for thousands of years, there will be *variant races.* On that time scale, such races will probably be bioengineered, although in some SF they are "natural" adaptations to new conditions (heavy muscles for heavy gravity) or the result of genetic drift (crimson skin and white hair).

Attributes: Variant humans use the same attribute table as humans (p. B13) – but they may get *bonuses* or *penalties* in one or more attributes. These bonuses and penalties affect the final attribute level, not the point cost. For example, the Skathi, a heavy-world race, get a +3 to ST. If a Skathi pays 0 points for ST, he gets a 10 (from the attribute table) plus 3 (the bonus), for a total of 13. If he pays 10 points for ST, he gets an 11 (from the table) plus 3 (the bonus), for a total of 14. And so on.

Advantages and Disadvantages: Many races have "automatic" advantages and disadvantages. For example, all Skathi have Absolute Direction and Bad Temper. When a variant-race PC is created, racial disadvantages do *not* count against game limits on allowable disadvantages.

Friends and Enemies: Variant races have whatever racial foes the GM gives them. Radical variants may not be attractive by normal human standards and may suffer a reaction penalty for their appearance. Well-traveled or cosmopolitan people (Patrol officers, for instance) will ignore or genuinely not notice racial differences, however.

Psychology: Variants will likely have psychological adaptations to go along with their physical ones. For instance, spacers adapted to living in the close confines of space suits and ships may end up mildly agoraphobic.

Variant races can be created for any environment – for instance, a barrel-chested race adapted to very thin atmosphere. Add some interesting racial advantages or disadvantages, and possibly some cosmetic change from human norms (0-point "features") – green skin, bald head, extra fingers, etc. There will usually be a character point cost to be a member of a variant race. To compute this, start by calculating the value of the race's attribute modifiers. Use the costs listed on the human attribute table on p. B13. For example, +1 on any attribute is worth 10; +3 is worth 30; +4 is worth 45, and so on. Negative modifiers have negative costs. Advantages and disadvantages have their normal point values.

The three most common variant racial types are:

Heavy Worlder — 45 points

Racial Attribute Modifiers: ST +3 [30]; HT +1 [10].

Racial Advantage: Improved G-Tolerance (0.5 G increment) [10].

Racial Disadvantage: Unattractive [-5].

A heavy worlder's mass is 25% over the human norm, but height is 1' less than indicated for ST. He is *wider,* which can present problems when negotiating narrow passages or doors designed for normal humans (a DX roll to squeeze through).

The heavy worlder is adapted for life in 1.5 to 2 Gs. He has more muscle to get around, stronger bones to avoid breaking them in falls, and a modified circulatory system to prevent early death due to heart failure. He is usually unattractive by human standards, with a barrel chest and a compact, blocky body.

Light Worlder — -5 points

Racial Attribute Modifiers: ST -2 [-15]; HT -1 [-10].

Racial Advantage: Longer Arms (+1 reach) [20].

Light worlders have a willowy build, often with long limbs and spidery fingers. Height is up to 2' over the norm for ST, but mass is 15% to 25% lower than normal. Light worlders can sometimes squeeze into places that normal people can't fit, but this is balanced by their extra height (needing to duck under doors and so on). In settings where artificial gravity is uncommon, this variant racial package should be worth an extra -5 points.

A light worlder's home gravity is 0.2 to 0.7 G.

Spacer — -73 points

Racial Attribute Modifiers: ST -5 [-40]; HT -2 [-15].

Racial Advantage: Slow Regeneration (Only to replace bone decalcification; -75%) [3].

Racial Disadvantages: G-Intolerance (0.05G increment) [-20]; Skinny [-5].

Racial Skill Bonus: +3 Free Fall [4].

Spacers are adapted to micro- or zero gravity, and as a result tend to be very tall and emaciated: increase height by up to 3' over the norm for ST, but mass is 25% to 50% of normal. Some "spacers" may be unattractive, while others have an elfin beauty.

Spacers have a home gravity of 0 G; a modified parathyroid gland restores calcium levels, preventing bone atrophy and otherwise adjusting their metabolism to life in zero gravity.

Genetically Enhanced Humans

At TL9, significant genetic manipulation of humans is possible, though expensive. At TL10, it is routine. Certainly, we'll be able to breed new types of man long before we're wise enough to decide what makes humans "better." Campaign possibilities include:

Men To Fit The Job. If genetic manipulation is fairly easy, "new men" might be built for all kinds of jobs. Heavy- and light-world colonists could be created in one generation by relatively simple manipulations. With a little more difficulty, the manipulators could create furred colonists for cold worlds, water-breathers for ocean planets, lemur-eyed folk for dark worlds . . . Indeed, a human-only universe could include races as alien as anything a writer ever imagined.

Reactions of regular humans to "new men" will vary from admiration to hatred. At least for the first few generations, though, many humans will be jealous of their superior traits and contemptuous of the fact that they were "bred like animals."

Everybody's Perfect. In a campaign where genetic manipulation is widespread, the GM may (for instance) halve the costs of better stats, physical advantages, and some mental advantages. Anyone can have the genetic improvements of their parents' choice.

Super-warriors. Suppose the manipulation process is new and difficult. A cadre of supermen, the offspring of a secret project, could be trained as devastating warriors. They would have very high attributes and possibly special abilities like Night Vision. Intelligence might be left at normal or even low levels.

Super-agents. If the process is *very* difficult, the results might be too expensive to use as cannon-fodder . . . so the super-kids would be trained as assassins and secret agents. A campaign might focus on the exploits of such a group . . . or they might be the feared enemy. Heinlein's *Friday* tells the story of one such agent.

For *much* more on altered humans, see ***GURPS Bio-Tech.***

Alien Races

If the campaign includes alien races (see pp. 9-10), the GM should permit alien PCs whenever they can reasonably fit in.

Everyone – GMs and players – must roleplay creatively when taking the part of aliens. Even in a space-opera campaign, where all the aliens are human beings in furry coats, this will add to the fun. And in a hard-SF campaign, it will be *necessary* to play other races as genuinely *alien.* A few points to keep in mind when dealing with alien races:

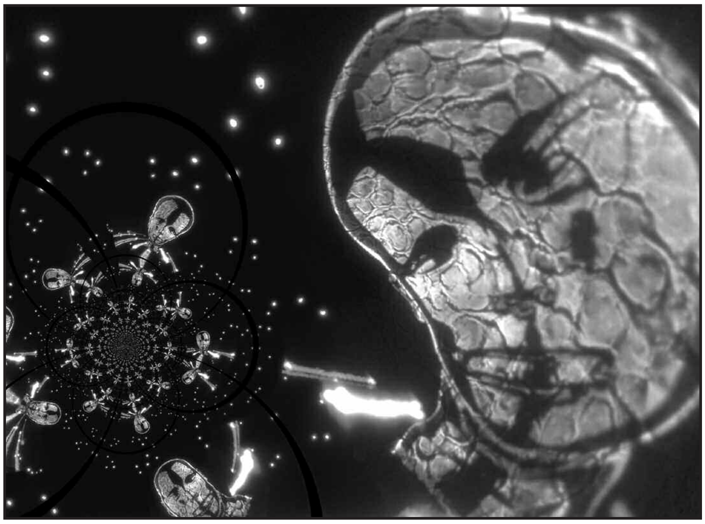
Charisma always works. For game purposes, we define this "force of personality" as universal.

Voice, good looks, etc., rarely work. Aliens will not respond to a pleasant voice unless it is, by coincidence, pleasant to *them.* Few aliens will notice physical beauty in a human. And so on.

Aliens will have racial likes and dislikes. This may be as simple as "reacts at +2 to Terrans" or as quirky as "will not deal with anyone wearing orange."

*Aliens may not **want** the same things we do.* Likewise, they may not fear the same things we do. Most humans want wealth, comfort, and the approval of their fellow man, and fear injury, ridicule, and death. Aliens may not see things the same way . . .

Aliens may like and dislike different things about individuals. For an example, see the Sparrials (p. 56).



Creating Alien Races

GMs may invent alien races at will, using the guidelines described for variant human types (p. 54). It is a good idea to develop a race and its homeworld in parallel. A race will be shaped by its world; if the race is very strong, for instance, it probably comes from a high-gravity world. If it breathes methane, it comes from a Hostile Terrestrial or Gas Giant planet. And so on. The creator of a race should always specify its preferred gravity, temperature, and atmosphere (both gas content and pressure). This defines the sort of real estate the race will be interested in.

Earthlike life – the only life we know of – has two major prerequisites. The first is water, which is the medium in which life-sustaining chemical reactions occur. The second is the availability of carbon atoms, which exhibit a unique ability to combine with hydrogen, oxygen, and nitrogen atoms in long-chain molecules. This creates the complex organic compounds that form carbon-based "life-as-we-know-it." Where carbon and water exist, there is a good chance of finding life, although whether it is intelligent is another matter!

In environments too dry, hot, or cold for liquid water, substances other than water might act as a medium for chemical reactions. Liquid methane and ammonia show some promise at very low temperatures, and sulfur at high ones. Gas giants such as Jupiter have also been suggested as having a suitable blend of heat, pressure, and atmospheric gases to enable hydrogen-methane based life, although their highly turbulent atmospheres might prevent this from happening. Alternatives to carbon are also possible, notably silicon and phosphorous, both of which form long-chain molecules under certain conditions. Unfortunately, silicon oxidizes easily to simple silicate minerals, while phosphorous requires extremely unusual conditions. Going further out, even more exotic possibilities may be feasible – in a suitable environment, intelligent gas clouds or magnetic plasmas might exist! Because of its low density, such a creature might have to be very large to support a complex nervous system, but for an entity that lived in space, that might not be a difficulty.

However you develop a race, don't just describe it physically. Consider its psychology. This will be determined largely by the race's planned role in your campaign – but make it interesting!

In a "space opera" campaign, most races will have human motivations, perhaps with one trait intensified . . . dog-like aliens who are very loyal, catlike aliens who are very proud and combative, snake-men who are creepy and sinister. In a "hard SF" campaign, some aliens are likely to have wholly unfamiliar shapes, and their physical makeup will give no clue to their psychology. Their motivations may be wholly unknowable to humans. Alternatively, they may be horrifyingly alien in shape and have very human motivations – contrary to the expectations of many players!

Advantages and Disadvantages

Alien races will have racial advantages and disadvantages, as described for variant humans (p. 54). Some things will be disadvantages only if the campaign is primarily human-dominated. For example, if a race averages 3' tall, they will have the racial Inconvenient Size disadvantage if they must rely on humans to get them into space . . . but if they build their own ships, their small size doesn't matter and they don't get bonus points for their size – it's just a "feature" of the race.

Reaction bonuses or penalties can be ignored unless they apply to *most* other races they will contact – or to the dominant intelligent life form in your universe. In that case, each +1 reaction bonus is worth 5 points and each -1 is worth -5 points. Other traits that affect reaction rolls, like Appearance, are treated the same way.

A race may have other strong or weak points that don't translate directly into listed advantages and disadvantages. GMs should allow a reasonable "cost" for these.

Aliens can often be built by taking a standard advantage or disadvantage and defining it creatively. For instance, you could choose Hideous Appearance and say it is because, instead of teeth, the alien's mouth is full of tiny, wormlike tentacles that squirm and wiggle obscenely as he talks. (Of course, to his own race, he is the very epitome of beauty.)

Alien "Features"

Alien races may also have *features* far different from the human norm. Something is considered a feature if it gives the possessor no significant advantage or disadvantage, but is interesting enough to mention. In humans, red hair might be a feature. Some sample features:

Native society. A race might be naturally patriarchal, or communistic, or attach a very high value to personal property or honor. Perhaps certain castes (or sexes, or ages) are not intelligent.

Physical appearance. Fur, feathers, scales and so on. But thick fur might be equivalent to armor. Fur or scales like this costs 25 points per +1 PD and 3 points per +1 DR.

Means of communication. But a particularly obscure mode of speech (such as that of Kurt Vonnegut's Tralfamadorians, who communicated by "farting and tap-dancing") would give a penalty on reactions.

Sexuality. A race might be asexual, or have several sexes. There may be social advantages and disadvantages, *within* the race, to the different sexes. The specific means of reproduction, or the life cycle, may be unusual.

Sample Aliens

Here are four alien races that can be dropped into any interstellar campaign. Really outré races require more special rules than can be given here, but all manner of races can be created using the race-creation guidelines on pp. CI173-180 and in ***GURPS Bio-Tech.***

The tech level of these races has *not* been specified. GMs may use them as the primitive natives of a new planet, the Elder Race that takes Man to the stars, or anything in between.

Sparrials — 8 points

The Sparrials are a small, vaguely feline race descended from a tree-dwelling predator. They are bipedal. Their hands have four skeletally thin opposable fingers with retractable claws. They are sleekly furred; most coats have varying patterns of brown or rust color, but albinos are relatively common. The mouth is their most "alien" feature; closed, it does not look unusual, but it contains several fleshy organs and a grid of rough, serrated bone that serves as teeth.

Sparrials have two sexes; the males are slightly smaller and faster than the females. By human standards, a Sparrial has normal height and weight for his ST.

Environment: Sparrials are native to a 0.95-G Terrestrial world with an average temperature of 65° – cool by human standards. However, they have a wider temperature tolerance than humanity; they can live anywhere a human can. They breathe a standard Terran oxygen mix at 0.97 atmospheres.

Psychology: Sparrials are active and adventuresome, but can be very patient when there is need. They tend to be quarrelsome among themselves until a "pecking order" is established, through argument, battle, or clever thefts. Sparrials steal from those around them in much the same way humans trade quips and insults – to establish dominance and to show their own worth without combat.

Sparrials react strongly to smell. They dislike some races and like others purely on the basis of odor. Human scent varies widely, in Sparrial view. The first time a human meets Sparrials, roll 1 die, subtract 3, and record the result. This determines how the Sparrials like his odor; that is the Sparrial reaction bonus (or penalty) for that person thereafter.

Racial Attribute Modifiers: ST -3 [-20]; DX +2 [20]; HT +1 [10].

Racial Advantages: Acute Taste and Smell +2 [4]; Night Vision [10]; Super Jump 1 [10].

Racial Disadvantages: Gluttony [-5]; Kleptomania [-15]; Short Lifespan 1 [-10]; Stubbornness [-5].

Racially Learned Skills: Climbing at DX-1 [1]; Detect Lies at IQ+3 (Scent-based; works vs. humans, Sparrials and most other races; -20%) [8].

Pachekki -3 points

The Pachekki's ancestors were amphibian omnivores, living in the branching vegetation of a fresh-water sea. They are upright bipeds, like men, but they are nothing like Terran life; one detractor called them "bastard offspring of bugs, lizards, and crabgrass." With their lipless mouths, bulging insect eyes and "hair" of waving auditory palps, they look rather awful to humans. Their hands are their most human feature – but they have six fingers and a thumb! Pachekki also have a limited regeneration ability: they can regrow lost fingers, eyes, palps, and other small body parts, but not limbs.

Pachekki are tall and slender: a foot taller than human-normal for ST, and 20 lbs. lighter than human-normal for their height.

Environment: Pachekki are native to a watery 0.7-G greenhouse world with an average temperature of 100° – very hot by human standards. They prefer a humid oxygen atmosphere, with atmospheric pressure 1.2 times Terran standard. This is rare on low-gravity worlds, so the Pachekki will find "perfect" planets rare and will lay strong claim to them.

Psychology: The average Pachekki is not very bright . . . but there are a few smart ones, and they become the explorers and leaders. "Underling" Pachekki are not slaves or drones, but they will follow their smarter leaders with a matter-of-fact loyalty that Terran rulers envy. Pachekki are very interested in technology and biotechnology. They work hard to shape their environment to fit themselves; with access to genetic technology, they'll work just as hard to shape themselves to other environments. As a race, they are somewhat jealous of species that can use the more common types of terrestrial planets.

Pachekki are bisexual, but each individual changes sex in response to random environmental stimuli. A Pachekki character rolls 1d each day; on a 6, he becomes she (or vice versa). A male Pachekki has the additional trait of Laziness; a female has Impulsiveness and is generally hyperactive. Sexes are not otherwise distinguishable without dissection, except to another Pachekki. Pachekki government tends toward collective leadership to balance the effects of sex changes on individual leaders.

Racial Attribute Modifiers: ST -4 [-30]; DX +3 [30]; IQ -1 [-10]; HT +2 [20].

Racial Advantages: Double-Jointed [5]; Peripheral Vision [15]; Rapid Healing [5]; Regrowth (Small extremities only; -50%) [20].

Racial Disadvantages: Dependency (Water; must swim or bathe regularly) [-5]; Hard of Hearing [-10]; Impulsiveness *or* Laziness [-10]; Increased Life Support (Extra heat and water) [-10]; Reduced Move -1 [-5]; Split Personality (Sex changes) [-10]; Ugly [-10].

Racial Skill Bonus: +3 Swimming [2].

Treefolk 75 points

On the Treefolk's home world, the kingdom of life did not split into plants and animals; the Treefolk share characteristics of both. They photosynthesize (using a purple pigment), and get nutrients from thick roots. But they also use their eight handlike fronds to gather food. They have three stalked eyes, which look very human. Their own speech is ultrasonic, but they can speak in lower registers for the convenience of other races. Their physiology is overall quite tough and resistant to damage.

Because of their unusual structure, Treefolk perform differently in combat. Of their eight fronds, only four can be used to swing weapons. They cannot punch, but they can fight effectively with two hand weapons at once (but can only aim one missile weapon at a time). See *Extra Arms* (p. CI54) and *360-Degree Vision* (p. CI68) for other combat bonuses.

Treefolk are huge: a foot taller than human-normal for ST, and 100 lbs. heavier than human-normal for height. Treefolk don't start aging until they reach 150, and then only at half the rate of a human.

Environment: Treefolk are native to a 1.1-G Terrestrial world with an average temperature of 75° – Earth-normal. They breathe carbon dioxide and release oxygen; atmospheric pressure makes very little difference to them. Their home star is type F6; under dimmer suns, they tend to be sluggish, losing one IQ point for each spectral type cooler than F.

Psychology: Treefolk love nature and tend to live near bodies of water or in areas of moist rich soil. Their "homes" are well-kept outdoor areas with small shelters; a Tree may have possessions that must be sheltered from the elements, but *he* likes standing in the rain. They are *not* pacifists, and can be implacable foes. They are independent and self-sufficient by nature; while they comprehend the idea of "government," they find it obnoxious, and will obey political authority only grudgingly. They fear fire above all else. Treefolk are bisexual, but the difference matters only to another Tree.

Treefolk like technology but dislike human cities, where they can't feel the ground under their roots. High-tech Treefolk would get around in small carts containing pots of earth, and would use bright sunlamps to colonize worlds of dimmer suns.

Racial Attribute Modifiers: ST +2 [20]; DX -3 [-20]; IQ +2 [20]; HT +4 [45].

Racial Advantages: 360-Degree Vision (Eyestalks, -20%) [20]; DR 2 [6], with +3 DR vs. non-explosive missiles [6]; Extended Lifespan 1 [5]; Extra Arms (2 fully functional arms, 4 short ones with no attack) [28]; Improved G-Tolerance (0.3 G increment) [5]; Injury Tolerance (No Neck) [5]; Pressure Support [5]; Ultrasonic Speech [25].

Racial Disadvantages: Color Blindness [-10]; Hard of Hearing [-10]; Honesty [-10]; Increased Life Support (see above) [-10]; Reduced Move -4 (Move cannot exceed 1!) [-20]; Vulnerability (3d from fire) [-30].

Racial Quirks: Demand Courtesy [-1]; Detest Poetry [-1]; Ignore Status [-1]; Love Nature/Hate Cities [-1]; Strongly Libertarian [-1].

Feature: Cannot Swim – drown in (HT/2) hours in water more than three feet deep [0].

Gormelites 19 points

These ogreish humanoids are something of a mystery. There is reason to believe that their ancestors manipulated them genetically or that they are descended from the survivors of a nuclear war. The general form is shockingly human: two arms, two legs, a head, two hands, each with four fingers and one thumb. But the differences are equally shocking. The mouth is flat and lipless, edged with bone; there are no teeth. Nose and external ears are absent. The eyes are blank white membranes. The body is covered with sparse fur.

Gormelites are 6″ taller than human for their ST and 50 lbs. heavier than human for their height. The Shaggy life span is about equal to that of humans, but few die a natural death; wars and duels account for most adults before their 40th year.

Environment: Shaggies are native to a 1.2-G Terrestrial world with an average temperature of 40° – cold by Earth standards. They breathe oxygen at slightly under Earth-normal atmospheric pressure.

Psychology: The race is very territorial and acquisitive. Gormelites would reject as nonsense the idea that "all men are created equal." To them, there is only master and servant . . . and those too weak to serve are usually killed out of hand. A Gormelite's goal is to be a master, or, failing that, to be a highly ranked servant of a very tough master. This is one reason why Terran scientists theorize they may have been an artificially bred warrior race. For whatever reason, Gormelites do not cooperate well with each other, and get along even worse with most other races. Their entire planet (and any other planet they may control) is divided into small, independent states, each controlled by a warlord whose only ambition is to conquer his neighbors.

Normally, Gormelite females are just as tough and nasty as males. Pregnant females secrete hormones that make them pacifists (self-defense only), and pacify others at close quarters; thus, a Gormelite "nest" is a comparatively peaceful place. Disagreements and duels are taken outside. The young Shaggies are kept in the nest until they begin to mature (about age 12). Danger to the "nest" will drive Gormelites of both sexes into total rage, and no normal Gormelite will endanger a nest, even his bitterest foe's. Unfortunately, they show no such compunction toward the homes and children of other races.

Note that Gormelites are *not* berserkers; their attacks are clever and calculated, and many are scheming sadists.

Racial Attribute Modifiers: ST +4 [45]; HT +3 [30].

Racial Advantage: DR 1 [3].

Racial Disadvantages: Bad Temper [-10]; Bully [-10]; Greed [-15]; Overconfidence [-10]; Paranoia [-10]; Reputation -2 (As dangerous, untrustworthy thugs, to everyone) [-10].

Racially Learned Skills: Axe/Mace at DX [2]; Brawling at DX+2 [4].

SPACE CAMPAIGN PLAN

GM: ________________ Date: ________________

Campaign name: ___________ Campaign's starting year: _____ Rate game time passes: _______ Campaign type: ___________

Known alien races: ______________________________

Campaign's base world: ______________________ (Suggestion: give players a Planetary Record for this world.)

Frequency of "good" worlds: ______________ Is exploration still going on? ________ Where? ______________

Campaign political background:

Name and type of stellar state: ______________________ Control Rating and (if different) weapons CR: ________

Brief description of the state and its neighbors: ______________________________

____

Brief description of the political/economic situation: ______________________________

____

Campaign's Tech Level: ______ Differences from this Tech Level as described in ***GURPS Space:*** ______________

FTL communications speed, range, and availability: ______________________________

Medical technology: ______________________________

____

Starship rules:

FTL drive type: __________________ Speed: _____________ Fuel: cost, consumption, etc.: ______________

Ease of FTL navigation: ______________ FTL Engineering Skill Difficulty: ______________

Obstacles to FTL travel: ______________ Time effects of FTL travel: ______________

FTL side effects, error effects, special notes: ______________________________

STL drive type: ___________ ______ Speed: _____________ Fuel: cost, consumption, etc.: ______________

Ease of STL navigation: ______________ STL Engineering Skill Difficulty: ______________

STL side effects, special notes, etc.: ______________________________

Power plant type: __________ Engineering Skill Difficulty: ________ Fuel: cost, consumption, etc.: ______________

Usual/allowable weaponry and shields: ______________________________

Player Character information:

PC races (or human subtypes) allowed: ______________________________

(GM should provide racial descriptions for any new races allowed as PCs.)

Base wealth for PCs: ________________ Starting social levels allowed for PCs: ______________

Language(s) the PCs will need: ______________________________

Especially useful/useless character types: ______________________________

Especially appropriate/inappropriate professions: ______________________________

Advantages and skills that will be especially useful in this campaign: ______________________________

____

Advantages and skills that will be worthless in this campaign: ______________________________

____

Disadvantages that will be discouraged in this campaign, either because they are fatal or because they won't really be disadvantages:

____

Appropriate Patrons (and base value): ______________________________

Appropriate Enemies (and base value): ______________________________

Special disciplines available in this campaign:

Magic? (How powerful? How common? General mana level?) ______________________________

Psionics? (How powerful? How common? ______________________________

Rules variants: New skills, advantages, disadvantages (summarize) ______________________________

____

Rules variants: Changes in combat rules (summarize) ______________________________

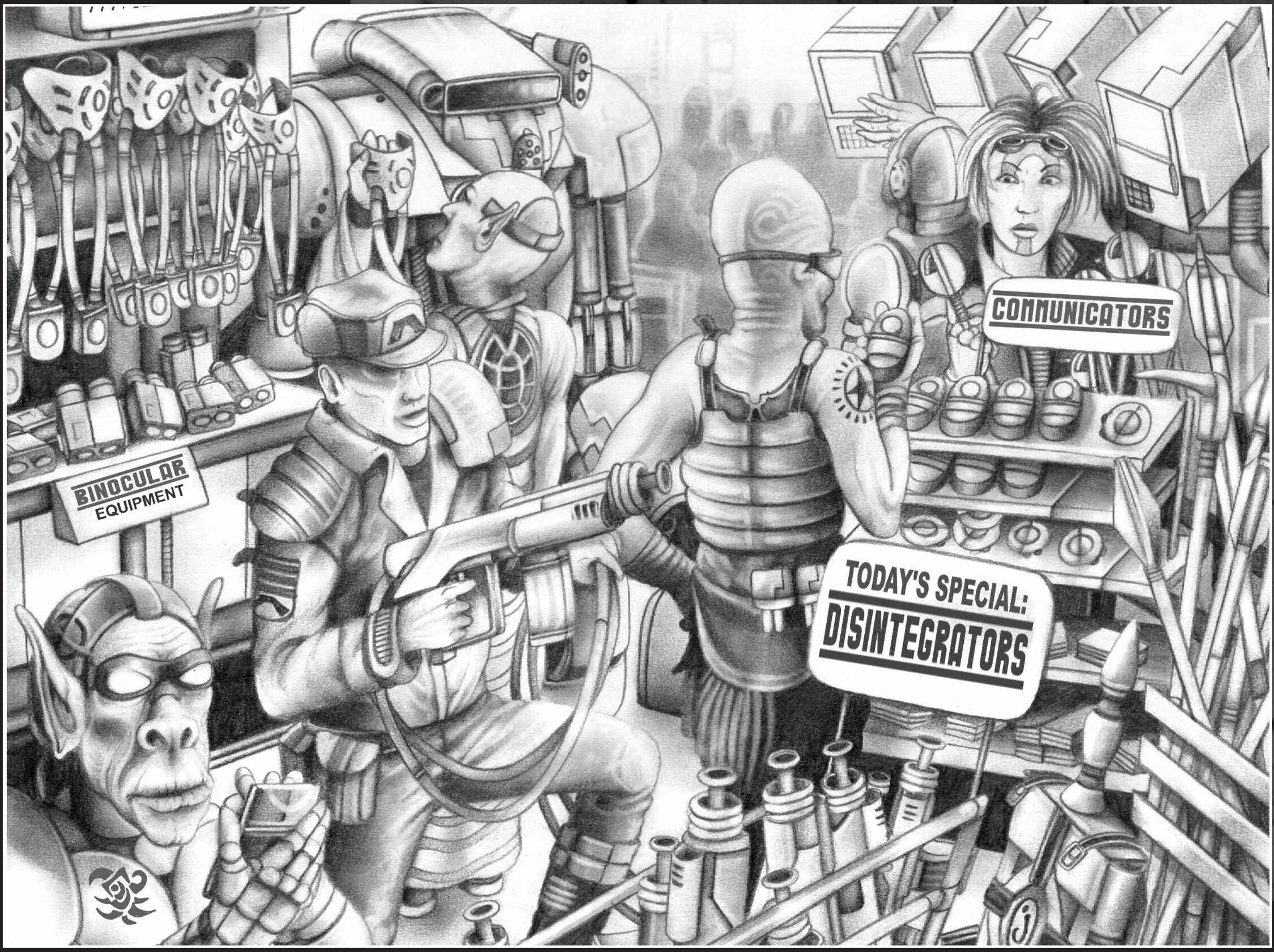
____

The GM should also provide the players with details on:

new gadgets, and their availability; new advantagees, disadvantages, or skills; "house rules" for character creation; changes in the combat rules; new NPC races; important organizations; and history.

GADGETS

CHAPTER 4



The equipment described in this book will work with most future universes. SF campaigns can never have too many gadgets, though: the GM should definitely invent new and unique devices. Some will be available anywhere; others will be secrets for adventurers to discover.

Additional gear can be adapted from other ***GURPS*** worldbooks, such as ***Cyberpunk,*** or from your favorite SF novels. Items can also be derived from equipment in today's world (certain items *here* are listed as "TL7"; they may not be in common use, but they would be if we needed them!). For entire books of gadgets, see ***Ultra-Tech*** and ***Ultra-Tech 2*** – and ***Robots*** and ***Vehicles*** for robots and vehicles.

GMs are free to *omit* any device that would unbalance their particular campaign. For instance, if the campaign is about mankind's first contact with an alien race, interspecies translation equipment should not be available!

Improvements at Higher TLs: Most items remain available at all TLs after introduction, but they become less expensive. For any item introduced at TL8 or later, *halve cost at the TL after introduction, and halve it again at the next TL.*

Any *electronic* device also becomes smaller at higher TLs. For electronics introduced at TL8 or later, *halve weight and size (if applicable) at the TL after introduction, and halve it again at the next TL.*

Some items, specifically mentioned, continue to drop in cost or weight; otherwise, there no further reduction. Some items become more effective at higher TLs as well.

Power: Power-using gadgets can be assumed to use either superscience power cells or advanced batteries (see *Energy Banks,* p. 26). If using cells, duration assumes *steady* use (e.g., a year means turning a radio on and leaving it on for a year); casual use will be about ten times as long. If using batteries, duration assumes *normal* use; steady-use duration will be about 1/10 as long.

The standard power cells used by TL8+ gadgets are described on p. 68.

Air Masks, Vacc Suits, and Life Support

Air Mask (TL7): Used on worlds that have harmless but unbreathable atmospheres (nitrogen, CO_2, and so on). Covers the entire face (human eyes get oxygen directly from the air). Always includes a short-range communicator (p. 63), which uses an A cell. Requires air tanks or a filter (below). 3 seconds to put the mask on, 1 to take off. 2 lbs., $100. For another $50, the mask includes an emergency tank with 3 minutes of air.

Air Tanks (TL6): For a 1-hour tank at TL6: 40 lbs., $200. For a 1-hour tank at TL7: 30 lbs., $100. For a 2-hour tank at TL8+: 10 lbs., $100. For a 24-hour tank at TL8+: 73 lbs., $400. Refills are $5 per hour if you don't have your own air compressor. Tanks take 10 seconds to put on, 2 to drop.

One hour of oxy-helium breathing mix, at one atmosphere, weighs about 1.5 lbs. (oxy-nitrogen, or ordinary compressed air, would weigh 4.2 lbs.); in all case above, the rest is the tank weight. Of course, these times are an approximation. Different people use air at different rates. For game purposes, assume that all adults breathe the same amount of air, and that children under 12 use half as much. All times assume an external pressure of 1 atmosphere or less. At 2 atmospheres, an air tank lasts only half as long, and so on.

Scrubber (TL6): Can be added to an air mask (+1 lb., $200). Gets rid of exhaled CO_2 and water; captures and recycles unused oxygen and inert gas in the breathing mix. Does not replace air tanks, but makes them last twice as long. Works for 12 hours on a B cell; also requires a chemical charge ($20 for 12 hours).

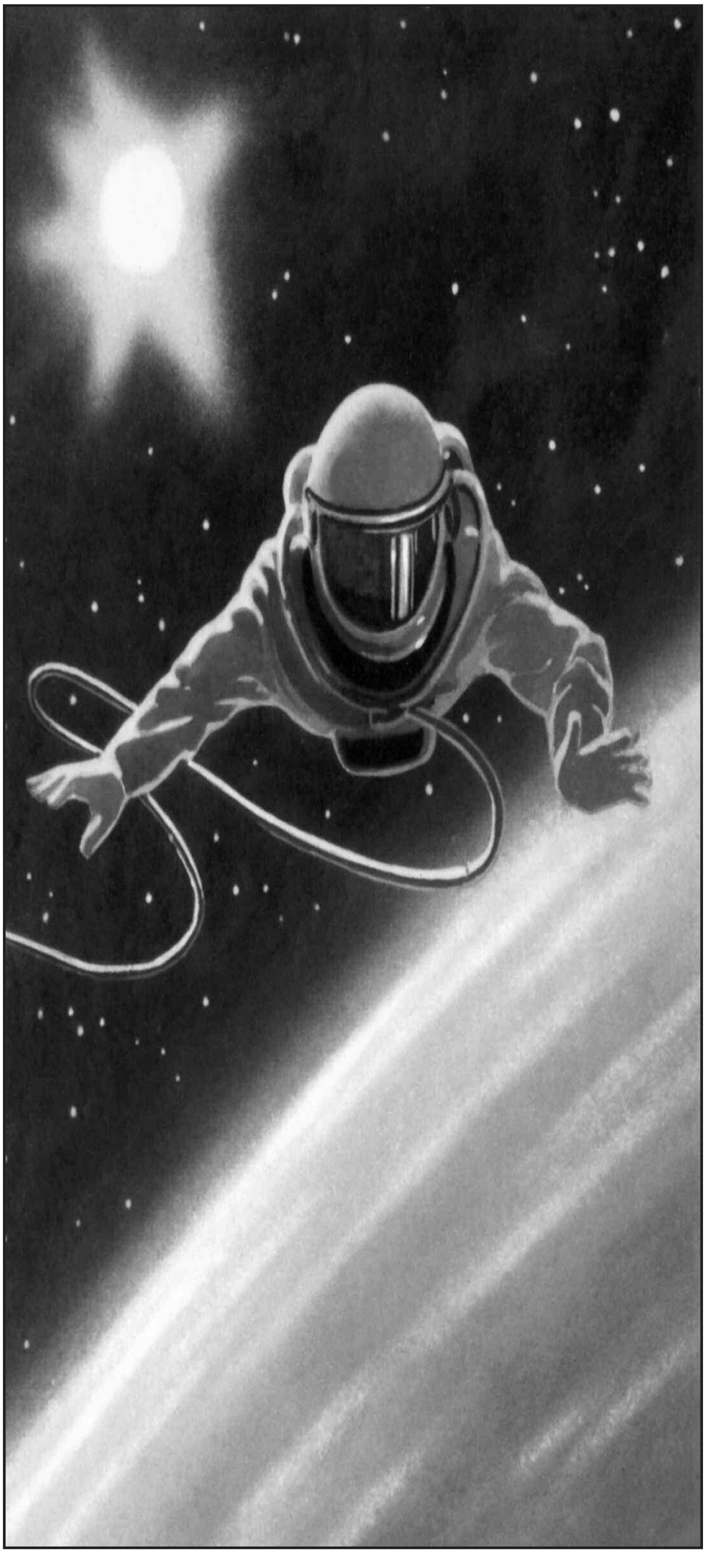
Rebreather (TL8): Can be added to an air mask (+1 lb., $200). Captures exhaled CO_2 and water and turns them into oxygen (for rebreathing), discarding carbon and hydrogen; captures and recycles inert gas in the breathing mix. Does not replace air tanks, but makes them last 10 times as long! Works for 12 hours on a B cell.

Respirator (TL9): Makes thin or low-oxygen atmospheres breathable by concentrating the oxygen. Often combined with goggles to protect eyes from effects of thin air. 3 seconds to put on, 1 to take off. Works for 1 month on a B cell; includes a short-range communicator (p. 63). 3 lbs., $300.

Reducing Respirator (TL9): "Reducer" for short. A mask which makes dense or very dense oxygen atmospheres breathable by chemically reducing the partial pressure of O_2. Includes goggles to protect the eyes from the burning effects of too much oxygen. 3 seconds to put on, 1 to take off. Works for 1 month on a B cell; requires a monthly chemical recharge ($50). Includes short-range communicator (p. 63). 5 lbs., $500.

Filter Attachment (TL6); For air mask or respirator. Used to filter out contaminants; cost depends on what is being filtered. Filter medium must be replaced periodically; again, cost varies from a $10 cartridge (to filter heavy dust or pollen) to replacing the whole mask (in highly corrosive atmosphere). 1 lb.; cost varies from $100 to $1,000 or more.

NBC Suit (TL7): Worn over regular clothing to protect from nuclear, biological, and chemical contamination – but not against actual radiation! Airtight, but not pressurized against vacuum. Includes a clear hood (-1 to vision and hearing) with a filter (see above). The suit has PD 0, DR 1; if penetrated, it no longer protects against fallout, disease, gas, etc. 30 seconds to put on, 15 to take off. 10 lbs.; $600.



For an additional $100, an NBC suit comes with a regular air mask, allowing air tanks to be used. For an extra $200, NBC suits will protect against corrosive atmospheres as well. Actual radiation protection can also be added: $200 for PF 2, $1,000 and +20 lbs. for PF 5.

Vacc Suit (TL7): A flexible, insulated pressure suit. Required in vacuum; may also be worn in poisonous (non-corrosive) or very thin atmosphere. Covers the whole body, with a rigid helmet. Has exterior pockets, Velcro patches, straps, hooks, etc., for equipment, and at least two lifeline hooks. Always includes a short-range communicator (p. 63), which uses an A cell. Styles differ widely. Requires an air tank.

The gloves reduce DX and manual skills by -1. The clear helmet allows undistorted vision (but cuts hearing rolls by -2 in air). Touching helmets in vacuum allows private suit-to-suit communications. Indicators tell the wearer how much air and power are left, what the suit's internal temperature is, etc. (At TL8+, this is a HUD projected on the helmet.) A tube leading to a 1-quart reservoir provides water.

A back-mounted life-support pack provides heat and cooling, and energy for the suit's systems. It uses a C cell, which is good for a week (longer than anyone would stay in a suit). The life-support pack has DR 3 and 20 hit points. After it takes 10 hits, there is a 50% chance of it malfunctioning on each further hit. When hit points reach 0, it no longer works; the user's survival time depends on the environment.

Any vacc suit has a front pocket with 10 emergency patches. Any damage that penetrates the suit must be patched immediately. This requires 3 seconds and a Vacc Suit roll. If the first attempt fails, each further attempt is at a cumulative -1. Every 3 seconds loses 10% of the suit's air.

A vacc suit takes 1 minute to put on or take off; if the suit is worn without the helmet, the helmet takes only 5 seconds to put on. A successful Vacc Suit roll can halve these times. Default skills cannot be used to decrease suit-up times.

A typical vacc suit is 10 lbs., $1,000, PD 0, DR 1. The helmet has PD 2, DR 3. The above weight and cost halve at TL9, and again at TL10. Suit exteriors are usually personalized so the wearer can be easily recognized.

Heavy-duty Vacc Suit (TL7): As above, but tougher: PD 2, DR 3; 20 lbs; $1,500.

Armored Vacc Suit (TL8): For very hostile environments or combat situations, personnel may be issued sealed combat armor, cybersuits, or battlesuits (see p. 85).

Vacc Suit Accessories: Many are available. Common ones include *helmet light* ($30, 6 days on B cell); *water and concentrated food* system, holding 24 hours' worth, delivered through helmet nipples ($500 for system; uses standard concentrated rations); *waste-relief system* (a good idea if you plan to wear the suit more than a few hours; $500); *better communicators or translators* (see pp. 63-64); *built-in computers* (see p. 65); *reflective coating* (acts as reflec armor and gives PF 2 vs. radiation; $300); *extra patches* ($10 per patch); *recorder* (see p. 64). Radiation protection (see p. 106) can be added: $200 for PF 2, $1,000 and +20 lbs. for PF 5, $2,000 and +40 lbs. (rigid suits only) for PF 10.

Exoskeleton (TL8): A mechanical suit which amplifies the wearer's ST. Often used by those who must work under high gravity. An exoskeleton wearer rolls against the lower of Exoskeleton skill (p. CI161) or DX for ordinary DX rolls. For DX-based skills, he rolls against the lower of (skill-1) or (Exoskeleton-1). The GM may assess extra penalties for actions that should be especially difficult in a suit, such as Acrobatics. Most exoskeletons (or "exosuits") have removable gauntlets to allow the wearer to do delicate work, however.

The wearer ignores ST penalties for high G; he uses the exo's ST instead. He halves (round down) all DX penalties for high G. HT and IQ penalties are unchanged. The suit should be fitted to the user, but "generic" models may be worn by anyone of the right general size, at an extra -1 to DX or skill rolls. It takes 2 minutes to strap into an exo, 1 to remove it. All necessary bodily functions can be performed while in an exosuit.

An exoskeleton will run for a week on a D cell; it always has sockets for two cells, for safety. Cost for a typical exosuit is $35,000 (ST 15, no armor, no frills). Subtract $4,000 if the suit is generic rather than fitted. Add another $10,000 for each additional ST point up to 20, $20,000 for each point after that. Any amount of frills (weapons, armor, life support, etc.) can be added, but this eventually turns the exoskeleton into an exploration suit or battlesuit at tremendous expense. An exosuit weighs 10 lbs. per point of ST up to 20, and another 20 lbs. per additional ST point.

Exoskeletal Vacc Suit (TL8): For use on high-G worlds with superdense or corrosive atmospheres. Start with a heavy-duty or armored vacc suit; add the cost and weight of the desired exoskeleton. Requires both Vacc Suit and Exoskeleton skills. Uses a D cell, plus an A cell for the communicator, as above. Fatigues wearer at 1 per hour (wearer *may* rest while wearing the suit). Note that certain "options," such as food and a waste relief system, are almost necessary. An EAVS (exoskeletal armored vacc suit) is only one step away from a military battlesuit, and anyone accustomed to one will be able to operate a battlesuit (but not its weapons!) using Exoskeleton skill.

Hand Thruster (TL7): A handheld unit for use in free fall. Propels the user with bursts of compressed nitrogen. Each burst accelerates a normal-mass human by 1 yard/second in the direction opposite to that in which the thruster is pointed. A successful Free Fall or Vacc Suit roll is necessary to point the thruster in the desired direction. The unit's N_2 cylinder is good for 30 1-second bursts. 4 lbs, $50, including cylinder; extra cylinders cost $10, weigh 1 lb., and take 5 seconds to replace.

Thruster Pack (TL7): A rocket-powered harness seat for short jaunts in free fall – ship to ship and so on. It consists of a "seat" unit with a thruster in the back, a pair of arms with reverse thrusters, and a control arm that curves in front of the user. Maneuver jets are located at strategic points along the entire pack. It takes 20 seconds and a Vacc Suit roll (which can be retried every 5 seconds if missed) to strap into the thruster pack. It can accelerate a normal-mass human by up to 3 yards/second each turn. The large N_2 cylinder allows 100 seconds of full acceleration, or the equivalent. Successful Free Fall+1 rolls allow the user to control his speed and direction (at TL8+, a dedicated computer gives +2 to this). 45 lbs., $2,000, including cylinder. Extra cylinders cost $30, weigh 10 lbs., and take 5 seconds to replace.

Magnetic Boots (TL7): These look like heavy sandals, and could be built and maintained at TL4, if needed. They let the wearer walk along bulkheads or on starship hulls in micro- or zero gravity: at regular Move if the character has Vacc Suit skill, and at ½ Move if not. There are two types: one sort is fitted like shoes, for inside wear, and the other fits onto any vacc suit. 10 seconds per boot to put on, 5 to take off. 2 lbs./pair, $100. Magnetized plates may be built onto the soles of any rigid suit's boots at an additional $100 and ½ lb.

Personal Reentry Kit (TL10): A foamed ablative heat shield, chemical thruster, and parachute that allow someone in a vacc suit or sealed armor to reenter atmosphere with a successful Free Fall roll (to reenter without burning up) and then a Parachuting roll (to land safely). 30 lbs., $15,000.

Artificial Gill (TL8): A backpack unit that allows the user to breathe underwater; uses electrolysis to extract oxygen from water, and feeds it to a face mask. Requires Scuba skill to use. Useless in fluids other than water. Takes 20 seconds to put on, 5 to take off. Works 24 hours on a C cell; always has sockets for 2 cells, and an alarm to warn when the first is 90% exhausted. 20 lbs., $2,000.

Wet Suit (TL6): A flexible suit that covers the diver's entire body, with goggles for the eyes and a face mask for attaching an artificial gill or air tanks. It insulates against cold and has ballast sufficient to keep the diver at any depth he wishes. Foot flippers add 25% to swimming speed (minimum +1 Swimming move). PD 0, DR 1. It takes 2 minutes to put on or remove the suit. 20 lbs., $500. Infrared or light-intensification goggles for improved underwater vision can be added for the appropriate cost.

Communications/Information Equipment

Implant Communicator (TL8): Implanted in the user's skull (mastoid process). Powered by an AA cell, which should last at least 10 years in this application. Has an effective range of about 10 miles. Frequencies, etc., are controlled remotely by a master unit; without the master unit in range, the implants are useless. With practice, users can subvocalize, communicating without moving their lips (IQ-4 to notice someone in the same room doing this). Ship crews and military units often use implants to keep in touch. Costs $500, plus $500 for implantation. The master unit costs $1,000 and weighs 5 lbs.; it includes a dedicated computer that assigns frequencies and routes messages by verbal request. Each master can control up to 100 implants, and masters can talk to each other if programmed to do so. The master uses a B cell, which lasts for a year.

Short-range Communicator (TL8): Small handheld communicator about the size of a cigarette lighter. Has an effective range of 10 miles (can be increased to maximum of 20 miles on an Electronics Operation (Communications) skill roll, -1 per extra mile). Can also be linked into a larger comm net at the appropriate costs (see *Prices,* p. 51). Can be built into a helmet, watch, locket, etc., at an additional 10% to cost. Uses an A cell, which lasts for a year. $50, weight negligible.

Medium-range Communicator (TL8): A larger, palm-sized communicator with an effective range of 100 miles (can be increased to a maximum of 200 miles on a skill roll, -1 per extra 10 miles). Can be linked into a comm net at the appropriate costs. An optional booster unit doubles the cost and weight and allows it to reach any orbiting starship equipped to pick up its signals. A B cell powers it for a year. 1 lb., $200. Double cost for a video display.

Long-range Communicator (TL8): A purse-sized communicator carried by a strap worn over the shoulder, with an extensor mike and optional earphones for private listening. Has an effective range of 1,000 miles (can be extended to a maximum of 2,000 miles on a skill roll, -1 to skill per extra 100 miles.) Can reach starships in standard orbits. A B cell powers it for 3 months. 10 lbs., $600. Add $100 for a video display.

Laser Communicator (TL8): A rifle-like communicator (but small enough to be helmet-mounted at TL10+) that transmits a signal carried on a modulated laser beam. Range is 200 miles, but limited to line of sight – it can be blocked by terrain and cannot transmit over the horizon. A lasercom cannot be jammed or intercepted, but its beam is blocked by anything that would normally block a laser: smoke, clouds, etc. If the lasercom has a blue-green frequency ($200 extra), it can transmit through water at 1% of range. A C cell allows 10 hours of continuous use. 10 lbs., $5,000.

To stay in touch with fast-moving vehicles or spaceships, attach the system to a tripod-mounted target-tracking system (TTS). This takes 30 seconds to set up. 10 lbs., $1,000.

Communicators at Higher TLs: For all of the above communicators, multiply range by 10 at TL9 and 50 at TL10. At TL9, video is standard at no extra cost. At TL10+, a 3D holo display is standard.

Digital Camera (TL8): Takes full-color pictures recorded on standard computer media (see p. 66). No "developing" is required. Each gigabyte of storage holds 40 very high-quality color pictures, or 50,000 shots of about the quality of a TV picture. In the latter mode, it works as a motion-picture camera, getting 20 minutes of TV-quality film, with sound, per gigabyte. Runs 1 month on a B cell. 2 lbs., $500.

Reader (TL8): A simple "dumb terminal" that reads databases or camera disks and project them on a screen. 2 lbs., $100.

Recorder (TL8): Records and plays back sound, using standard computer disks. Holds about two hours of hi-fi sound, or 1,000 hours of low-fi voice recording, per gigabyte (see p. 66). 1 lb., $175.

Holo Camera (TL9): Records full-color still holograms on special film (requires developing). 5 lbs., $1,000. A film pack takes 20 shots and costs (including developing) $200.

Holomotion Camera (TL9): Looks something like a rifle, but takes 3D color *movies.* 20 lbs., $3,000. Film cartridges, in sizes up to an hour, cost $50 (including developing costs) and weigh 2 oz. per minute.

Holo Projector (TL9): Allows projection of holo movies or still shots in any space from 1 to 6 cubic feet (commercial entertainment models produce much larger images). Runs for 2 months on a B cell. 8 lbs., $750.

Translator Medallion (TL10): Disk-shaped device, usually worn around the neck. Preprogrammed to translate any one spoken language to another with a skill (typically) of 14. Extra languages can be programmed in at extra cost when the unit is built; most units (except those carried by slave masters, for instance) are at least two-way. Uses an A cell (lasts at least a year). Weight negligible; $1,000 to translate A to B only; $1,200 to translate A to B and B to A; an additional $1,000 for each language database added, with full two-way translation between any two languages. Can also radio-link with a computer that knows more languages.

Superscience Info-Tech

Brainwave Communicator (TL13): A helmet device that picks up the wearer's brain waves and transmits them to any other brainwave helmet to which it is tuned. Messages transmitted this way are commonly believed to be impossible to jam, or to intercept without the users' knowledge, but both sender and receiver must make a successful IQ roll to open communications. This is, in effect, mechanical telepathy. Language is no barrier between creatures of the same species; members of different species are at a -2 (or more) to open communication, even if they share a common language. Words are transmitted automatically. Separate IQ rolls are required to send pictures or diagrams, or to tell a lie successfully! Effective range is 50 miles, though messages may be relayed at greater distances through other tuned-in helmets. Different species usually need different types of helmets; one make does not fit everyone! Requires a B cell. 5 lbs., $3,500.

Mental Translator (TL13): Picks up and translates brain wave patterns to spoken (or whatever) language, and vice versa. Enables aliens who could not normally reproduce or understand human speech to do so. Usually capable of translating only one species' brain waves into one other major language. Usually worn near the brain. Uses an A cell. 1 lb., $2,000. Each additional language it can translate into increases cost by $1,000.

Computers

Computers first appear at TL6 and develop rapidly after that, evolving so fast that a home system of late TL7 would seem miraculous to a user of even a few years earlier.

At TL6, computers are huge and experimental, practical only for mass-storage uses. They are very costly.

At TL7, computers go from desk-sized to palm-sized, and are available to the middle classes. They are easy to program. By late TL7, if a modem is available, globe-spanning remote networks can be reached and used.

At TL8, computers are no bigger than the keyboard and screen, maybe smaller, and are trivial to use. Many computers are capable of speech recognition; the more complex mainframes can carry on a good conversation.

At TL9, computers are self-programming and troubleshoot their own problems. Most systems with voice boxes can carry on a good conversation. Though they are not "sentient," they can easily fool you. And some systems *are* sentient – see below.

At TL10, it may be hard to tell the computers from the people. At TL11 and above, there may be no reason to *try* to tell them apart.

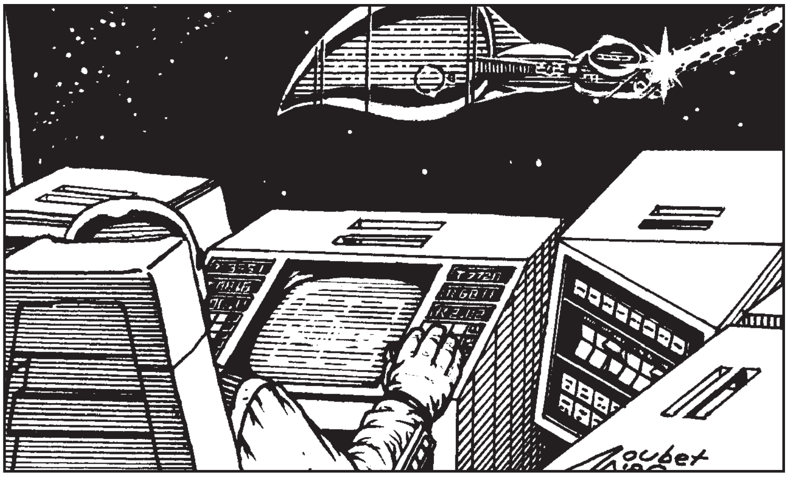
Complexity

Computers are rated in terms of *Complexity,* which refers to the programs (pp. 66-67) that they can run. Complexity is an abstract representation of processing power; each Complexity level can be seen as representing at least a tenfold increase over the previous level. Complexity 1 is the simplest; Complexity 6+ computers may be sentient. In addition to the usual reductions in weight and cost, Complexity increases with TL. For instance, a TL12 personal computer is only ¼ the weight and cost of a TL8 model, and since Complexity is given by TL-6, it has Complexity 6 – compared to Complexity 2 at TL8!

A system's Complexity determines what programs it can run, and how many. A program of Complexity 2 can run on a computer system of Complexity 2 or above, but not on a Complexity 1 system.

The number of programs that can be run *simultaneously* is calculated as follows: A computer can run two programs of its own Complexity level, 20 programs of one Complexity level less, 200 programs of two Complexity levels less, and so on.

Thus, a Complexity 1 computer can run two Complexity 1 programs. A Complexity 2 computer can run two Complexity 2 programs, or 20 Complexity 1 programs, or one Complexity 2 program and 10 Complexity 1 programs, and so on.



Using Computers

At TL8+, all computers can have voice-instruction capability; Computer Programming rolls are not required for most purposes, and Computer Operation rolls are at +3. At TL9, Computer Operation skill is almost never necessary, and therefore almost unknown.

Complexity 2 computers can give simple spoken replies; Complexity 4+ systems can understand idiomatic conversation and reply in kind, within their realm of expertise. Users may give any instructions to a computer, if it has the appropriate program. GMs make the ultimate decision as to the capabilities of a program and the response of a computer to an impossible order. Simple systems can be dangerously literal-minded.

Players may give any instructions to computers they control, if the computers have the appropriate programs. For instance, a computer with Optical Recognition and Gunner programs could be told to fire on any ship identified as Pachekki-built. The owner writes down the instructions for the "program" in as much detail as he wants and gives this to the GM. A sentient computer may ask for clarification if the instructions seem unclear or unwise. Other computers will follow instructions literally; the GM can have a lot of fun with ambiguous commands.

TL Differences

No system can run a program of a later TL. Systems can run programs from the previous TL without difficulty; beyond this, specialized (and archaic) hardware will have to be found to interpret the media, and the GM should *decrease* the effective Complexity of the computer by 1 for each TL of difference; systems often lack the capability to translate old machine languages!

Hardware

Personal Computer: A system that fits into a pocket or a briefcase. There is a tiny screen and keyboard, but it's usually voice-activated, and users often plug in HUD goggles (p. 84) so they can wear the computer on a belt or whatever without having to peer at a screen. Complexity is TL-6. Runs for one year on a B cell. 2 lbs., $1,000.

Desktop Computer: A full-featured version of the personal computer. It includes a full-sized monitor and keyboard (less fatiguing to use), but isn't as compact. Complexity is still TL-6. Runs for two months on a B cell. 40 lbs., $1,200.

Minicomputer: Complexity is TL-5. It uses building power or can run for six months on a C cell. With monitor, keyboard, and basic peripherals, it is 80 lbs., $16,000.

Microframe: These multi-user systems are used in vehicles, labs, etc.; they use vehicle or building power. Complexity is TL-4. The base cost is $40,000, plus $1,000 per user for generic "workstation" computer terminals. Weight is 200 lbs., +40 lbs./user.

Mainframe: Used for a capital ship, major business, etc. Such a system would have a Complexity of TL-3, and cost $200,000. Weight is 500 pounds; size is 10 cubic feet. Add 40 lbs., $1,000 per workstation attached to it.

Megacomputer: Commonly referred to as a "megacomp," this system has Complexity TL-2 and is most often found administering functions for an entire city! $2,000,000, 4,000 lbs., 80 cubic feet, plus 40 lbs. and $1,000 per workstation.

Hardware Options

Dedicated: This system provides built-in computing capacity for a single device. It runs one program, and only one; that program is hardwired and cannot be changed. Complexity of the computer is equal to the Complexity of the program. Start with an equivalent general-purpose computer of that Complexity, then halve weight, multiply cost by 1/5, and add the cost of the program.

Hardened: Ordinary computers can be damaged or destroyed by the electromagnetic pulse (EMP) of a nuclear weapon. A hardened system is immune to EMP effects, but is three times as large and heavy, and five times as expensive, as a standard one.

High-Capacity: The capacity of a system can be enhanced by 50% (to *three* programs of its own Complexity level) for a 50% price increase.

Sentient: At TL9, it is possible that a megacomp will become self-aware; it may or may not let its users know! Once per year, the GM can roll 3d for each megacomp in his campaign. On a 6 or less, it will "wake up." A computer that becomes sentient is immediately upgraded to Complexity 8 in terms of processing capability. Depending on the society, the awakening of a megacomp may cause rejoicing . . . or panic.

At TL10, computers cannot accidentally become sentient, but those of Complexity 6+ can be built that way on purpose. Such a system has its own personality and an effective IQ (on things it's not specifically programmed for) of Complexity+5. Cost of a self-aware computer is 3 times normal.

Fully sentient "artificial intelligence" (or AI) systems are considered people in some places; they can't be "enslaved," and are eligible for citizenship. In some places they are property, with varying degrees of "civil rights," but never equal to "natural sentients." Other governments outlaw AI completely.

Sentient computers should be considered characters, complete with quirks.

Software

Programs listed below are introduced at TL8 unless otherwise noted. If a program has a skill level, or gives bonuses to skill, more complex versions of a program give increased bonuses. For each +1 to program skill desired, double the cost and add +1 to the program's Complexity. Unless otherwise specified, a program has a base skill of 12, or gives a user a +2 bonus, when it is introduced.

Software is stored on memory units that we will call *disks* – though at high TLs, they might not look like disks. A "generic" TL8 optical disk can be assumed to be about 3" across and hold 10 gigabytes. At TL9, they might be dime-sized, with the same capacity. At higher TLs, size stays the same, with memory density increasing by a factor of 10 per TL. Blank disks can be assumed to be about $5 apiece.

Above TL8, many programs and databases are protected against unlawful copying. GMs may assume a Computer Programming-4 roll (or harder) is required. Failure may destroy the original or produce a subtly defective copy. Critical failure can wreck the system.

Typical Programs

Astrogation: Cost and complexity depend on the difficulty of astrogation in the game world. Requires a database of astronomical information.

Damage Control: Requires a complete technical manual for the ship; a Computer Programming roll is required to input data about refitting at TL9 or less. Any attempt at damage control is at +2 if this program is running and in communication with the damage-control crew. Complexity 2; $2,000.

Datalink: This enables a computer to link (through a cable or communicator) with another electronic device, such as a computer, scanner, etc. A sophisticated datalink program capable of carrying high-grade streams of encrypted information is Complexity 1, $400. GMs can assume that simpler programs (for example, modem software) are no more than $40 (and often included with the computer's operating system).

Electronics Repair: In conjunction with the probes from an electronics tool kit (p. 72), this program troubleshoots any electronic device in its technical database. Roll against the program's skill; a success tells the operator what to fix and how, giving +2 to Electronics or Electronics Operation, or 12 on the appropriate skill, whichever is higher, *for repairs only.* Complexity 2; $500. See below for technical databases.

Environmental Analysis: Assists in the analysis of physical data from scanner readings. It can spot possible hazards, analyze the ecosphere, and so on. The program gives +2 to appropriate skills, or analyzes at skill 12. Complexity 3; $3,000.

Expert Systems: These are programs with the knowledge of an expert in a particular skill, such as Biochemistry, Shipbuilding, or Survival (Arctic). They are available for all Professional and Scientific skills, Diagnosis, Intelligence Analysis, and Survival. Effective skill is 12 for Mental/Average skills, 11 for Mental/Hard skills, and 10 for Mental/Very Hard skills. They are used in place of the user's own skill, but the time to perform a skill with the assistance of an expert system is doubled. Cost is $10,000 for Average skills, $20,000 for Hard skills, and $50,000 for Very Hard skills; Complexity is 3.

Gunner: This program requires a copy of the Targeting program (below). It lets the computer act as a gunner with a skill of 12, or adds an additional +2 to the Gunner skill of a human gunner. It uses the same sensors that the Targeting program does, but has sophisticated target-recognition routines and friend-or-foe identification. Complexity 4, $45,000.

Interpreter: This program translates from any language to any other, as long as the right databases are online. Nonverbal languages can be handled if appropriate sensors and "speakers" are available; costs vary widely. Typical language skill is 14, though this depends on the database. Complexity 4, $10,000.

Medical: A TL8 medical program adds +2 to Surgery or Diagnosis and +1 to First Aid for any medic working with it. At TL9+, double each bonus. Complexity 4, $40,000.

Optical Recognition: The computer must have cameras or other optical sensors. This program lets the computer recognize faces, ships, vehicles, or anything else that can be pictured. Complexity 4, $20,000.

Piloting: Requires that the computer be tied in to an appropriate vehicle, with attachments to all necessary sensors and controls (this adds $1 per ton of vehicle, minimum $1,000). The computer has Piloting-12. It is not sufficient for combat operations; moreover, unlike a human pilot, when it performs landings or dockings a simple failure is a mishap and a critical failure leads to disaster. Complexity 3, $30,000 for surface vehicles or slow contragrav craft (under 200 mph). Complexity 4, $80,000 for aircraft, fast grav vehicles, or spacecraft. Costs much less for very common vehicles!

Targeting: Linked to fixed- or vehicle-mounted weaponry, this program gives a +2 to the skill of a human gunner. The number of guns that can be aided at once is limited only by the system's capacity; each gun requires a separate copy of the program in memory (of course, only one copy has to be *bought*). Complexity 1, $1,000.

Translation (TL11): Analyzes and translates new languages with ten minutes' exposure to conversation, starting at a skill of 5, and adding 1 to skill for each half-hour of exposure, up to a maximum of 11. Nonverbal languages can be handled if appropriate sensors and "speakers" are available; cost varies widely. Complexity is 6. Cost depends on the level of language that can be translated: $5,000 for Easy only, $7,500 for Average, $10,000 for Hard, and $25,000 for Very Hard languages.

Limiting Programs

In a campaign in which humans do not rely on computer programs as much (e.g., classic space opera), the GM may wish to ban expert systems and to limit high-Complexity skill bonuses (e.g., +1 per 2 levels of Complexity increase rather than +1 per level).

New or Custom Programs

Players may develop ideas for new programs; the GM may decide they are standard or require them to be custom-created. Customized programs should be very costly. A new program is likely to have some amusing bugs in it when it is first used.

If someone wants to write his own computer program, use the *New Inventions* rules (p. B186; see also pp. CI125-127), using Computer Programming instead of Engineer, with a skill penalty equal to twice the Complexity of the program rather than -15.

Databases

A *database* is a collection of information in computer-readable form. At TL8+, any database has its own built-in search and indexing programs (treated as Complexity 1). For a database of a given size, the wider the subject it covers, the less detail it has.

Size of a database is measured in gigabytes. One gig might hold any one of the following: general information about a thousand star systems; complete physical data about a single star system; the complete history, in rough detail, of a world; the complete history, in fine detail, of a whole world for 20 years; a year's records for a medium-sized business; complete dossiers on 100 people, in incredible detail; a large bookshelf full of books of any kind; a translation database, with dictionary, grammar, and detailed cultural referents, for any one language.

Technical databases are important. One gig might hold a technical manual for a starship; or for ten different fighter craft; or for 100 types of complex vehicle, exosuit, etc.; or for 1,000 simple vehicles, weapons, or complex devices; or for 10,000 different radios or similar small devices.

Information costs are highly variable – at TL8, an encyclopedia or similar item might be free for download, or cost from $10 to $100. On the other hand, proprietary data (blueprints, manuals, etc.) may cost $100 to $1,000 per gigabyte. Secrets, very specialized information, or information costing lives or money to gather, will be more costly. Adventurers who bring back information on new systems, etc. can sell it to database publishers!

Contragrav Gear

This is all "superscience." Regardless of general tech level, none of this equipment is available unless contragrav (antigravity) technology exists. The default TL is 12, but GMs can choose any TL. Note that the GM is free to decide that contragrav tech is too bulky for personal use, in which case the smallest CG systems would be car-sized or larger flying vehicles.

Contragrav Chair (TL12): Essentially a flying wheelchair. It supports itself and flies at any height; it also keeps its wearer in a 1-G environment (or whatever he prefers). Removes all penalties for heavy-gravity living, but is not suitable for manual labor. Usual maximum speed is 10 mph (Move 5). A CG chair can carry up to 600 lbs. plus its own 200-lb. weight. Runs 1 month on a D cell. A typical CG chair is $30,000. Accessories, life support, weapons, and armor can be added.

Contragrav Platform (TL12): The contragrav chair without the chair or motive thrusters. Can carry up to 700 lbs. in addition to its own 100-lb. weight. Has no motive power of its own, but can be pushed or pulled like a cart; effective weight to the puller is only 50 lbs., regardless of its load. Runs 1 month on a D cell. $4,000.

Contragrav Chute (TL12): An antigravity "parachute" that almost completely nullifies gravity so that the wearer falls to earth very slowly from any height. This harness-like device takes 10 seconds to strap on, 5 to remove. Requires a Parachuting roll at +4 to use safely. Weapons fire while in a CG chute is at -2, more in rough air; recoil penalties are *doubled.* The wearer has poor maneuverability; his Dodge is 1. A CG chute works for about an hour (to be safe, one drop) on a C cell. 20 lbs., $2,500.

Contragrav Belt (TL13): A harness unit that lets the wearer fly at up to 80 mph (Move 40) at heights up to 5 miles on a standard 1-G world. Carries up to 500 lbs., though speed and maximum height are halved with over 250 lbs. Flies 1 hour on a C cell; belts always have at least two cell sockets, and a beeper goes off when the first cell is 90% exhausted! It takes 5 seconds to put on and activate, 2 to remove. Controls are at the user's chest, and require only one hand. Piloting (Contragrav) rolls are required for takeoffs, landings, and difficult maneuvers; those unfamiliar with the belt (see p. B43) are at -4 to skill. 20 lbs., $5,500.

Assault troops often use CG belts. Weapons fire from someone flying a belt is at -2, or worse if the user is doing tricky flying or dodging, or is in rough air. Dodge is half Piloting (Contragrav) skill, rounded down. Anyone dodging is at an extra -2 to fire on the next turn.

Personal Gear

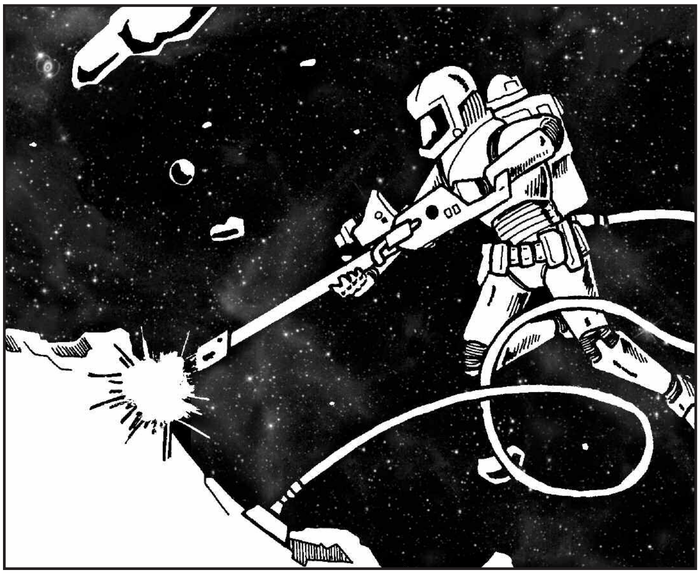
Personal Kit: Attaches to a belt, etc. Holds eating utensils, pen, fire starter, small change, toothbrush, comb, etc. ½ lb., $25.

Utility Belt (TL5): A web belt with pouches for money, equipment, ammo, and other valuables, plus hooks and loops for tools, equipment, holsters, etc. ½ lb., $25.

Debit Card or Credit Card (TL7): A small electronic-currency storage device (see p. 66). Usually free with a bank account; sometimes a small annual fee is charged. Negligible weight.

Chronometer (TL5): A wrist or pocket timepiece, with other functions optional. TL5: $500+, ¼ lb., local time only. Winds up. TL6: $100+, weight negligible. TL7: $25+, weight negligible, may keep a variety of times at extra cost; may include calculator at extra cost. TL8 and 9: As TL7, but may also include a communicator. TL10+: Most people use wrist-sized personal computers – see p. 65.

Towel (TL1): 2′ × 4′; terrycloth or similar. 1 lb., $10.



Power Sources

An important feature of a high-tech campaign is that the PCs' gadgets make them very powerful . . . *while they work.* But a laser without batteries doesn't even make a good club. Most gadgets have to have power; if no power requirements are listed, though, the device needs none. We assume that electricity will continue to be used at least through TL15.

The GM is free to ignore this section entirely, and assume that everything gets whatever power it needs.

Power Cells

An assumption common to much SF is that at TL8 and above, most equipment runs on standardized *power cells.* Full rules for power cells are given on p. B247; see also pp. CII15-19.

The energy densities in power cells are perfect for a space-opera campaign where portable beam weapons are easily available, but are roughly an order of magnitude too high for a hard-SF setting.

Advanced Batteries

An advanced battery is assumed to weigh as much as a power cell of the same size (AA, A, etc.), but to store exactly one-tenth the energy of that power cell. It is also cheaper:

AA battery: Costs $0.60; 500 to the ounce.
A battery: Costs $3; 25 to the ounce.
B battery: Costs $10, weighs 0.05 lb.
C battery: Costs $30, weighs 0.5 lb.
D battery: Costs $150, weighs 5 lbs.
E battery: Costs $600, weighs 20 lbs.

If using ***Vehicles,*** advanced batteries at TL9+ have exactly ten times the weight of an equivalent power cell of that TL; cost multiplier is $30. For another option, see *Power Slugs,* p. UTT14.

Solar Panels

Starting at TL7, solar panels can substitute for power cells in any environment where the sunlight is at least 70% of that of Earth's. Size B and smaller panels will work under normal, artificial indoor light.

Panels come in sizes AA through E. Each may be substituted for the equivalent cell in applications requiring steady demand (including slow vehicles) but not for sudden high demand (like weapons). Any suitable cell-operated device will have jacks where a panel can be plugged in. It automatically goes over to its power cells when light is cut off to the panels. Many devices can be bought with built-in solar panels (add half the price and weight below).

AA: 1/20 square inch. $2; negligible weight.

A: ¼ square inch. $10; negligible weight.

B: 2 square inches. $50; negligible weight.

C: 16 square inches. $300; 5 ounces.

D: One square foot. $2,000; 2.8 pounds.

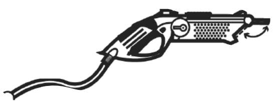
E: One square yard. $10,000; 25 pounds. 7 cubic feet when stored.

Solar panels improve greatly as TLs increase. At TL9, halve cost and divide weight by 10. At TL10, halve cost again, and divide TL8 weight by 100. At TL11, divide TL8 weight by 1,000; at TL12, divide TL8 weight by 10,000.

Solar panels are relatively tough (DR 2) and damaged panels may continue to work at reduced levels (GM's option). Each point of damage that gets past the DR will destroy 12 square inches; it takes 12 points of damage to destroy one square foot of panel. A critical hit, or a deliberate use of clippers, cuts the connection from the panel to the device it powers.

Beamed Power

At TL13 and above, robots, vehicles, and sometimes other devices might operate on power "beamed" from a central station. There will be many such stations on a civilized world; a colony may have only a few, and a new colony will have just one. A very large spaceship will be able to beam power to ground units in line of sight. This simply means that nobody has to worry about powering vehicles . . . unless something happens to the power station. A power receiver costs and weighs as much as the equivalent cell(s).



Cosmic Power and Precursor Artifacts

At TL15-16, GMs may rule that everything comes with a built-in, permanent power source, or draws power from another dimension, vacuum fluctuations, etc. This eliminates all concern with power supplies.

Precursor artifacts may have this kind of power. Then again, they may require Precursor power cells, which are *not* in stock at the corner store . . . PCs may need to make an IQ roll at a significant penalty (don't bother with Electronics; you never saw anything like this before) just to figure out where to *put* the cells. There may be no way to adapt any present-day power to a Precursor device – and if there is, extensive study may be required first, with the chance of a significant accident (see p. 77).

Sensor and Vision Equipment

Anti-Glare Goggles (TL7): Goggles that darken automatically to cut glare and very bright light. Allows direct viewing of the sun and other stars without risk of blindness. Also protects the eyes against hand-laser fire. ½ lb., $150.

Infrared Goggles (TL7): Reduces darkness penalties for combat, vision, etc., to -1 (because of the slight distortion when seeing via infrared). Allows vision in *total* darkness if there is at least 10° difference between objects. At any temperature, allows weapons fire in darkness at only -1 if the target produces heat – which most living things and active machines do! Gives +2 to vision rolls to spot beings if used in *daylight.* Can be blinded by a powerful heat source. Works for 6 months on an A cell. ½ lb., $600 at TL8; half price, but no lighter, at higher TLs.

Light-intensifier Goggles (TL7): Pick up and intensify available light, effectively granting the user the Night Vision advantage (p. B22) and eliminating darkness penalties for anything but complete darkness. Will burn out if hit by a laser! Works for 3 months on a B cell. 1 lb., $200. At TL8, $300 will buy light-intensifier contact lenses with negligible weight.

Multiview Goggles (TL8): Combines the functions of infrared, light intensification, and anti-glare goggles. Works for 3 months on an A cell. $1,200, 1 ½ lbs.

Radar, Mini (TL8): A man-portable surveillance radar set. It includes no display of its own – it must plug into a computer monitor or helmet HUD (p. 84). It searches a fan-shaped, 120° area in front of the user, out to one mile range. Background items like trees, garbage cans, etc., make spotting stationary human-sized or smaller objects on the ground virtually impossible in anything other than open terrain, but its built in software can easily spot dog-sized or larger moving objects. The radar cannot see through solid objects or over the horizon. The only information provided is a digital readout of target speed, altitude, position, and approximate size.

Most moving targets are detected automatically, but an Electronics Operation (Sensors) roll (possibly opposed by the target's Stealth skill in a Quick Contest) is required to detect something moving slowly and carefully or using countermeasures of some sort. Picking out a single target in a large crowd also requires a skill roll. Stationary targets are impossible to distinguish from ground clutter unless the user previously saw that particular "blip" moving.

Instead of reducing weight and cost at TL9 and TL10, the radar's range can instead double at each higher TL. Range also doubles at TL11. The radar is 3 lbs., $1,000; a pair of C cells runs it for 8 hours.

Radar, Backpack (TL8): Heavier version of mini-radar, with five times the range. Uses a D cell (works for 8 hours). 15 lbs., $5,000.

Radiation Detectors: See sidebar, p. 106.

Televiewers (TL8): Lightweight electronic binoculars that provide an extremely sharp image. Magnification can be adjusted from 5× to 20×. Includes an electronic range-finder that works out to 5,000 yards (this gives +2 to Gunner skill if used with artillery of TL6 or below, which normally lacks such accurate distance measurements). Infrared or light-intensification can be built in at $300 each. Gives 3 months' continuous operation on a B cell. 2 lbs., $950.

Scanners (TL9): Small, handheld sensors, designed to locate and identify one sort of thing:

Chemscanners scan for minerals, metals, and chemical compounds.

Bioscanners are highly specialized chemscanners that locate the characteristic complex molecules produced by life forms.

Radscanners detect energy, power, and radiation sources of all kinds (not just radioactivity). They can pick up the scanning radiation of other types of scanners, but since they are passive detectors, they cannot be detected themselves.

A scanner allows a roll against Electronics Operation (Sensors) skill to detect its general category of item within its base scanning range. A search for a specific item within its category is at -2 to skill (or more, if the user is not sure just what he is really scanning for), but can detect the item at up to 2.5 times base range. Large concentrations can be detected at up to twice these distances. More specific data can be picked up at half range or less on a skill+2 roll. The device can be used for detailed analysis of an item within 5% of base range, but the user must roll against the appropriate science skill to properly interpret the data. Scanners may be set for a specific area sweep, which lets the user scan a 60° arc each turn at the ranges listed above. A scanner can be set for a 360° scan instead, but all ranges are divided by 5. Changing settings takes 1 turn.

Scanning ranges are up to the GM. "Superscience" scanners can be assumed to have a base range of 1,000 yards. Radscanners may indeed have that range, but it is quite unrealistic for chemscanners and bioscanners. Hard-SF chemscanners may be T-ray scanners (advanced millimetric radars capable of spectroscopic analysis) with a base range of ten yards. Bioscanners become *passive* "sniffers" that (bloodhound-like) detect organic molecules produced by targets and compare them against a database; they are only good in an atmosphere, no use against people in sealed suits, and also limited to about ten yards (modified by wind), with detailed analysis only possible with physical contact (usually a blood or tissue sample).

Scanners can be linked to a hand computer or (by communicator) to a larger computer for more detailed information or analysis. Individual scanners are about the size of a pack of cigarettes. They get 2 months of continuous operation on a B cell; in practice, one cell will last for years. 1 lb., $1,000.

All stats above are for TL9 scanners. TL10 scanners weigh half as much, have twice the range, and give +1 to rolls. TL11+ scanners have 5 times the range listed above, and give another +1 to skill per TL above 10.

Multiscanner (TL9): Combines the functions of all three above scanner types with a dedicated computer (+1 on science rolls to interpret data) and a data recorder. Includes a short-range communicator for linking with a larger computer. About the size of a 20th-century cassette recorder; can be hooked to a utility belt or carried on a shoulder strap. Works for a month of continuous operation on a B cell. 5 lbs., $5,000.

Multiscanners improve at higher TLs, as for scanners.

Psi Scanner (TL??): Only exists if psi talents are generally known, and maybe not even then; GM's option. Possibly it can be used only by a psi. Or it may be a military secret. Operates like the above scanners. The standard psi scanner detects only *active* use of psionics, but the GM may allow other versions that can detect inactive psi powers, latent psionic potential, anything currently thinking, or anything capable of thought. 1 lb., $1,000.

Survival Gear

Bush Knife (TL5): A large knife. Serrated top allows it to be used as a saw. Standard issue to Survey scouts, Rangers, etc. 1½ lbs., $60.

Survival Knife (TL7): As above, but handle is hollow and contains a variety of miniaturized survival equipment, including fishing line and hooks, antiseptic, stimulants, miniature tools, light, fire starter, compass, knife sharpener, wire for animal snares, and up to three other very small items that the owner specifies beforehand. 1 ½ lbs., $100 at any TL. Custom versions are available, at ever-escalating prices, with assorted built-in electronics such as radios, rad detectors, homing buttons, etc.

Biphase Rope (TL8): 3⁄16″ diameter supports 1,000 lbs.; ½ lb., $5 for 10 yards. 3⁄8″ diameter supports 4,000 lbs.; 2 lbs., $30 for 10 yards. Strength doubles at TL10 and again at TL12.

Concentrated Rations (TL7): Highly nutritious concentrated food pastes in squeeze tubes. One tube supplies a human with all the nutrients required for one meal. Tastes good, but not filling at all. A full day's worth of rations (3 tubes) is 2 lbs., $50.

Food Tablets (TL7): "Survival rations" with a long storage life. One quart-sized bottle (which can be used as a canteen when empty) provides sufficient calories and nutrients for a human to survive for 2 days at TL7. Optionally, the tablets may become more nutritious at higher TLs: double the duration at each TL (4 days at TL8, 8 days at TL9, and so on). This probably requires superscience past TL8, and nearly eliminates the threat of starvation. 1½ lbs., $25. Food tablets are not filling at all, but appetite suppressants can be added for an extra $5; this is free at TL9+.

Filtration Canteen (TL7): A canteen with a built-in filtration unit designed to purify and hold up to a quart of water. Will remove *almost* all impurities, microbes, and poisons; there is always the possibility of a contaminant for which the filter was not designed! It takes 5 minutes to purify a quart of water. Filters must be replaced every 100 quarts; a color change signals this. An "exhausted" filter still has a few quarts of capacity, but only the manufacturer and the GM know how many. 1 lb. empty, $175; 3 lbs. full. Replacement filters are $25.

Vapor Canteen (TL8): A canteen that actually draws moisture from the atmosphere as long as there is any water vapor at all. It extracts and holds one quart of water. Time required varies with the amount of water vapor in the air – with an Earth-standard humidity of 50%, it takes four hours to extract a quart of water. Extracts 100 quarts on a B cell. 2 lbs. empty, $450; 4 lbs. full. Larger versions are available for use at base camps: $3,000 buys a 15-cubic-foot version that weighs 300 lbs., runs for a month on an E cell, and generates a quart per five minutes in 50% humidity with a fair breeze.

Magnetic Compass (TL5): Standard compass; always points to magnetic north on any world with a strong enough magnetic field (a Navigation or Planetology roll may be needed to know the difference between magnetic and geographic north on a particular world). The same at higher TLs. Gives +1 to Orienteering skill. Negligible weight, $5.

GPS Unit (TL7): This device automatically queries a constellation of navigational satellites, enabling the user to know his position to within a few yards. This effectively gives him Absolute Direction (p. B19). Plugged into a computer with a map display, it shows exactly where the user is. GPS systems are commonly installed in some late TL7 and many TL8+ vehicles, helmets, etc., but are only useful on worlds where a navigational satellite network has been established. The owners of a GPS satellite network can also *turn it off,* and may do so during times of conflict. Works for a month on an A cell. 1 lb., $200.

Inertial Compass (TL8): A hand or belt unit that indicates the direction and distance traveled from any preset point on a planetary surface. This effectively gives the user Absolute Direction (p. B19). It can be set for the location at which the user is physically present, or for any other coordinates (requiring a Navigation roll if the coordinates of the location aren't known). Must be calibrated for the planet (1 hour and a Navigation roll with a hand computer, or connect it to a properly programmed computer for an instant recalibration). Uses an A cell. Distances measured are accurate within 1 yard per 1,000 miles. 1 lb., $250.

Thermo Suit (TL7): Insulated hood, jacket, and leggings, with internal heating coils. Uses a C cell. Protects against freezing (p. B130) by increasing effective temperature as set by the wearer: 48 hours at +10°, 24 hours at +20°, 12 hours at +30°, and so on. Gives +10 to effective HT for all rolls to resist freezing, even if the heater is off. PD 0, DR 1. 5 lbs., $150.

Envirobag (TL7): An insulated sleeping bag, good for temperatures down to -10° and up to 100°. An optional heating unit, using a C cell, works as for the thermo suit (above). It can be sealed and hooked up to air tanks. Folds to the size of a paperback book. 6 lbs., $75. Heating unit, 1 lb., $50.

Desert Environment Suit (TL9): A specially designed full-body suit that insulates the wearer from the extremes of desert heat and cold. It also recycles the wearer's body fluids, collecting pure water in a reservoir from which the wearer may drink. Good for temperatures up to 150° and down to 0°. Uses one C cell to operate a built-in refrigerator. Cell life depends on the setting: 24 hours for -10°, 12 hours for -20°, 6 hours for -30°, and so on. Gives +5 to effective HT for all rolls to resist freezing or overheating. DR 1. 20 lbs., $700.

Pressure Tent (Personal) (TL7): A completely airtight one-man tent (holds 2 very tightly). User(s) must have an air supply with them! Opening it loses a half-hour of air. As big as a large book when folded. DR 2. 15 lbs., $500.

Pressure Tent (Two-Man) (TL7): As above, but larger; holds 4 in a pinch. Backpack-sized. 30 lbs., $1,500.

Pressure Tent (Base) (TL7): As above; meant for up to 8 men, but 20 could crowd in. 30 cubic feet as cargo. DR 4. 150 lbs., $5,000.

Enviro-Bubble (TL8): Emergency inflatable bubble with self-sealing flap that can be entered and inflated within a few seconds (make a DX or Vacc Suit roll). Provides 15 minutes of air. It is flexible enough to move in, but Move is only 1. Usually worn on the belt for quick activation. 5 lbs., $800.

Thief/Spy Equipment

Lockpicks (TL4): High-quality lockpicks that give +1 to Lockpicking skill rolls to open mechanical locks of the appropriate TL. Negligible weight, $200.

Electronic Lockpick (TL8): A sensor/decoder that gives +3 to Lockpicking or Electronics Operation (Security Systems) skill rolls to open any electronic lock, +/-2 for each TL of difference between lock and lockpick. Uses an A cell. Illegal on many worlds. 3 lbs., $1,500.

Thermal Lockpick (TL7): Consists of a contact disk and a remote (up to 5 yards) detonator. Burns through all types of locks (except on a roll of 17 or 18, in which case the lock fuses and won't open at all). However, the lock is ruined and entry can't be covered up. Will also burn a 3" hole in walls of up to DR 10, unless the wall is of heatproof material (ordinary metals and plastics are not heatproof!). Illegal on most worlds. Failure of the Lockpicking roll can be risky; critical failure does 3d burn damage to user! Detonator uses an A cell. Comes with 5 contact disks. 1 lb., $500. Extra disks, $100 each.

Contact Mike Set (TL7): A sensitive, adhesive-backed, dime-size microphone which transmits to an ear button. Range is only about 5 yards. Can be used for routine "bugging," but also gives +2 to any attempt to open a mechanical combination lock or safe when the mike is placed on the lock mechanism! Uses an A cell. $300 for a mike and button on the same frequency.

Disguise Kit (TL5): Suitcase-sized kit with makeup, wigs, mustaches, beards, false noses, etc. Gives +2 on Disguise rolls. 10 lbs., $300.

Living Disguise Kit (TL11): Far more sophisticated disguises and makeup. Includes pre-molded sensa-skin sections (noses, ears, facial sections, etc.) for living disguises, along with sensa-skin neutralizer for removal of the otherwise permanent material. Depending on the exact contents, the kit may allow users to realistically impersonate aliens, the opposite sex, and so on. Gives +4 on Disguise rolls. Illegal on many worlds. 10 lbs., $5,000 (and up).

Chameleon Suit (TL10): A full-body suit sensor-controlled to match the background. All attack and vision rolls against the wearer are at -3. The suit takes 5 seconds to change color(s), during which time it offers no protection. It also suppresses the wearer's heat signature, giving a -3 to infrared spotting and targeting, but must be allowed to vent waste heat (which produces a large heat signature) every 6 hours or it starts to leak heat and becomes uncomfortable. It works for 24 hours on three A cells. It takes 20 seconds to put on, 10 to take off. PD 0, DR 1. 10 lbs., $1,850. This system can be added to any full suit of armor.

Superscience

Holobelt (TL10): A belt-mounted holo projector that casts a preset 3-D image around the wearer for concealment. The image must be bigger than the person concealed! Standard planetary holo disks let the user choose from among a variety of native-looking rocks, trees, mailboxes, bushes, animals, etc. All attacks on the user are at -1 to skill, and aimed shots to specific body areas are not possible.

The belt gives no protection against infrared or bioscanners, however. An image inappropriate for a given planet is more likely to draw attention to the user than it is to conceal him, and because the belt projects light, the image *glows in the dark.* Operates for 24 hours on a B cell. 4 lbs., $1,100. Prerecorded holo disks, $100 each.

Distort Belt (TL10): The distort belt affects incoming scanner pulses, producing a distorted or false reading of the belt's wearer and giving a -5 penalty to anyone using a scanner to detect him. On a failed roll, the scanner either will not register the wearer at all or will show him to be something else (as preset by the user). Even a successful scan will give no more than general information about the wearer. Also effective against low-tech radar, but useless against visual sighting or psionic detection. Works for 12 hours on a B cell. 3 lbs., $2,200.

Holodistort Belt (TL10): A combined distort and holobelt that works for 6 hours on a B cell, matching its distort readings to the image. 5 lbs., $4,000; $200 per holodistort disk.

Psi Shield (TL??): This device exists only if there are psi powers in the campaign, and even then only if the GM permits it. When worn, it gives the user a mental shield which protects against telepathy. The user does not know if someone is trying to penetrate the shield, but any attempt to detect, read, or control his mind is at (suggested) -10. Presence of the shield is obvious to any telepath who attempts to contact the shielded individual. At the GM's option, the shield may also interfere with psi use by the wearer, or even cause headaches and IQ penalties for psi users. Works for a month on a B cell. 1 lb., $1,000 (or much more, if it is a secret).

Tools

Tool kits exist at all tech levels; this section deals with those for TL8+. Note that tool kits do not drop in price or weight as TL increases; as gadgets get more complex, so do the tools required to fix them. All tool kits contain several power cells, but the cells found in salvaged kits are likely (GM's decision) to be partially or completely used already.

Basic Tool Kit (TL8+): Standard tool kits for engineers, mechanics, armourers, and electronics technicians allow major and minor repairs to be made at no penalty to skill. A kit from the next lower TL gives a -2 penalty. Each type of kit must be purchased separately, though a user may "make do" with the wrong kit at -3 to skill. Any kit will include a few devices requiring small power cells, and is therefore a source of extra cells in a pinch – 1d+2 AA cells, 1d A cells, 1d-2 B cells. Mechanic or engineer kits are 15 cubic feet as cargo, 300 lbs., $800. Armoury or electronics kits are 7 cf as cargo, 100 lbs., $1,200.

Portable Shop (TL8+): A more elaborate version of the basic tool kit – equivalent to a repair shop on a small starship. Has almost everything necessary for emergency repairs, plus a wide range of "generic" spare parts that can be tooled to specific requirements. Use of a portable shop adds +2 to the appropriate skill; a shop of the next lower TL is about as useful as a basic kit of the proper TL. It will have 2d each AA, A, and B cells, 1d C cells, 1d-2 D cells, and 1 E cell. Mechanic, engineer, or armoury shops are 135 cubic feet as cargo, 3,000 lbs., $4,000. Electronics shops are 110 cubic feet, 1,500 lbs., $7,000.

Mini-Tool Kits (TL8+): Small, belt-sized versions of the various tool kits. Routine repairs can be made with one of these at only a -2 to skill, but major repairs are at -4. Kits of lower TLs are at a further -2 per TL. Roll 1 die for AA and A cells, 1d-3 for B cells. All types, 2 lbs., $400.

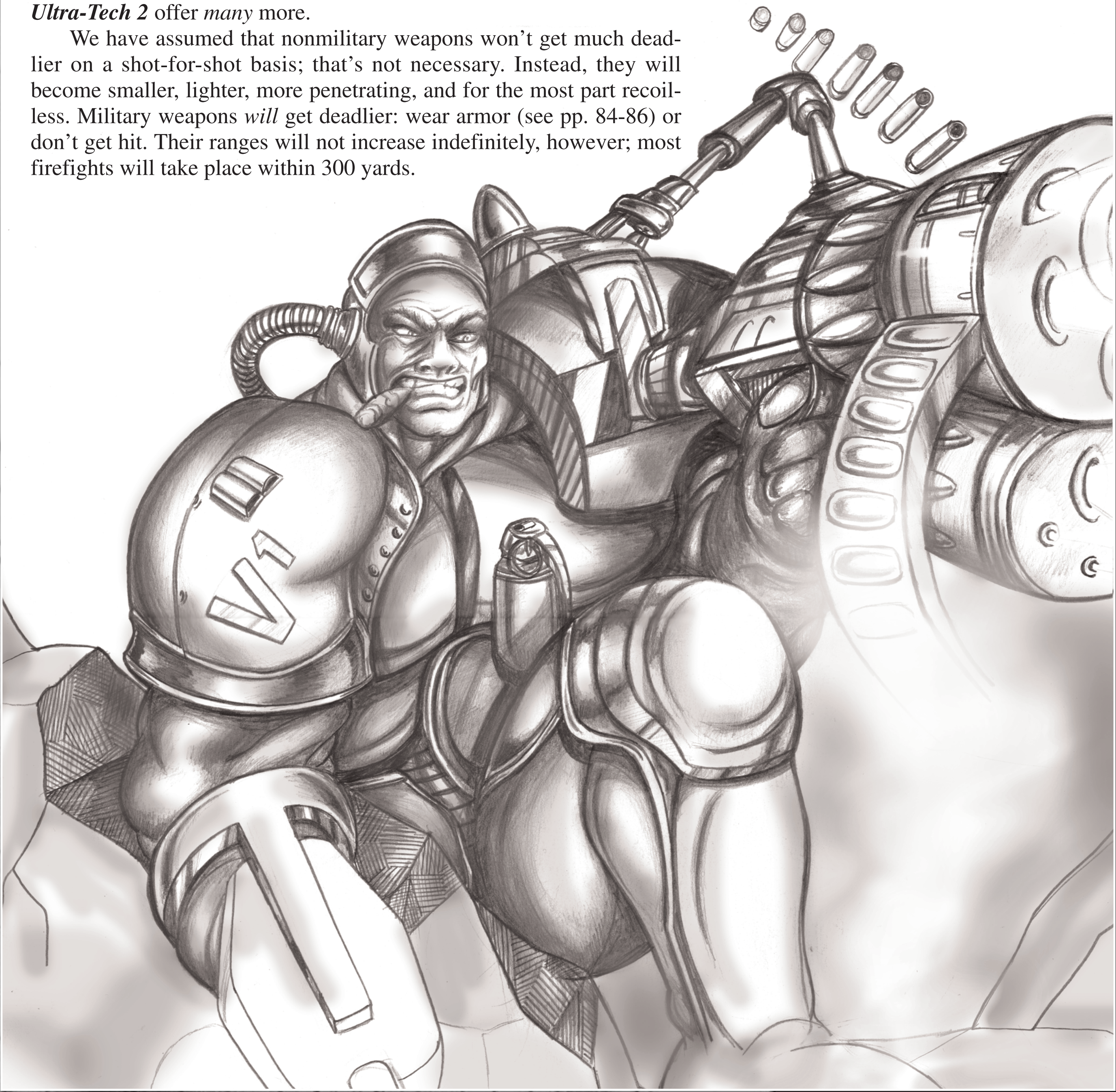
Laser Torch (TL8): Small, close-focus hand laser for light cutting and spot welding. Does 4d cutting damage per second to doors, bulkheads, etc. Damage is cumulative per turn to cut through tough materials. Can be used in combat (SS 12, Acc 1, RoF 4, Damage 1d cutting, ½D 3, Max 15). Uses a C cell which lasts 60 seconds. 5 lbs., $250.

Flashlight (TL8): Throws a 50-foot beam for 6 continuous days on a C cell. 1 lb., $20. A belt or helmet model that leaves the hands free costs $10 more. $100 buys a heavy-duty light that can be used as a baton without being damaged. Larger and smaller lights are available, of course.

CHAPTER 5 WEAPONS

Futuristic weapons are inseparable from action SF and space opera, but the technology varies widely. In some universes, especially near-future settings, there is one standard weapon technology: everyone carries a laser . . . or a Colt .45 Model 2050. But there may be *many* types of weapon available in a huge and diverse universe with dozens of races and thousands of years of history. Below are some options for the GM to consider; ***GURPS Ultra-Tech*** and ***Ultra-Tech 2*** offer *many* more.

We have assumed that nonmilitary weapons won't get much deadlier on a shot-for-shot basis; that's not necessary. Instead, they will become smaller, lighter, more penetrating, and for the most part recoilless. Military weapons *will* get deadlier: wear armor (see pp. 84-86) or don't get hit. Their ranges will not increase indefinitely, however; most firefights will take place within 300 yards.



Weapon Legality

One question most adventurers will ask when reaching a new world is "What weapons can we carry?" Each weapon has a *Legality Class* (LC); full rules for LC are found on p. B249 and pp. CII188-189. Note that starship passengers aren't likely to be permitted any weapons at all, and even the crew won't want to use heavy weapons in space, for fear of damaging the ship.

Black Market Weapons

Weaponry illegal on a particular world can usually be bought anyway . . . on the black market. Successful rolls against Streetwise or Merchant-3 are necessary. Modifiers: a penalty equal to the world's Control Rating; +2 if the world is a criminal sanctuary; +2 in any starport startown; +1 for each time you've successfully contacted a dealer on that particular world; -1 for LC 1 weapons, or -2 for LC 0 weapons.

Each roll requires one day of searching for one person (or cooperating group). A critical success means you've found exactly who you're looking for, and he has just what you need. A critical failure means the searcher is mistaken for a police spy, or contacts a police "sting" operation!

Black-market dealers charge 10-60% above normal prices. Successful use of Merchant skill can lower the price by 10%; a critical success gives the normal price, while a critical failure *doubles* normal price, no matter what the dealer was asking originally (take it or leave it!). Of course, a dealer may not have what you want – or his gear may be defective or substandard (appropriate Armoury specialty to tell). The GM determines this, based on the needs of the campaign or scenario.

Weapon Quality

List prices buy a *good*-quality weapon in all cases. TL8+ ranged weapons are also available in other quality levels:

Cheap weapons drop one step in reliability – from Ver.(Crit.), to Ver., to Crit., to 16 – *and* have -1 Accuracy. They cost 60% of the listed price.

Fine weapons get +1 Accuracy *or* increase one step in reliability (thus, Crit. becomes Ver.). They cost 5 times the listed price.

Very fine weapons get +2 Accuracy. They cost 30 times the listed price, and may not be available on all worlds or at all TLs.

Weapon Improvements at Higher TLs

Power: All power-cell-using equipment gains shots or increased operating time at higher TLs: an extra 50% of power (or 50% more shots) for each TL after the one in which the device was first introduced. This is because the high-tech cells *contain* more power.

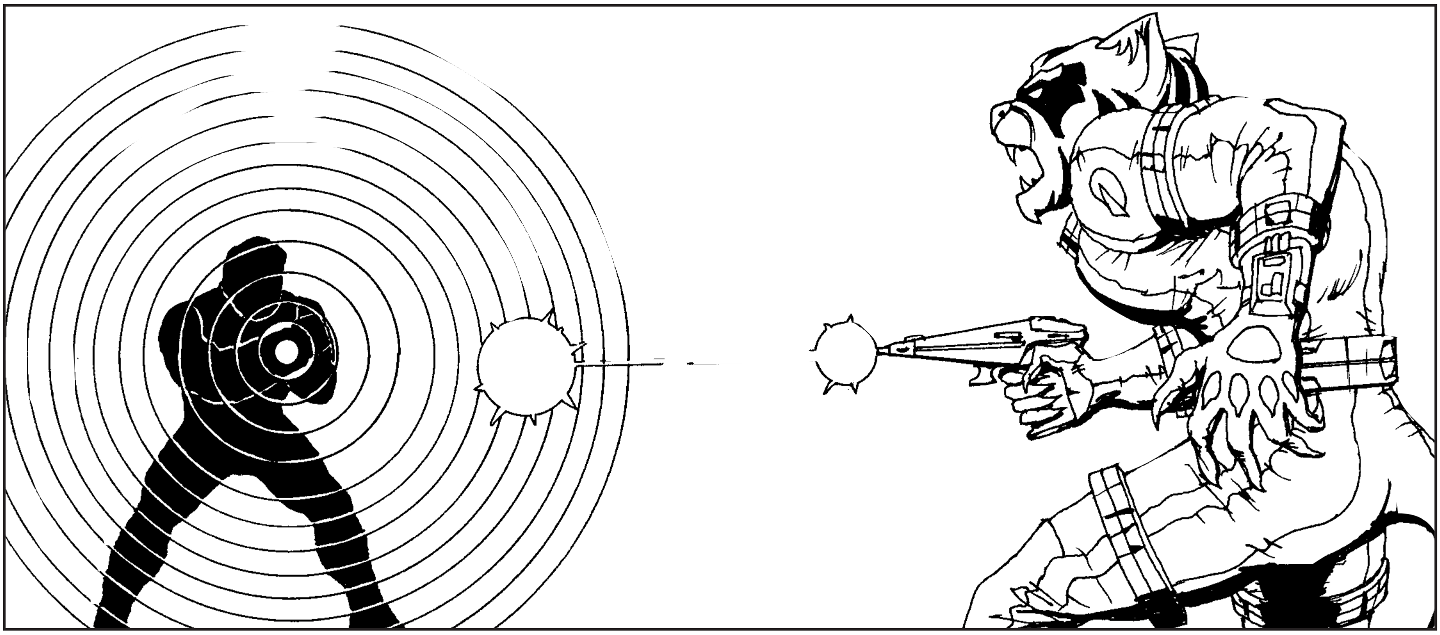
Energy Weapons: Energy weapons include all beam weapons, all electromag (Gauss) weapons, and all powered melee weapons (e.g, vibroblades and force swords). For each TL after the type's first appearance, add +1 to damage for every 1d of damage it normally inflicts. For weapons with damage adds, 3+ points of damage adds also gives a +1.

Range increases as well: add 10% to the ½D and Max ranges per TL after the weapon first appears.

Unlike shots, damage and range only increase for the first three TLs after the weapon's introduction.

Example: A TL9 blast carbine normally does 11d damage, with ½D 300 and Max 600. It gains +11 damage per TL after 9, so at TL10, this would be modified to 11d+11 damage (which can be translated to 14d – see *Modifying Dice + Adds,* p. B114). Its ½D and Max ranges improve by 10%, adding 30 to ½D (for 330) and 60 to Max (for 660). At TL12, it would do a whopping 11d+33 and would have ½D 390 and Max 780. At TL13, our blaster carbine has the same range and damage as it had at TL12.

Other Weapons: Conventional slugthrowers and other chemical-propellent weapons do not increase in range or damage.



Weapons Tables

The weapons tables below use the same format as those in ***GURPS Basic Set,*** *Third Edition Revised.* Costs and weights assume a loaded or charged weapon, including one magazine (if the weapon uses magazines). Power cells are described on p. 68.

Melee Weapons

Weapon	Type	Damage	Reach	Cost	Weight	Min ST	LC	TL
Force Sword	Imp./Cut	4d/8d (5)	1	3,000	2	–	3	11
Neurolash I	Spcl.	Spcl.	1	650	2	–	5	10
Neurolash II	Spcl.	1d	1	2,000	2	–	2	10
Vibroblade	Imp./Cut	+1d (5)	*	*	*	*	3	8

* Varies by weapon type.

Ranged Weapons

Weapon	Malf	Type	Damage	SS	Acc	1/2D	Max	Wt.	RoF	Shots	ST	Rcl	Cost	LC	Hld	TL
Assault Chaingun	Ver.(Crit)	Cr.	6d-1	12	10	530	5,300	15	20	400	10B	-1	1,800	0	No	8
Assault Rifle	Ver.	Cr.	6d-1	12	10	530	3,300	7	12	100	9	-1	950	1	-5	8
Blast Carbine	Ver.	Imp.	11d	12	13	300	600	4.5	3~	13/C	8	-1	5,000	2	-4	9
Blast Rifle, Heavy	Ver.	Imp.	6d×3	15	14	600	1,600	12	3~	60/D	9	-1	6,000	0	-6	9
Blaster, Semi-Portable	Ver.	Imp.	6d×15	20	18	1,700	3,400	66	1	84/E	13T	-1	23,000	0	No	9
Blaster Pistol	Ver.	Imp.	6d	10	6	150	300	2	3~	20/C	5	-1	2,000	3	-1	9
Electrolaser Pistol	Crit.	Spcl.	2d+1	8	4	60	120	1.5	1	10/C	–	0	1,200	3	0	9
Electrolaser Rifle	Crit.	Spcl.	3d+1	9	12	100	300	5	1	5/C	–	0	1,800	2	-4	9
Electromag GL	Crit.	Spcl.	Spcl.	10	8	–	1,000	10	1	5	–	0	5,000	0	-6	8
Electromag Mortar	Crit.	Spcl.	Spcl.	20	15	–	6,000	70	1	20	15T	0	15,000	0	No	8
Gauss Carbine	Ver.	Cr.	9d(2)	12	11	930	4,600	6	12	125/B	–	0	4,200	0	-5	9
Gauss Pistol	Ver.	Cr.	4d(2)	9	6	310	2,400	1.4	16	250/B	7	0	2,400	2	0	9
Grenade (any)	Crit.	Spcl.	Spcl.	12	0	–	ST×3 ½	1	–	1	–	–	Varies	Varies	-3	Varies
Laser, Gatling	Ver.(Crit.)	Imp.	20d	10	20	4,000	12,000	75	4	150/E	15T	0	20,000	0	No	9
Laser, Holdout	Crit.	Imp.	1d-1	10	4	50	100	–	1	5/B	–	0	500	0	+3	9
Laser Pistol	Crit.	Imp.	1d	9	7	200	500	2	4	20/C	–	0	1,000	3	0	8
Laser Pistol, Heavy	Ver.(Crit.)	Imp.	2d	9	8	300	800	3	4	12/C	–	0	1,500	2	-2	8
Laser Rifle	Crit.	Imp.	2d	15	13	450	1,200	5	3~	12/C	–	0	2,000	4	-4	8
Laser Rifle, Military	Ver.(Crit.)	Imp.	2d	12	15	1,500	2,000	9	8	140/D	–	0	4,000	0	-6	8
Pistol, Heavy	Ver.	Cr.+	3d	9	4	200	1,900	2.75	3~	20	10	-2	720	3	-1	8
Submachine Gun	Ver.	Cr.+	3d	12	8	200	1,900	5.9	12	60	9	-1	870	2	-4	8
Stun Rifle	Crit.	Spcl.	–	12	10	300	1,000	4	3~	20/C	–	0	2,000	5	-4	9
Stunner	Crit.	Spcl.	–	10	3	12	20	1	3~	40/C	–	0	800	6	+1	9
Tangler	Crit.	Spcl.	–	6	8	–	20	6	1	5	8	-4	1,000	5	-4	8

Malf: The die roll on which the weapon malfunctions. Most TL8+ weapons have a Malf of Crit. or better. *Crit.* means the weapon malfunctions only on a critical miss when the roll on the *TL8+ Firearm Critical Miss Table* (p. 77) indicates a malfunction. *Ver.* means the weapon requires a *verification roll,* another roll against skill. Any failure is the malfunction from the table; any success is simply a miss. *Ver.(Crit.)* means the verification roll must be another critical failure for the weapon to malfunction. Any other result is simply a miss.

Type: The type of damage the weapon does: crushing (Cr.), impaling (Imp.), or a special effect (Spcl. – see text description of the weapon). A + indicates that the weapon fires a 10mm or larger-caliber round; multiply penetrating damage by 1.5.

Damage: The damage inflicted. A number in parenthesis is the armor divisor; e.g., (2) means armor DR is divided by two vs. the attack, protecting at half value.

RoF: The weapon's rate of fire. If greater than 3, the weapon is capable of automatic fire; see pp. B119-121. RoF 3~ indicates a semiautomatic weapon that fires one shot per trigger pull; the trigger can be pulled three times per turn. All TL8+ automatic weapons are capable of *selective fire:* automatic fire at full RoF, or semiautomatic fire at RoF 3~.

Shots: The number of shots the weapon gets from a magazine or power cell. If a cell is used, the type of cell is shown; e.g., 100/B means 100 shots from a B cell.

ST: Minimum ST to pick up and fire the weapon. *T* indicate a tripod mount; the ST requirement only applies if the user removes the tripod and fires from hip. Firing such a weapon from its mounted position requires no minimum ST. *B* means the weapon is usually used prone from a bipod; apply +1 to ST and -1 to Acc if firing from the hip.

Hld: The modifier to Holdout skill.

Ammunition

Ammo costs and weights are given below. Clips, magazines, or power cells normally require three turns to replace: one to remove the old one (dropping it to the ground), one to ready the replacement, and one to insert it. Fast-Draw (p. B50) and Speed-Load (p. B52) skills may be learned for replacing clips and power cells; each shaves one second off this time.

Ammunition Table

Weapon	Shots	Weight	Cost
Assault Chaingun	400	5	$20
Assault Rifle	100	1.75	$5
Electromag GL*	5	varies	varies
Electromag Mortar	20	varies	varies
Gauss Carbine**	125	0.35	$2
Gauss Pistol**	250	0.35	$2
Pistol, Heavy	20	0.53	$1.5
Submachine Gun	60	1.6	$4.5
Tangler	5	5	$50

* Plus a C cell. ** Plus a B cell.

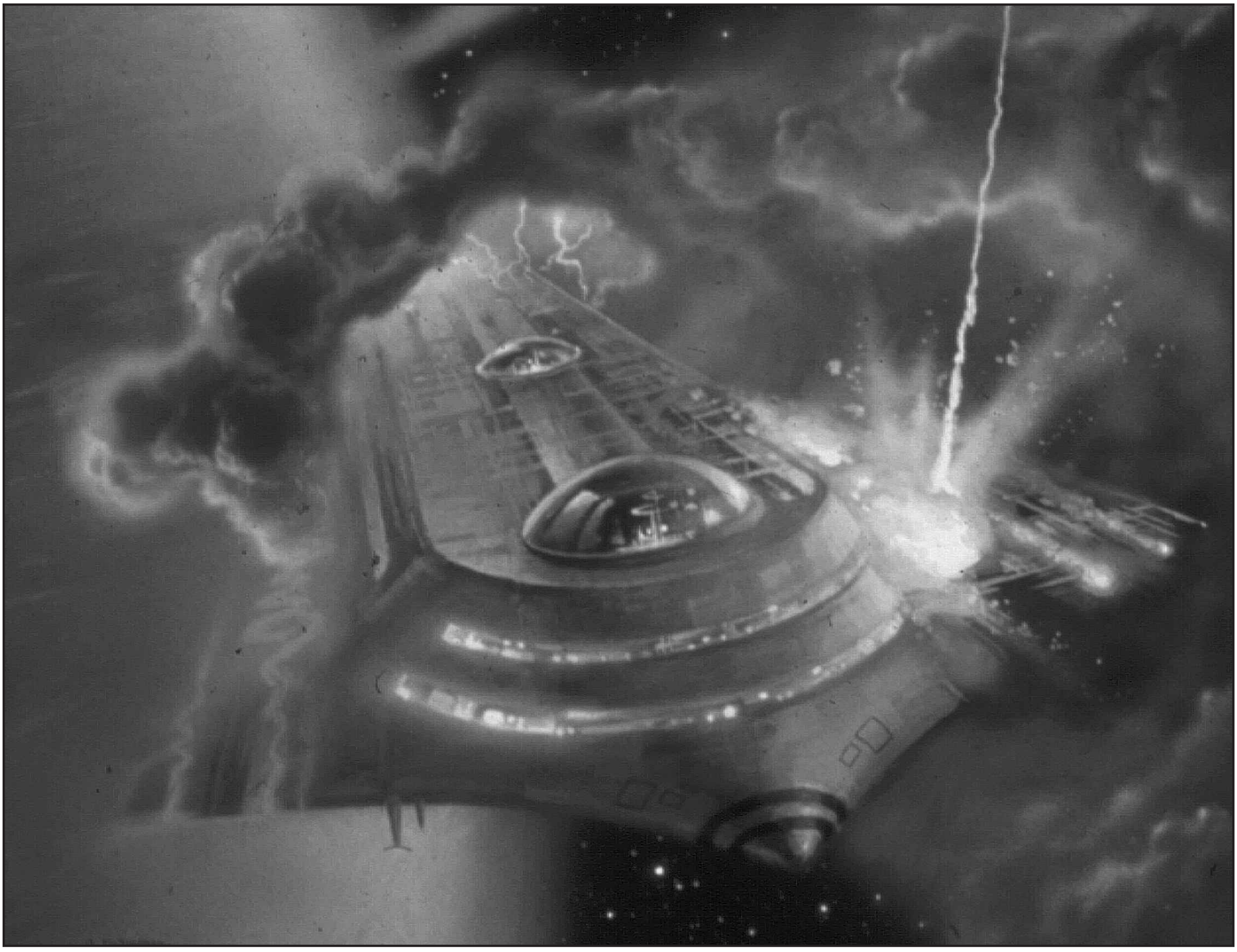
No Power Cells?

If power cells have been replaced by more realistic advanced batteries (see p. 26), either reduce the number of shots by a factor of 10 or add a belt or backpack power pack with the next larger size of power cell in it.

D-cell power packs weigh about 6 lbs., including a D cell, and are normally attached to a belt.

E-cell power packs weigh about 25 lbs., including an E cell, and are normally worn on the back.

Example: A military laser rifle (140 shots on a D cell) would drop to 14 shots. An extra 14 shots could be acquired by adding a D-cell belt pack; an extra 140 shots could be added with an E-cell backpack.



Critical Failure Tables

TL8+ Firearm Critical Miss Table

On any critical failure except a natural 18, a TL8+ weapon has *misfired.* Roll vs. the appropriate Combat/Weapon skill (or Armoury, if you have it) for "immediate action" to clear the misfire. A critical success returns the weapon to service in 1 second. A success returns it to service in 1d seconds. A failure means the weapon is really broken; repair will require an Armoury roll and 2d hours. A critical failure on the immediate action roll – or a natural 18 on the original skill roll – sends the user to this table:

3, 4 – The weapon breaks, or a critical circuit shorts out. It can be repaired – with the proper tools – in 1d-1 hours (minimum 1) with a successful Armoury roll. If the attack is with a grenade or explosive device, it simply fails to go off.

5, 6 – The firing mechanism fails. An armourer can repair it; each attempt requires 3d minutes.

7 – The feed mechanism or circuitry has failed. Projectile weapons can be used for single shots (reload time: 5 seconds). Others will not fire again until repaired (Armoury roll; each attempt requires 1d-1 hours, minimum 1).

8 – A dud round, magazine, or power cell. Roll randomly if more than one might apply. It must be replaced, but the weapon is unharmed.

9-11 – The weapon jams or shorts out completely; grenades or explosives fail to detonate. It will require a successful skill roll (Combat/Weapon skill -4 or Armoury) to clear the weapon, to reconnect the circuit, or to correctly reset a grenade's fuse. Roll at -3 if the weapon is *cheap.* Time required is 2d seconds.

12 – A dud, as #8 above.

13, 14 – Same as #5, 6 above.

15 – Same as #7, above.

16, 17 – You accidentally shoot yourself in the foot (or drop a live grenade). Roll to see which foot you hit.

18 – The weapon explodes. You take the damage amount of the weapon in crushing damage (1d for a laser pistol, for example), with the following additions: If you had been *aiming,* you are also blinded for 5 minutes (unless wearing anti-glare goggles). If the weapon was a grenade, it goes off in your hand, doing double damage.

TL8+ Mechanical/Electronic/ Biochemical Critical Failure Table

Use this table whenever it seems appropriate. In particular, refer to it when a critical failure occurs when alien or Precursor equipment is being investigated, scientists are experimenting, superscience gadgetry is being repaired, or damage control is attempted on a spaceship, or (GM's option) when a critical failure is rolled during use of a superscience weapon.

3, 4 – Your equipment shorts out catastrophically; a vital part breaks; your chemicals interact cataclysmically. Roll 2d for the number of hours/days/weeks (as GM rules appropriate) it takes to repair damage, get replacement parts, or re-mix the proper chemicals to compensate for the setback.

5 – You set off an explosion, doing 2d damage to yourself and anyone in an adjacent hex.

6 – Same as #5, above, but doing only 1d damage.

7, 8 – You botch the experiment or repair badly, but can repair your mistake with the loss of only 1 day or 1 hour of time (as appropriate); your next roll is at -3 to skill.

9-11 – You almost make a serious error, but catch it in time. No time is lost, but your confidence is shaken. You have a -3 on your next roll for success (if that was the final roll, roll again at a -3).

12, 13 – You lose ½ day or ½ hour of time (as appropriate), and have a -3 to your next attempt.

14 – You think you may have used the wrong procedure, but you're not quite sure because your notes (or the repair manual) have been misplaced, gotten out of order, etc. Roll IQ-3 to know for sure (GM determines truth). If you miss the IQ roll or you really did goof, either start from scratch or attempt to complete the work with a -5 to skill (your choice).

15 – A serious error. Biochemical experiments produce a toxic chemical cloud; electrical repairs administer a sizable shock; mechanical repairs end in a heavy component falling on you. Roll HT-5 or go to 0 HT. If you make your roll, you still take 1d of damage and pass out for 20-HT minutes.

16, 17 – As #15, but you automatically go to 0 HT and take an additional 2d damage. If working with electricity, you take a point of damage every five seconds until someone shuts the power off. You can do nothing during this time except use psionic abilities (at -6) if you have them.

18 – A major explosion. Effects are as #16, 17 above, except that you take 4d damage after going to 0 HT. Anyone within 10 yards takes 2d damage. Better hope someone stays conscious and gets you to an automedic or freeze tube quickly!

Projectile Weapons

Chemical-Propellent Guns

These are improved versions of modern-day pistols and rifles. The main difference is the increased use of lightweight composites and plastics. In some SF settings (those without portable superscience power cells), they may remain standard weapons even at high TLs.

The weapon tables assume that standard TL8+ chemical slugthrowers will use *caseless* ammunition: the bullet is embedded in a block of propellent rather than using a traditional cartridge. This reduces ammunition weight and bulk, and eliminates the need for ejection ports (which can allow dirt into the weapon), making the weapon's action more reliable. However, caseless ammo may never catch on, and the guns are more complex to build, so some places may prefer old-style *cased* ammunition, like that used by 20th-century guns. These guns are half as expensive, but their magazines have only half as many shots for the same weight and cost. Reduce reliability of cased-ammo weapons with Malf. of Ver. or better by one step.

Assault Chaingun: A man-portable squad-support machine gun with electric feed. Usually used prone, from a bipod, but a strong individual can fire it from the hip. Use Guns (Light Automatic).

Assault Rifle: The standard early TL8 infantry weapon, a progressive development of assault rifles like the M16 and Steyr AUG. It has a light alloy/plastic bullpup design (i.e., the magazine is behind the hand grip). Use Guns (Light Automatic).

Heavy Pistol: A large-frame handgun firing 10mm (0.40 caliber) bullets. Use Guns (Pistol) skill.

Submachine Gun: SMGs are automatic weapons that fire pistol-caliber ammunition. Due to their compact design and firepower, they are favored by special ops troops (and terrorists). This is a modern SMG firing 10mm bullets and equipped with a folding stock; stats become SS 10, Acc 5, Rcl -2, Hld -2 when folded. Use Guns (Light Automatic).

Electromagnetic Guns

These weapons use an electromagnetic impulse to accelerate a projectile. Other common names for electromag guns are Gauss guns, railguns, coilguns, and mass-drivers. The Gauss needlers on pp. B208-209 are small-caliber examples.

Electromag guns are silent except for a sharp crack as the round breaks the sound barrier, but this sound is hard to localize: a Hearing-2 roll is necessary to locate the firer by sound alone. Some smaller electromag weapons are effectively recoilless (their recoil is too small to be significant in game terms). However, a few of the more powerful guns have significant felt recoil. Electromag guns require both a magazine of ammunition and a power cell.

Gauss Carbine and Gauss Pistol: These shoot 3-5mm *high-density darts* at substantially greater velocities than conventional bullets. A high-density dart is a tungsten or depleted uranium-tipped steel dart. It has a (2) armor divisor: DR is halved against it. Unlike most armor-piercing rounds, damage is *not* halved after it penetrates DR. This is standard ammunition for these weapons; there is no extra cost. Use Guns (Needler).

Electromag Grenade Launcher: An electromag grenade launcher is a short, stubby, shotgun-like weapon, similar to a 20th-century grenade launcher. It holds a clip of five grenades of any of the types listed below. Grenades are usually set for contact detonation, though they may be timed instead. Grenades may be mixed in the clip. The launcher will fire 10 grenades on a C cell, one per turn. Grenades may be loaded and fired individually, but it takes one second to load each grenade and one second to fire it. Misses will result in scatter; see p. B119. Use Guns (Grenade Launcher).

Electromag Mortar: A heavy, base-mounted tube, similar to the grenade launcher. It fires heavier shells, singly or from a 20-shell magazine, over greater distances. It will fire 60 shells on a D cell. Performance is otherwise like the grenade launcher. All grenade types described below are also available as mortar shells. Cost and weight double. A gas mortar shell covers a circle with a radius of 8 yards. A fragmentation or concussion shell from a mortar does 6d damage at TL7, 6d×4 at TL8. Fragmentation effects are normally 2d over a circle of radius (10 yards × dice of concussion damage), but shells can be ordered that limit fragmentation range to any desired amount, down to that for the frag grenade of the same TL. Use Gunner (Mortar).

Grenades

Numerous types of grenades are available at TL6+. Some are listed below, many others appear in ***GURPS*** supplements like ***Autoduel, Ultra-Tech*** and ***Ultra-Tech 2.*** All weigh 1 pound, and are armed and set the same way. First, either the grenade is set for contact explosion (i.e., once it is activated and released, it will explode as soon as it hits something), or a time delay is set from 1 to 5 seconds. Second, an activator is pressed and the grenade is thrown or fired. It takes one turn to set or change the delay on a hand grenade and another to press the activator and throw the grenade. If the grenade is loaded in a grenade launcher, the delay or contact setting must be preset, but activation is automatic when the grenade is fired.

The ability to put a hand grenade where you want it is the Throwing skill (not Thrown Weapon skill); see p. B49. The distance a character can throw a grenade depends on ST (see table). Even a missed roll may get a grenade close enough to damage the target; see *Scatter,* p. B119. If a critical miss is rolled, see the *TL8+ Firearm Critical Miss Table* (p. 77).

Fragmentation Grenade: A TL7 fragmentation grenade does 3d concussion damage, plus 2d fragmentation (cutting) damage to anyone in range (30 yards). At TL8, a similar grenade does 6d×2 concussion damage plus 2d fragmentation damage, but the fragmentation radius is limited to 10 yards to make it a more useful close weapon. At any TL, standard frag grenades are 1 lb., $20. Legality Class 0.

Concussion Grenade: Has the same cost, weight, and concussion damage as the equivalent fragmentation grenade, but fragmentation damage is limited to that caused by the ground at the explosion site; see pp. B121-122. Legality Class 0.

Gas Grenade: Creates a cloud 11 yards across – that is, the target hex and five hexes in every direction. Gas clouds may disperse within a few seconds or linger for minutes, depending on the wind; divide 300 seconds by the wind speed in mph (minimum 1 mph). Most gases have no effect once dispersed, but some virulent poisons will cause injury even when greatly diluted. Types include:

Sleep Gas Grenades (TL8): For every turn spent in a sleep gas cloud without holding his breath, a character must roll HT-4. If he misses the roll, his ST goes to 0 and he falls asleep. If he makes the roll, he takes 1 point of fatigue. If ST drops to 0, he falls asleep. If he gets out of the cloud, he may regain the lost ST normally. Those who fall asleep remain so as long as they continue to breathe the gas and for at least 30-HT minutes after that. When that time is up, the victim may roll HT each minute to awaken. He may be awakened normally by a successful First Aid roll. 1 lb., $50. Legality Class 2.

Poison Gas Grenades (TL6+): Many kinds are available; they are distinguished by different-colored markings on the grenades. See p. B132 for some typical gases. Although gas masks and holding your breath will offer protection from some poison gases, only an airtight full-body suit will protect against a contact agent. Prices vary widely. Legality Class 0 (or even -1).

Blackout Grenades (TL8): Release a nearly opaque cloud of thick, inky black smoke that covers the area of effect (see above). Everyone in the cloud functions as though in complete darkness; any action requiring sight is at -10, or is impossible (see p. B92). Attempting to fire at a target in the cloud gives the same modifier. Infrared sighting will reduce the penalty to -5, and other sensors or senses, such as radar or sonar, will be unaffected. Night Vision and light-intensification scopes are useless. Lasers (except for X-ray lasers) cannot penetrate the cloud. Anyone in the cloud without breathing gear also must make a HT roll each round or take 1 point of damage, choking on the thick smoke. 1 lb., $30. Legality Class 2.

Tanglers

Tanglers are short, stubby two-handed weapons resembling 20th-century riot guns. They fire egg-sized capsules which release a number of strong, sticky strands to wrap around and completely immobilize the target. Recoil is high: -4 to skill for each successive shot. Use Guns (Tangler).

The victim may try one Contest of Strength per minute to break the strands; together, they have ST 20. Alternatively, if the victim is fully clothed, an Escape-3 roll (one try every 10 minutes) will let him wriggle out of his clothes and escape. Any failed attempt to break free or wriggle out results in the strands constricting, causing 1 point of damage. If hit by multiple tangler rounds, each additional round adds 5 to the ST of the strands and gives a further -1 to Escape attempts. The strands lose their constricting ability after one day, and then begin to lose ST at the rate of 1 per 2 hours.

Ten points of damage from intense heat, as from a laser, will free a captive – but he will take full damage from the weapon if he isn't otherwise protected. The strands are too tight and too sticky to be cut off. The proper way to remove them is with anti-tangler aerosol spray. A can costs $100, weighs 2 lbs., and will treat 25 captives, one per turn.

Neither the PD nor DR of armor protects against being hit by tangler strands, as they simply wrap around it as well as the person wearing it. However, rigid armor with DR2+ protects totally against the constriction damage. Force fields *will* turn back the tangle strands, causing them to fall harmlessly to the ground. And anyone hit by the charge has an extra Dodge roll to evade the strands before they close.

A tangler can only be fired once per round. Tangler ammunition comes five to a disposable magazine, which weighs 5 lbs. and costs $50. The magazine includes its own gas propellant. Cheap Tangler ammo has strands with less ST – from 15 on down to 10 or so. Beware of bargains.

Tangler mines are also available. They can be triggered electronically or by foot pressure, and have the same effect as a normal tangler round; the victim gets a (DX-4) roll to jump out of the way. They cost $10 apiece.

Directed-Energy Weapons

Electrolasers

These beam weapons, also known as "shockers," "zap guns," and "stat guns," stun and damage via discharges of electricity. They fire a low-powered laser beam to ionize the air, following it instantly with an electrical charge that travels along the path of the laser to the target. Work has begun on electrolaser prototypes *today,* and reliable models are likely by TL9.

Electrolasers are most effective in dry climates. In damp climates or in rainy weather, they are less accurate, as the electrical bolt tends to jump off the laser path to follow other paths of low resistance. This gives -2 to hit in moist, humid environments, and -6 to hit in rain, drizzle, or heavy fog. They are practically worthless in a vacuum: since there is no air to ionize, the discharge arcs randomly to some nearby metal item.

Nonmetallic armor protects normally from an electrolaser. Metallic armor conducts the electrical charge, making it worse than useless: it *attracts* the charge, giving the attacker +2 to hit if the target is wearing more than 20 lbs. of metal.

The weapon has two settings: "stun" and "kill." Changing settings takes one second and counts as a Ready maneuver.

"Stun" fires a less powerful bolt. Roll damage normally, but instead of actually taking the damage, the target must make a HT roll at a penalty equal to half the damage that got past DR (rounded up). A failed roll means he is stunned. The effects are similar to those of a stunner (p. 82) – unconsciousness or incapacitation for 20-HT minutes – but the target is at a -2 DX for an additional 20-HT minutes after recovering from stun.

"Kill" does the full listed damage. If any damage penetrates DR, the target must also roll immediately against HT minus half the damage taken. If the roll is failed, his heart *stops.* He will die in HT/3 minutes (round down) unless someone performs CPR to save him. This requires one minute per attempt and a successful First Aid-4 or Physician roll.

Electrolasers use Beam Weapons (Electrolaser).

Lasers

Lasers fire pulses of coherent light. In the case of weapons lasers designed for use in atmosphere, the laser pulse is usually infrared or in the visible light spectrum.

Although a low-powered laser (like a laser sighting beam) is silent and hard to spot unless it is pointing directly at you, a high-energy laser, while invisible in space, will be very noticeable in atmosphere: it will appear as a "linear lightning bolt" as it zaps air molecules on its way to the target. There may be a crackling noise as well.

The size of the optics necessary to properly point and focus a laser beam depends on the frequency of the laser and the range to the target. Realistically, a laser rifle or cannon would end up looking more like a big flashlight or searchlight than a gunpowder weapon. A vehicle- or ship-mounted laser is likely to have optics many yards across.

The main advantages of a laser are that the beam travels in a perfectly straight line at the speed of light and that it is recoilless, making it very accurate. Large, vehicle- or installation-mounted lasers are excellent for intercepting fast, small targets, like missiles. Another advantage of laser weaponry is its wide range of effects. A low-powered laser beam can temporarily or permanently blind sensors or people, while a high-energy laser pulse dumps so much energy into a target that flesh, plastic, or metal can actually explode.

Atmospheric conditions can reduce the effectiveness of a laser beam. Fog, clouds, and smoke will block most laser beams, and rain or snow will degrade them. Some frequencies of light cannot penetrate through atmosphere at all. The favored frequencies for weapons-grade lasers seem to be infrared and blue-green visible light. Realistically, X-ray and gamma-ray lasers should not be able to penetrate more than a foot or two of atmosphere; this is ignored in many SF settings.

A laser has no recoil, either for successive shots in the same turn or for successive groups in a burst. It is thus so accurate that the dispersion of shots is less than the diameter of the beam. Because of this, automatic-fire laser weapons use special rules. When a laser is fired on full automatic setting (see p. B119-121 for automatic fire rules), successive shots from *all* groups fired in the same turn at the same hit location are effectively a single beam. Instead of making defense rolls and applying armor or force screen DR separately against each "round" that hits, only one defense roll is made. If it fails, the damage from all rounds striking the target is *totaled* into a single damage roll *before* subtracting DR.

Semiautomatic lasers cannot be held on target precisely enough to get this armor-penetrating bonus. The mechanical action of firing multiple shots is enough to disperse them. Thus, such weapons are useful for hunting but not for combat against armored foes, and have a higher Legality.

Lasers require Beam Weapons (Laser) skill. They do impaling damage, so damage that gets through DR is doubled. In rain, fog, or smoke, lasers do half damage or less (GM option). Smoke bombs block lasers entirely.

Any laser hit to the eyes does double damage, and blinds the victim unless he can make a roll of (HT-damage). Antiglare goggles give a +5 to this roll. He may recover later; roll as for other crippling injuries – once more at (HT-damage).

Laser Weapons

Laser Pistols and Rifles: These basic laser weapons use C cells; a pistol gets 20 shots, a heavy pistol or a rifle gets 12. For an extra $100, they can be modified with a B-cell socket for emergencies; a B gives 3 pistol shots or 1 heavy pistol or rifle shot.

Holdout Lasers: Palm-sized hideaway weapons, like old-time derringers. They can be disguised as anything small: a pen, a wristcomp, etc. An Armoury roll can replace the cell(s), but the weapon is disposable; effective skill is at a cumulative -2 for each shot after the 4th, as the barrel lining vaporizes. Built of plastic, holdout lasers are virtually undetectable as weapons until fired. A radscanner might detect the power source at a -7 to normal skill.

Military Laser Rifles: Slightly heavier than standard laser rifles (mostly due to their D cell), and capable of automatic fire.

Gatling Lasers: Heavy lasers with four rotating barrels; each can pulse once per second, giving it a RoF of 4. Gatling lasers are area-effect weapons, and use Gunner (Beams) skill. They are tripod-mounted. Their weight breaks down into three 25-pound loads (barrel, tripod, and power system) for carrying; it can only fire if the gun and power system are joined. Disassembling or reassembling the weapon takes two turns for one man or one turn for two. The connections are virtually idiot-proof; IQ or DX rolls should be required only for those totally unfamiliar with the weapon. The weapon can be fired off the mount with ST 15 or better (it will weigh 50 pounds) – this is a favorite sidearm for battlesuited troopers. Used this way, it has SS 15 and Acc 4. It uses an E cell; it takes 3 seconds to switch power cells.

Laser Options

For an extra $50, a laser weapon can serve as its own laser sight (see p. 84 for effects). The weapon then has a two-stage trigger. Light pressure on the trigger activates a low-intensity aiming beam that places a visible dot where the weapon is pointed. More pressure fires the weapon.

For an extra $100, a laser can be given a dazzle setting. Treat as an ordinary laser attack, except it does *zero* damage, but a hit to the eyes can still blind someone on a failed HT roll. Each shot counts as only 1/10 of a shot for power consumption. "Dazzle lasers" with *no* lethal setting at all are ¼ normal price and Legality Class 4.

For an extra $100, a handheld laser weapon can have a variable beam, making it useful as a tool. Welding uses one "shot" every five seconds; cooking a meal would use one shot per minute. It can even be used as a flashlight, expending one shot every 5 minutes. It can also be used to light a fire, expending a trivial amount of energy.

X-Ray Lasers (TL10)

These fire pulses of X-rays rather than visible light. An X-ray laser ignores reflec armor (p. 85) and is more effective than a standard laser against other armor as well: *halve* the DR of any armor or force screen against an X-ray laser. Smoke, weather, and other factors that hinder normal lasers are totally ineffective against X-ray lasers.

Power cells give only half as many shots with an X-ray laser. Double the cost to make any laser weapon an X-ray device; Legality Class is automatically 0.

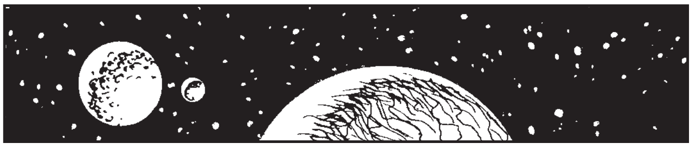
Most real-world means of generating X-ray lasers involve nuclear bombs, but it may be possible to do so without one. More significantly, X-ray beams are rapidly absorbed by atmosphere; realistically, this is a space-only weapon system. However, they are very effective in vacuum: divide listed range by 1,000 in atmosphere, but multiply it by 100 in space.

Particle Beams

Particle beams are an outgrowth of conventional particle-accelerator technology. They use megavolt electric potentials and powerful magnetic fields to accelerate beams of subatomic particles to near light speed. A particle-beam strike delivers immense kinetic energy, both heating the target and disrupting its atomic structure. In atmosphere, a particle beam would look and sound like a linear lightning bolt. In vacuum, it would be invisible.

The main weakness of a *charged* particle beam is that a planetary magnetic field combined with the beam's strong electrical charge eventually causes it to break apart. This restricts atmospheric range to several hundred yards (at most). In vacuum, the problems are even worse: the particles repel one another, diffusing the beam almost instantly. However, a *neutral* particle beam can be produced by adding systems that strip away charge – such a beam is no good in atmosphere, but very effective in space.

Realistic weapons-grade particle beams require energies in the hundreds of millions of electron volts, beam powers in the tens of megawatts, and heavy, evacuated beam tunnels to generate them.



Blasters

Charged particle beams are the best candidates for the traditional SF blaster. They work as described above; the resulting energy beam causes kinetic, thermal, and radiation damage, as well as ionization that will fry electronics. Blasters are even more visible than lasers in atmosphere, and a thunderclap (as air rushes into the vacuum left by the beam) may accompany each shot. They can dump more energy into a target than a laser, but are somewhat less accurate, as the charged beam is vulnerable to atmosphere. In reality, it's unlikely that particle beams could ever be effectively scaled down to a man-portable size, but they are a good choice for space-opera campaigns.

Blasters do impaling damage which includes a surface explosion effect, so targets may experience knockback (see p. B106). The radiation produced by a particle-beam hit is likely to fry circuits. Unlike normal impaling damage, the damage multiple should also be applied when the beam strikes any non-living target that uses a lot of electronics, like cybernetics, robots, or vehicles. A particle beam may also irradiate its target: GMs can optionally have a particle beam hit inflict at least 5 rads (see *Radiation,* p. 104) per point of damage caused – a localized radiation burn to a hit location.

All of these weapons use Beam Weapons (Blaster):

Blast Carbine and Blaster Pistol: These are typical side arms.

Heavy Blast Rifle: A heavy and lethal military weapon, and an alternative to the military laser rifle.

Semi-Portable Blaster: A big, tripod-mounted weapon, more potent than a Gatling laser but slower-firing. Like a Gatling laser, it can be detached from its tripod and shoulder fired. It can be broken down into three loads: the blaster is 23 lbs., the power cell 20 lbs., and the tripod another 23 lbs. Time required to assemble or disassemble is as per the Gatling laser (p. 81).

Blaster Options

The term "blaster" is a fairly generic one in science fiction, and can apply to a variety of weapon types besides particle-beam weapons. Some SF blasters behave more like lasers; others have additional capabilities. Here are some possible alternative "blasters" – it is up to the GM which of these, if any, exist:

Plasma Blaster (TL9): These fire bolts of super-hot ionized gas (plasma) down a path burned by a laser beam, causing both thermal and kinetic damage. Plasma blasters are available in the same varieties as blasters, but cost 1.5 times as much. They function exactly like blasters, except as follows: instead of impaling damage, a hit does burn damage (no multiple after subtracting DR) and knockback, and will splatter plasma over the target area. Anyone within two yards takes ¼ the blaster's damage (roll damage normally, divide by 4). This will set fire to anything flammable (wood, paper, etc.) within two yards of a hit. Plasma blasters offer a greater area effect at the expense of slightly reduced wounding. Use Beam Weapons (Blaster).

Electrolaser Setting (TL9): For an extra $800, a blaster can be built with an electrolaser setting capable of producing effects identical to the electrolasers on p. 80 (blaster pistol as electrolaser pistol, rifle as electrolaser rifle). This adds 1 lb. to weight. It takes one turn to switch between blaster and electrolaser settings; two charges per shot are used up when a blaster operates in electrolaser mode. Use Beam Weapons (Electrolaser).

Tight-Beam Blaster (TL9): A tight-beam blaster fires a much narrower particle beam. It does ⅓ normal damage (round fractions of 0.5 or more up) and its energy pulse is treated as a projectile rather than as a beam weapon for blow-through purposes, but DR protects at ¼ normal! For instance, a blaster pistol does 6d imp. damage normally, while a tight-beam version does 2d(4) imp. damage. A blaster that has only a tight-beam setting is identical in cost and weight to a normal blaster; a "variable" blaster that can use normal or tight-beam settings (one turn to change) costs 1.5 times as much. GMs may want to create a universe where tight-beam-only blasters are the standard energy weapon: their lack of overkill combined with superior armor-piercing capabilities makes them a good choice for simulating settings where a hero can survive a blaster hit or two without wearing armor but where a few well-aimed shots can still bring down an armored trooper. Use Beam Weapons (Blaster).

Neural Blaster (TL10): Fires an electromagnetic bolt similar to an electrolaser beam but more sophisticated. A hit causes shock and spasms that progressively weaken the victim. It has identical statistics to an ordinary blaster except that it is one LC more legal, does "special" rather than impaling damage, and has no recoil. Damage that penetrates DR is treated as fatigue rather than as real damage, but shock, knockdown, knockback, and stunning effects apply as if the character had lost HT (e.g., fatigue of more than HT/2, or HT/3 on a brain hit, would stun the target). Lost fatigue returns normally, and as usual, ST cannot fall below 0 . . . which means that anyone knocked out by a neural blaster will wake up in 10 minutes. A neural blaster costs and weighs the same as a normal blaster; a normal or tight-beam blaster can be given a neural setting at +50% to cost. Use Beam Weapons (Neural).

Omniblaster (TL10): These "superscience" weapons are multipurpose beam weapons with normal blaster, plasma blaster, tight-beam blaster, and neural blaster settings. They are available in the same versions as normal blasters, but are three times as expensive. Changing settings takes one turn. Omniblasters may also include an electrolaser setting at extra cost and weight, as described above.

Stunners

Stunners fire focused beams of sound that assault the target's nervous system, rendering him helpless or unconscious. They come in two models: short-ranged hand stunners and longer-ranged stun rifles. Because of their non-lethal effects, stunners are legal on all but the most restrictive worlds. They are useless in vacuum, since air is required to carry the sound.

Anyone hit by a hand stunner must roll HT-3 to avoid its effects (HT at 12 yards or more). If a limb is hit, a failed HT roll incapacitates the limb for 20-HT minutes; on a head or body hit, the victim is "asleep" for that time. Victims recover quickly when the time is up, but cannot be revived before then. If the HT roll is a critical failure, the effects last three times as long.

A stun rifle is more powerful. Anyone hit must roll HT-6 or be stunned, as above (HT-3 at 300 yards or more).

Armor is only partially effective against stunners. For every 5 points of DR at the target point, the victim's effective HT is raised by 1. Thus a complete armor suit with a DR of 15 would allow the target to avoid hand stunner effects on a roll of HT, instead of HT-3.

Stunners have no recoil and use Beam Weapons (Sonic) skill. A hand stunner gets 40 shots from a C cell; a stun rifle gets 20 shots from a C cell. For an extra $100, stunners can be modified with a B-cell socket for emergencies; a B gives 4 pistol shots or 2 rifle shots.

Melee Weapons

Force Swords

A force sword is a superscience energy weapon that consists of a powered hilt, similar in size and appearance to a regular sword hilt. When activated, a "sword blade" of annihilating energy, held in shape by a magnetic field, extends from the hilt. Similar in length to a broadsword or katana blade, the energy blade can be used just like a sword to do devastating cutting or impaling damage. On a successful Fast-Draw roll, a force sword may be activated as it is being readied; otherwise, it takes one turn to activate. In either case, it takes one further turn for the blade to form and stabilize.

Armor protects at ⅕ DR vs. a force sword. Any limb that takes twice the damage needed to cripple it (see p. B127) on any one hit is lopped off, and the wound cauterized; excess damage is lost. Any weapon that successfully parries a force sword – except for another force sword – is considered broken unless the parry was a critical success.

A force sword can also be used as a saw to cut through most materials, as described for vibroblades (p. 83).

A force sword is powered by a C cell in the hilt. It lasts for 5 minutes of continuous activation. Most swords have two or more cells, since one cell may not last through the battle.

For an extra $500, length may be varied from dagger-sized to about 5 feet. Varying the length requires a Ready maneuver and allows the reach to be altered from C to 2.

Neurolashes

These advanced electroshock weapons use electric pulses to stimulate the nervous system of a living target to feel excruciating pain. They are commonly used as dueling weapons, or by slavers. They require Knife or Shortsword skill.

Armor with a DR over 2, or reflec, protects fully; lighter armor and open-weave armor like monocrys do not protect at all. Anyone hit by a neurolash must roll HT-3, +/- Will modifiers. High Pain Threshold gives a +3 bonus, while Low Pain Threshold doubles all penalties. If the roll is successful, the victim can still function, but the pain will cause him to be at -2 to ST, DX, IQ, and all skills based on those attributes for 15-Will turns (minimum one turn). If he was hit on a limb, that limb is useless for the same time.

If he fails the HT roll, the victim is in such agony he can do *nothing* for this time. A critical failure will cause unconsciousness for 20-HT minutes (minimum 1 minute).

Each additional hit lowers the resisting HT roll by 1 (e.g., the second hit is resisted at HT-4). With each successive hit, start recovery time over. Penalties to attributes are *not* cumulative.

Type I neurolashes are small, rod-like weapons resembling short plastic batons with protected hand grips. They use a B cell, and can strike 50 times before losing power. Without power, a neurolash is just a baton.

Type II neurolashes, sometimes called "tinglers," are the same, except that if they affect the target at all, they also do 1d of actual damage. They can hit only 5 times before losing power.

The only way to tell the types apart without close examination (and an Armoury roll) is the damage.

Vibroblades

These blade weapons vibrate thousands of times per second. This adds 1d to the regular damage of the weapon, and armor protects at ⅕ DR against the entire damage. As the blade vibrates so rapidly, its movement is invisible, and it is impossible to tell a vibroweapon from a regular weapon of the same type. A Hearing roll made from one yard away will detect a faint hum that marks the vibroweapon for anyone familiar with it. Anyone whose weapon parries a vibroblade or is parried by it will realize its nature on an IQ roll.

Vibroblades are powered by B cells. To find the life of the cell, divide 1 hour by the weapon's weight in pounds. Thus, a half-pound knife runs for 2 hours, but a 5-pound sword vibrates for only 12 minutes.

Turning on the vibro effect when the weapon is in hand takes one turn. A successful Fast-Draw roll, for one practiced with the weapon, activates it as it is drawn. When not activated, it performs like a normal weapon.

A vibroblade can also be used as a very powerful cutting tool, doing its regular damage against any material. The hit points listed for a large, flat surface, such as a wallboard or steel slab, should be interpreted as the amount of damage required to make a 3-inch cut. For example, to cut a 24-inch slice in a slab of half-inch steel, you must do 320 points of damage – 40 points per 3 inches of steel cut. This damage may be done over any number of turns, but you must overcome the DR of the material *every turn.*

Any bladed weapon can be made in vibro versions. Regular knives of all sizes cost $200 extra in vibro; regular swords of all sizes cost $400 extra and are less common. Any other weapon (e.g., a vibro battleaxe) would be very unusual, and would cost $1,000 more than the regular weapon, if it could be found at all.

Weapon Accessories

Head-Up Display (HUD) (TL8): Consists of two parts: a sensor mounted on any weapon and a pair of special goggles (or a built-in helmet visor). The goggles project a holographic reticle that shows the wearer exactly where the gun is pointing, reducing SS by 2 at TL8 or by 5 at TL9+. Runs a year on an A cell. HUD goggles are ½ lb., $500. The weapon fitting is negligible weight, $500 per weapon.

Laser Sight (TL7): Attached to any pistol or rifle weapon, this item projects a low-powered laser beam, displaying a dot at the point where the weapon will hit. This gives +2 Acc and reduces the Snap Shot penalty to -1 at up to 50 yards and -2 at up to 100 yards (it remains -4 past 100 yards). GMs may also wish to give a bonus to Intimidation rolls when a laser dot is trained on a target. A B cell should power it for its normal life span. Negligible weight, $200. For an extra $100, infrared sights are available; the dot is only visible to someone with infrared viewing gear. After TL8, laser sights can be assumed to be built into all ranged weapons for no extra cost and weight.

Power Holster (TL8): Available for any pistol-type weapon or knife. Consists of three parts: a wrist sensor unit, a homing sensor on the hand grip of the weapon, and a breakaway holster. When the wrist sensor detects nerve impulses that mean the wearer wants to draw, the holster ejects the weapon toward the hand. This lets the weapon be readied instantly.

For game purposes, treat this as a separate Fast-Draw skill. However, Fast-Draw (Power Holster) rolls always have a +2. Failure indicates the weapon isn't gripped properly and still requires a turn to ready. On a critical failure, the weapon bangs the user's fingers and falls; on a natural 18, the user may be shot or stabbed in the foot! Gives 100 ejections on a B cell. 5 lbs., $1,000. Price doubles if the weapon is unusual and requires a custom-made power holster system.

Personal Armor

Characters facing ultra-tech weapons may not last long unless they avoid combat or wear armor. At high TLs, armor once again catches up with small-arms damage; heavy military armor will stand up to incredible punishment. But such armor, like military weapons, is rarely available to civilians!

Body Armor (TL8)

A multi-piece suit of articulated plastic and carbon-composite armor covering the entire body. It does *not* have airtight seals on the joints, etc. As well as being worn by soldiers, light and medium body armor is often used by police and vehicle crews. This armor has a better protection/weight ratio than combat infantry dress (p. B211) thanks to the use of more expensive armor materials and carefully shaped pieces. It takes 60 seconds to don the entire outfit and 40 seconds to remove, or half as long on a successful DX roll.

The usual range of armor accessories can be added to body armor. A gas mask or NBC filter can be worn with the helmet. This will provide full protection against respiratory agents (see p. B132), but only gives +2 to HT to resist contact agents like nerve gas, as they can penetrate the unsealed joints.

Light Body Armor: LBA has PD 4, DR 20 on the torso, PD 2, DR 12 on the limbs, and PD 2, DR 10 on hands and feet. The helmet protects the head with PD 4, DR 15, except for the face (location 5 from the front) which is PD 2, DR 10. The armor gains DR 5 per TL after TL8. LBA costs $800 and weighs 20 pounds.

Medium Body Armor: MBA has PD 6, DR 30 on the torso, PD 4, DR 20 on the limbs, and PD 4, DR 12 on hands and feet. The MBA helmet protects the head with PD 4, DR 18, except for the face (location 5 from the front) which is PD 2, DR 10. The armor gains DR 8 per TL after TL8. MBA costs $1,200 and weighs 30 pounds.

Heavy Body Armor: HBA has PD 6, DR 45 on the torso, PD 4, DR 30 on the limbs, and PD 4, DR 15 on hands and feet. The HBA helmet protects the head with PD 5, DR 25, except for the face (location 5 from the front) which is PD 2, DR 15. The armor gains DR 10 per TL after TL8. HBA costs $1,800 and weighs 45 pounds.

Many military units add a standard set of accessories to the helmet: At TL8-9, this is usually a HUD ($500), a short-range communicator ($50), and a multiview visor (light intensification, anti-glare, and thermal imaging; $1,200) for 2 lbs. and $1,750. Halve accessory cost and weight at TL9, and again at TL10+. Rather than using individual power cells, the helmet system runs off a single C cell for 6 months; the cell adds another ½ lb. to weight.

Clamshell Cuirass (TL8)

This is a two-piece hinged cuirass made of sloped, molded ceramics, carbon composites, and plastics over an inner layer of impact-absorbing ballistic fiber. It is favored by soldiers who don't want to carry around the weight of a full suit of sealed body armor but who *do* want tough, rigid armor protection where it counts. A clamshell cuirass can be worn over any flexible armor. It takes 10 seconds to put on or remove. It protects the torso (locations 9-11, 17-18) only. Three grades are available:

Light Clamshell Cuirass: PD 4, DR 20, 7 lbs., $280. Add +5 to DR per TL over TL8.

Medium Clamshell Cuirass: PD 6, DR 30, 12 lbs., $400. Add +8 to DR per TL over TL8.

Heavy Clamshell Cuirass: PD 6, DR 45, 18 lbs., $600. Add +10 to DR per TL over TL8.

Combat Armor (TL8)

These suits are identical in protection to LBA, MBA, and HBA (p. 84), but are fully sealed "space armor." This makes them somewhat heavier and more expensive. With the helmet visor closed and its integral NBC filter (see p. B211) locked into place, the suit is completely airtight, providing complete protection against contaminated atmospheres, pressure loss, or chemical and biological threats. Operations in the absence of breathable air are possible with the addition of air tanks (p. 61) and a life-support pack ($750, 2.5 pounds). In addition to armor accessories, the entire range of vacc suit accessories (pp. 61-63) can be used with combat armor.

Light Combat Armor: LCA is $1,000, 24 pounds. Otherwise, treat as LBA.

Medium Combat Armor: MCA is $1,500, 36 pounds. Otherwise, treat as MBA.

Heavy Combat Armor: HCA is $2,250, 54 pounds. Otherwise, treat as HBA.

See *Body Armor* (p. 84), for helmet accessories.

Light Infantry Helmet (TL8)

This is an infantry helmet similar to that used by 20th-century soldiers, but made of futuristic composite materials to significantly increase toughness compared to any TL7 helmet. It is unsealed and has no built-in electronics; soldiers often pick up separate radio headsets, HUDs, gas masks, etc., to suit the mission. It protects the top of the head only (brain, locations 3-4) with PD 4, DR 15; this DR increases by +5 per TL over TL8. The LIH weighs 1.5 pounds and costs $30.

Monocrys (TL8)

A high-tech replacement for Kevlar, this is an advanced, flexible armor material woven from two-phase, single-crystal metallic fiber, available in vests or full-body suits. (The GM can use these rules for *any* kind of advanced, supple body armor.) It protects well against crushing and cutting attacks, but less so against impaling damage, which penetrates the weave. Statistics depends on thickness:

Light: PD 2, DR 8 (PD 1, DR 2 vs. impaling). $400, 3 lbs. for a vest; $1,000, 7 lbs. for a full suit.

Medium: PD 2, DR 16 (PD 1, DR 2 vs. impaling). $600, 5 lbs. for a vest; $1,500, 12 lbs. for a full suit.

Heavy: PD 2, DR 24 (PD 1, DR 2 vs. impaling). $800, 7 lbs. for a vest; $2,000, 16 lbs. for a full suit.

Even if a blow or bullet is stopped by DR, a certain amount of kinetic energy gets through to do crushing damage: any "6" rolled on the damage dice indicates *1 hit* that affects the wearer, despite the armor. Monocrys is Legality Class 3. A vest covers the torso and groin only, and can be concealed under clothing. Vests take 10 seconds to put on, 5 to take off; double these times for suits.

Reflec (TL8)

Light, highly reflective armor of polished metallic fibers that reflects laser fire, and that of other beams to a lesser extent. It is useless against other attacks. It can be worn over other armor, giving the wearer the benefit of its PD against beams. Reflec gives PD 6, DR 2 against lasers and flamers; PD 3, DR 0 against other beam weapons, including blasters but not sonic weapons, and PD 0, DR 0 against all other weapons. It protects completely from normal fire (but not plasma) for 3 seconds, after which normal damage is taken. Reflec is Legality Class 3.

A jacket (covering torso and arms only) is 1 lb., $150. A suit covering the entire body is 2 lbs., $300. It takes 20 seconds to put on a reflec suit, 10 to take it off; 10 and 5 seconds for a jacket.

Reflec helmets (made of light plastic, silvered) weigh ½ lb. and cost $25. Any helmet can be made reflective, getting the PD of reflec, for $50.

Battlesuit (TL10)

A battlesuit, also known as "powered combat armor" or "powered armor," is an heavily armored exoskeleton which amplifies the wearer's ST and provides protection against attack. Because of its cost, it is often restricted to special units like the Marines. There are many types of battlesuits; rules for designing them can be found in ***GURPS Mecha*** (with less-detailed rules in ***Vehicles*** and ***Robots***). A sample suit is described below:

The battlesuit's body is protected by thick plates of advanced laminated armor over shock-absorbing padding, giving the wearer PD 5, DR 100 over the torso (locations 9-11, 17-18) and head, and PD 4, DR 80 over the limbs. (At TL11: DR 160/DR 80; TL12: DR 266/DR 133; TL13+: DR 400/DR 200.)

The suit's exoskeleton gives the wearer ST 30 (ST 40 at TL11; ST 60 at TL12+). The suit's weight does not count as encumbrance while powered-up. If the suit loses power, the wearer can still move, but he must use his own ST to carry the weight!

The battlesuit takes 4 minutes to put on, 2 to take off. Each suit must be specially fitted to its wearer; refitting a suit takes 2 hours and requires an Armoury (Body Armor)+2 roll. Failure means that another attempt is required; critical failure damages the suit, requiring repair using Mechanic (Battlesuit) skill.

The helmet has an integral holographic HUD (p. 84), global positioning system (p. 71), and medium-range communicator (p. 63), all tied into a voice-activated personal computer (Complexity 4 at TL10). It has sensor systems equivalent to multiview goggles (p. 69) with a one-mile range (two miles at TL11+).

The battlesuit is airtight and pressurized for vacuum, with a radiation PF of 20. It has a life-support pack, including an air tank good for six hours at TL10 (at TL11+, recycling systems give unlimited air as long as power holds out) and a waste-relief system. Other vacc suit options (pp. 61-63) – like more air – may be added at extra cost. It is powered for one day by a D cell, costs $57,800, and weighs 222 pounds.

Cybersuit (TL11)

The ultimate in "smart" body armor, the cybersuit resembles a skintight vacc suit with a small backpack. Not as heavily armored as an actual battlesuit, but lighter and more convenient, making it especially suitable for TL11+ Rangers, light infantry, spacecrew, and explorers. A cybersuit functions as a fully sealed vacc suit capable of withstanding up to 100 atmospheres of pressure. It absorbs sunlight for power, and recycles waste and exhaled carbon dioxide, giving it a six-week air and water supply. The suit's backpack also includes a D cell (which will run all suit systems for a day without sunlight), and a week's supply of concentrated rations.

A cybersuit consists of a multi-layered, three-dimensional molecular weave of diamond-based fibers, and microscopic computer-controlled electric motors. Guided by pressure sensors lining the interior of the suit, the fabric of the suit acts like artificial muscle, duplicating the wearer's every movement, instantly and without resistance, as if the suit were not there at all. More pressure sensors covering the suit's surface feel the shape of whatever the user touches and transmit it through the suit. As a result, DX is not reduced in a cybersuit, and its weight does not count as encumbrance for the wearer.

The suit's muscles are normally programmed to match the user's normal ST, but the user can set it to amplify ST instead, increasing ST to a maximum of 20.

Every cybersuit incorporates laser sensors which warn the wearer if a laser sight or active designator is being used against him (giving a +1 to Dodge) and a chameleon surface that automatically changes color, pattern, and infrared signature to blend in with its surroundings, giving a -3 on any roll to spot the suit visually or by infrared. The wearer can use voice control to override the suit's chameleon circuits. Civilian spacers often use this feature to decorate their suits with garish colors or designs.

A cybersuit protects the wearer with PD 5, DR 80. DR increases by 20 per TL over 11. Because of its unique construction, the cybersuit has no joints or vulnerable points. Cybersuits are Legality Class 1. They weigh 35 pounds and cost $20,000.

All vacc suit accessories (pp. 61-63) are available, but the cost of the suit includes a helmet with sensor visor, short-range (500 miles) communicator with neutrino receiver, and a holographic HUD.

Force Fields

Here are two different examples of defensive force fields. They are very much "superscience" technology; the GM decides whether either of these will exist in the campaign.

Force Shield (TL11)

The force shield is a flat, circular energy field that performs the same function as a medieval shield – to block attacks. Duelists often use one of these in conjunction with a force sword (p. 83). It gives PD 4 against *any* attack from the front; a bullet or beam hitting it may be deflected, but total armor and shield PD cannot exceed 8. It has no DR, but no attack can damage it. It allows a Block defense against any weapon that can be blocked. See p. B50 for Force Shield skill description.

The shield is generated by a solid bracelet worn on the wrist. It will function for 30 minutes on a C cell. ½ lb., $500. For $1,000, a force shield can be adjustable, giving the user the option to enlarge it to PD 5 (lasting 15 minutes) or PD 6 (5 minutes). Legality of any Force Shield is 5.

Force Screen (TL13)

Force screens act as armor, absorbing electromagnetic and kinetic energy. Energy beams will be absorbed, hand-weapon attacks will hit an apparently solid wall, bullets that fail to penetrate will fall to the ground. They are transparent to non-coherent visible light and harmless frequencies of sound, and do not react to physical objects moving at walking speed or slower. A man could reach into a force screen, but not run through it. A force screen only stops incoming attacks – the wearer can shoot out with ease.

Force screens have DR but no PD (armor, shield, or force shield PD still applies). Their DR is effective against any physical or energy attack other than close-combat maneuvers (a screened person can still be grabbed, thrown, or strangled). Armor divisors of energy- and explosive-based attacks (like force swords, X-ray lasers, and shaped charges) apply to force screen DR, but those of purely kinetic attacks (like armor-piercing bullets and vibroblades) do not.

A force screen can be overloaded. If it stops damage greater than half its DR, but not enough to penetrate, it gains one "energy level." For each attack that penetrates its DR, it gains two energy levels. After gaining seven energy levels, the screen overloads and the generator melts. In some universes, there is no visible effect as a screen suffers overloads; in others, its color shifts up the spectrum as each energy level is gained: red to orange to yellow to green to blue to indigo to violet before flaring and dying.

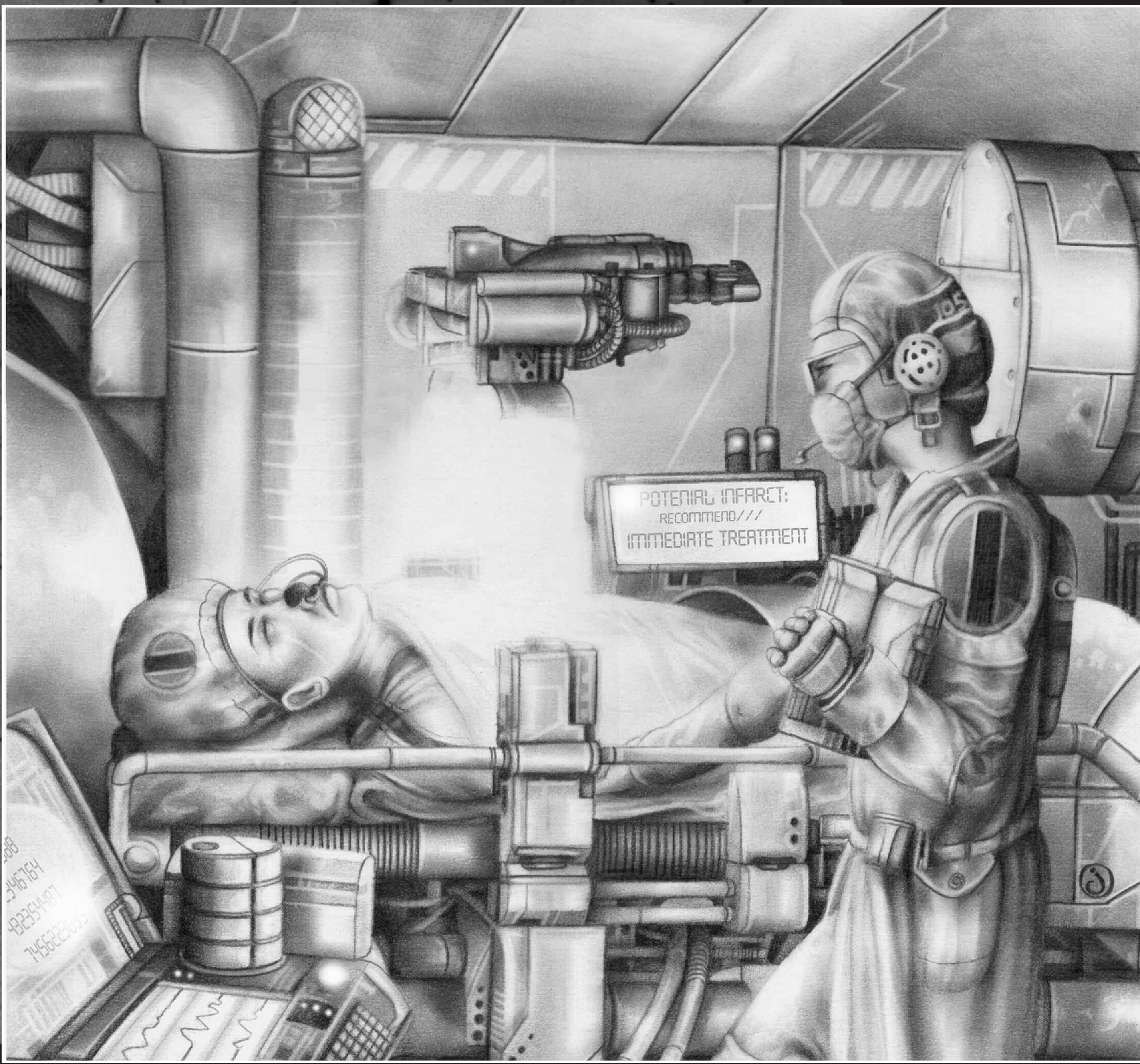
As a default, it sheds energy levels at one per ten seconds, emitting energy harmlessly (perhaps as neutrinos). Until a force screen has shed all its energy, it cannot be turned off without overloading and destroying itself.

There are several ways to customize force screens to better fit a particular campaign setting. Some examples appear in this section; GMs are encouraged to make up others. Note that heavier shipboard screens may be around as early as TL11, while man-portable screens appear two TLs later.

Personal Force Screen (TL13): A belt-mounted screen with DR 200 (+100 per TL over 13). Runs for 15 minutes on a C cell. 2 lbs., $5,000.

Backpack Force Screen (TL13): A more powerful screen with DR 500 (+250 per TL over 13). Runs for one hour on a D cell. 25 lbs., $25,000.

CHAPTER 6 MEDICINE



At high tech levels, medical and healing techniques improve greatly – see p. B128. Even death is not necessarily final.

The GM must decide which of the following medical techniques will be available, and at what prices. For instance, even if full-body replacement is available to the very rich, ordinary star-tramps may have to get along with prosthetics. And some repressive governments may reserve advanced medical treatment as a reward for the favored few. Cost can be tinkered with as well. For example, if the GM wants braintaping as a plot device, but does not want it to be common, he can just rule that it costs a thousand times as much . . .

At the GM's option, any medical technique which provides a permanent "improvement" for a character can cost both character points *and* money.

For a more detailed look at future medical care – including cloning, transplants, cryonics, and braintaping – see ***GURPS Bio-Tech.***

First Aid and Medical Care

First Aid

Above TL7, first-aid *techniques* are no different from earlier ones, but new drugs and sensa-skin (p. 95) can make a big difference. TL8 first aid takes 10 minutes and restores 1d of damage, but requires the use of plastiskin (p. 95). If this is not available, first aid is as per TL7: 20 minutes, repairing 1d-1 damage. TL9+ first aid is as for TL8, with the *addition* of any specific ultra-tech healing aids actually available.

Physicians

As described on p. B128, a doctor can help patients suffering from ordinary wounds or illness, as follows:

Medical TL	Frequency of Roll	Patients Per Doctor
TL8	1× daily	50
TL9	2× daily	50
TL10	3× daily	50
TL11	4× daily	100
TL12	5× daily	100
TL13	6× daily	100
TL14	8× daily	200
TL15+	10× daily	200

Certain injuries are treated differently. Replacement limbs are covered under *Cloning* (p .00). Damage from radiation is insidious and deadly, because it destroys the cells themselves, and is covered on pp. 104-106.

Physicians at TL7+ are dependent on their equipment; without it they function as TL6 doctors.

Medical Costs

Cost of medical care varies widely between societies. Some, especially socialist societies, will give some or all care free; others will charge the costs below. The higher the society's Control Rating, the more questions one will have to answer at *any* "legal" hospital.

All costs are geared to standard humans (or to the primary race in your universe). For variant humanoids, mutants, or genetically enhanced humans, add an additional 10-60% to the cost (either randomly, at 1d×10%, or based on the degree of variation from the norm). Costs for aliens will double, if they are at least relatively humanoid, and increase by up to 600% (1d×100%) if they are more alien. Treatment for humans will be similarly expensive in alien territory.

Medical care comes in four levels:

Outpatient Care: Physician skill of 12. $150/day.

Hospital Care: Physician skill of 14. $750/day.

Automedic Care: See p. 96. $3,000/day.

Luxury Care: Private room, doctors, etc. Physician skill of 16. $3,500/day.

Other Types of Healing

Exotic processes may exist in some universes – psionic healing, for example, or unusual alien techniques. Perhaps human minds can be placed in robot bodies. Perhaps the Precursors had the secret of immortality . . .

Fighting Disease

Inoculations

Even at lower tech levels, inoculations are available to make the user immune to many specific diseases. At TL8, almost every known disease can be prevented by a specific inoculation. Any star-traveling civilization will provide these as a matter of course; you'll have to "update your shots" before you travel.

Unknown diseases are another matter. New planets are likely to carry their own infections, and scouts and colonists are at special risk. GMs may entertain themselves by inventing loathsome diseases; see pp. CII167-174 for inspiration. The specter of an alien plague is a frightening one; suspected disease carriers will be barred from civilized worlds.

Panimmunity

Artificial organisms, tailor-made for each individual, are injected into the body. They recognize "friendly" cells, and attack others. If you accidentally get someone else's immunity shots, the effect will be as though you had caught a bad case of the flu, and there will be no benefit.

Panimmunity is permanent, and the better the bioengineering techniques of the society, the more thorough it can be:

Level 1 (TL9): +3 to HT to resist any disease. Suggested cost: $1,000, and optionally 2 character points.

Level 2 (TL10): +8 to HT to resist any disease; the equivalent of the Disease-Resistant advantage (p. CI24). Suggested cost: $5,000, and optionally 5 character points.

Level 3 (TL12): Full panimmunity; the equivalent of the Immunity to Disease advantage (p. B20), with no minimum HT required. Suggested cost: $20,000 (though it might be free to members of the Survey Service), and optionally 10 character points.

Cloning

Cloning is a TL8 technique by which an identical body can be grown from an individual's cells.

Realistic Cloning

Mammalian cloning was successfully achieved in 1997, although the process still has a number of bugs in it – not surprising, as we are just edging into TL8 in ***GURPS*** terms! The most significant problem appears to be that a clone's cells retain the age of the original; thus, if you take samples from a 50-year-old man, your clone is "born" with 50-year-old cells, which means the rapid onset of age-related problems. The Short Lifespan disadvantage (p. CI104) can be used to handle this.

Clones and Transplants

There are no rejection problems when you have an organ or limb transplant from a clone of yourself, which allows a lost limb, eye, etc., to be replaced without complications. Of course, the clone must be old enough to provide a suitable limb or organ. There may also be *ethical* problems with this – keep reading.

Forced-Growth Cloning

Everything that we currently know about cloning suggests that clones will grow at normal human speeds. This limits many of the more interesting possibilities of cloning. To get around this limitation, GMs may assume the existence of *forced-growth* technology that allows an embryo to be grown to any desired age at a highly accelerated rate.

A new force-grown clone body is physically mature (normally seeming about 25 years old or the current age of the original, whichever is less) but mentally blank. Forced-growth cloning facilities are only available at major hospitals at TL8 (at TL9, your family doctor may be able to do it). It takes six weeks to force-grow a clone. Typical cost to grow a single limb, eye, or organ is $5,000. Or you may grow a whole clone body for $10,000 and keep it as a source of spare parts. However, it costs a further $1,000 a month to maintain it.

The actual transplant operation might cost another $10,000 per part replaced. Two months' bed rest will then be required while nerves knit. (Reduce this time by a week for each TL above 8; minimum time 1 day!)

A character who starts with a physical disadvantage such as a missing eye or limb must buy off that disadvantage if the missing body part is replaced.

In some campaign cultures, few will see anything wrong with using a clone body as a source of transplants. Other cultures may disagree and severely limit or ban such procedures.

It is possible to educate a clone and bring him into society. In some societies, such clones are given minimal training and used as servants and workers. In others, cloning is simply another way to produce offspring. In this case, though, the newly created clone is only forced to the level of maturity the parents want, from baby to adult.

Clone Families

Societies which embrace cloning may produce "clone families." Such a family might consist of any number of genetically identical individuals. They might all be the same age; they might act like a real family, of all ages. Simple genetic alteration might let some be male and some female – but otherwise, they would look alike, and (if they shared all their experiences) they might even think alike and act alike. Members of such a group could cooperate very well. A ship crew, or the population of a whole town, might be formed of clones, all trained in different specialties. A clone family might be a Patron to its members.

Social Hazards of Cloning

Some societies may be threatened by unregulated cloning, although the danger is very slight unless forced-growth technology is also available. Possibilities include:

- Rich people cloning themselves repeatedly, out of vanity.
- Use and abuse of clones (especially of very attractive or famous people) as pleasure-slaves or living toys.
- Use of a clone body to "prove" that a criminal is dead – while he continues his career under another name.
- Lack of genetic diversity making a society vulnerable to a new disease.
- Militaristic governments producing super-armies by cloning their most capable, loyal soldiers – especially if braintaping (see below) is also possible.

To forestall such possibilities, most governments of Control Rating 2 and above will regulate cloning. Unauthorized cloning of an individual is almost always illegal. Clones may or may not have civil rights, and these rights may depend on the original intent of the clone's creator.

Brain Transplants

The ultimate transplant, feasible at TL8, is to put an old brain and spinal cord into a whole new clone body. If this is feasible, the operation will always cost at least $50,000, and take two months of recovery. Since brain cells don't regenerate, this doesn't offer immortality . . . but it can extend the life span.

The GM should "set the clock back" on any physical attributes the PC had lost to age, restoring them to the level appropriate for that person at his new age, *and* charge him character points for the improvement, just as though improved stats were being bought (normal cost, not doubled). Keep separate track of the brain's age (which will control rolls for IQ loss due to aging) and the body's age (which controls aging losses of the other three attributes).

Braintaping

This speculative technology allows an individual's mind to be read mechanically and "played back" into his clone. Braintaping is strictly optional – while it is not superscience, it is uncertain whether or not it will ever be achieved, and it does remove "fear of death" from the campaign.

Accessible Braintaping

GMs who want braintaping to be common can assume that it is a TL9 technology that uses the following rules: "Programming" a clone body costs $5,000 and takes one hour and hospital facilities. The clone is no longer mindless; it is a mental duplicate of the original. There may sometimes be a need to duplicate people – once or many times – but the usual reason for braintaping is to have a "backup" so that if the original dies, the clone can take his place. This amounts to an Extra Life (p. CI36), and optionally costs 25 character points.

When a clone is "activated" after the legally proven death of the original, most societies consider the clone to *be* that person in the eyes of the law, with all his rights and property. Some societies charge a hefty Revival Tax, though!

There are two ways to transfer memories. One is direct programming: the original visits the clone-storage facility and programs the clone with his memories. This may be repeated as often as desired, at $2,000 a visit. If not reprogrammed within a month, the clone's mind goes blank.

Alternatively, if the original corpse is available, all its memories up to the moment of death can be read directly into the clone for $5,000. This must be done within a day. The body must be reasonably intact: HT no worse than -5×HT, and brain undamaged and not radiation-scrambled (see p. 105). The PC will remember his death, and must make a Will roll or acquire an appropriate new Phobia (see p. B27) from the trauma.

The second method is to store memories mechanically. This is called a "braintape." TL9 braintapes require the use of a mechanical memory storage device, or MMSD: a special data unit that takes up 54 cubic feet and weighs 800 lbs. (perhaps storing the data in a mechanically maintained, semi-organic protein-based matrix). TL10+ techniques can store all of a person's memories digitally in a "mere" 100 gigabytes of storage media (see p. 66). Either way, mechanical memory storage takes 2 hours and costs $25,000 per update. But it lasts indefinitely.

Once a clone has been awakened and has had experiences of his own, attempting to program him with new memories, by either method, will simply drive him mad.

Other Kinds of Braintaping

There is reason to believe that braintaping may be possible, but it is just as likely to prove impossible. Braintaping also has many campaign implications (see below) that GMs may find undesirable. GMs who wish to restrict the technology should feel free to adjust its TL upward, or increase its cost or difficulty dramatically. For instance, a "conservative" (and perhaps more realistic) version of braintaping may allow digital braintaping only, make it TL13, and increase the storage requirement to a more realistic 100,000 gigs. See ***GURPS Bio-Tech*** for several alternative versions of braintaping.

Even if digital braintapes can be created, it may not be necessary (or even possible) to play them back into a clone; they could "reside" on a computer instead. A Complexity 8+ computer (perhaps specially modified at 10 times normal cost) should be enough to handle this. The person who was "stored" thus becomes a self-aware program, much like a sentient computer (see p. 66). A community of such digital ghosts may create numerous copies of themselves, or construct entire virtual worlds to live in. For more on these "ghostcomps," see ***GURPS Ultra-Tech*** or ***Bio-Tech.***

Game Effects of Braintaping

If a clone is activated from a braintape, it has only the memories and skills that the PC had when memories were last transferred. The new body is effectively 25 years old unless the owner chose to make it appear older; adjust stats as described under *Brain Transplants* (above).

In either case, the newly awakened clone will start out at DX-6 and IQ-2, as the mind adapts to its brand-new body. Make a HT roll each week; a successful roll regains 1 point of each; a critical failure is a temporary setback that costs 1 point of each.

Social Effects of Braintaping

First and foremost: You can *never* be sure that someone is permanently dead. Cell samples can be frozen; braintapes are easy to hide. Even if a foe is legally dead, and no longer has access to his money or property, he can return to haunt you.

Braintaping also makes it possible for many copies of an individual to exist. Most societies disapprove of this (though some don't care, and allow people to duplicate themselves at will, producing the clone-family effect). If an individual is sentenced to death, his clones and braintapes will be destroyed as well.

Therefore, some societies require braintapes to be uncopyable. Playing them into a clone automatically erases the tape. Braintape recording and clone growth will be strictly supervised by such governments, though bootleg clone labs will exist.

At the GM's option, TL10+ technology can allow a braintape to be played into a blank-minded clone of *someone else.* This leads to fascinating and horrible possibilities.

Suspended Animation

Another way of cheating death – or at least postponing it – is suspended animation, or *freeze.*

Suspended animation might rely on a combination of exotic drugs and low temperatures, analogous to a bear's ability to hibernate. However, it is difficult to literally freeze someone without killing him: as cells freeze, ice crystals form and rupture cell membranes. One possible solution is to use nanotechnology (p. 41) to shut down metabolic processes and build a "scaffolding" around each cell to protect it.

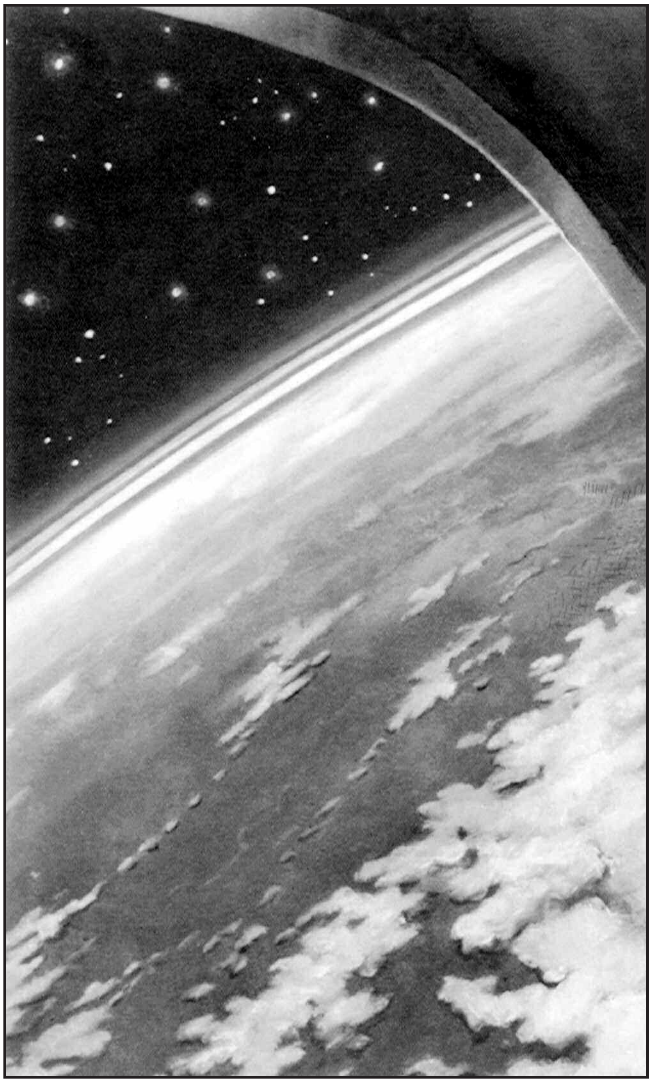
We assume that this technology may become available at TL9, but it could easily require a higher TL. Either way, anyone in suspended animation ceases to age or deteriorate – even if they are clinically dead. In this way, an injured or dying person can be preserved, perhaps long enough to reach a medical facility with the means to cure him. And if the means aren't yet available, and he (or his heirs) can afford it, his body can be placed into storage in hope that a cure will become available later. If cloning and memory transfer are feasible, a freeze tube can also be used to keep the body "on hold" until a clone can be prepared. The occupant will not even *begin* to decay or deteriorate until 1d hours after removal.

The other use of freeze tubes, of course, is for slower-than-light starships (see pp. 27-29).

Putting someone into freeze, or taking him out, takes an hour. Freeze tubes use a combination of deep-freeze and drugs to preserve the occupant, as long as the power remains on (a freeze tube can run on an E cell for six months in a room of normal temperature). No other maintenance is needed.

Generally not portable units, these are usually installed in a sickbay or hospital. A freeze tube, with dedicated monitoring computer, is $55,000. 750 lbs., and 50 cf.

Freeze tube storage costs $250/day for short periods, or $50,000 annually; discounts of from 10% to 60% off the annual fee are available for long-term storage of 50 years or more. This price includes a very safe, well-guarded storage space.



Chrysalis Machine

This TL13 invention is the ultimate in biomedical technology. A coffin-sized or larger device, possibly resembling an automed (p. 96), it is capable of *radical* cell repair and transformation. It maps every cell in the user's body and then surrounds each one with molecular biological repair and support machinery that takes over from the patient's own metabolism. The chrysalis machine sends instructions to the DNA in each cell, telling the cells how to begin self-repair procedures; if necessary, it takes the patient apart cell by cell (reducing him to molecular goop) and then rebuilds him in accordance with its programming.

A chrysalis machine can heal almost any wound. Normal HT loss is restored at 1 point per hour. Crippled body parts or missing extremities are fixed in 24 hours; limbs or major organs take a week. On a successful Physician-2 roll, these times can be halved; failure means it takes the normal time, but critical failure may have unpleasant side effects.

A person who is dead but who has not suffered serious brain injury can be restored to life. Roll against Physician at -2 per hour dead. Success restores the patient to life, failure by 1 or 2 indicates memory loss (equal to Partial Amnesia, p. CI86), and failure by 3+ restores the patient as a blank-minded clone with no memory (this occurs automatically if the subject suffered severe brain damage).

Beyond that threshold, as long as there are a few cells left, the chrysalis machine can clone the original person – again, as a blank-minded clone (see *Cloning,* p. 89).

A chrysalis machine can also transform an individual into a member of a "variant" race, grow biological implants, and place someone in suspended animation.

A chrysalis machine is 1,100 lbs., $150,000. It runs on building power. Experimental versions may be available in TL12 hospitals at 5-10 times weight and 100-1000 times cost.

Aging

In some futuristic campaigns, the human life span will be greatly extended. First, because TL is added to HT for aging checks (see p. B83), loss of attributes due to aging will be rare at high TLs. In addition, the GM may wish to make the following optional change to the aging rules:

Starting at TL8, aging rolls do not start until a character reaches a natural age of 70. The increases in frequency for aging rolls that normally fall at 70 and 90 years of age are also set back by 20 years each.

At TL9, aging rolls are not made until age 90, and their frequency increases at ages 110 and 130.

At TL10+, aging rolls begin at 110 and frequency increases at ages 130 and 150.

This modification raises the age at which the Age disadvantage is legal for a character; if age checks don't begin till age 70, being a 56-year old is no disadvantage at all.

If anti-agathic drugs (see p. 94) are also available, aging may be stopped almost completely.

Bionics

At TL8, missing limbs can be replaced by realistic mechanical ones: *bionics.* With plastiskin coatings, these parts can be made to look and even feel natural. Bionic replacements will be less popular if cloned limbs are available, but they'll still exist.

It is possible to build bionic parts that are very different from the originals – better, stronger, and so on. Details of most such super-parts are beyond the scope of this book (see ***GURPS Cyberpunk***). They would count as advantages – requiring the user to pay character points. But even "standard" bionic replacements have some advantages over the original equipment.

Bionic parts weigh about the same as a natural limb or organ, and are treated the same unless specified otherwise. Remember that these bionic parts are attached to regular flesh. Superhuman feats are likely to damage non-bionic areas of the body.

Abilities and Costs of Bionic Parts

Costs given are for TL8; halve costs at TL9 and again at TL10+. The GM may allow other bionic replacements, at appropriate costs. These costs are for the part only. The operation to attach a part costs $20,000 ($30,000 for a pair of eyes); this price is halved at TL9 but not reduced further at higher TLs.

Second-hand parts will sometimes be available. They'll be cheaper; they may or may not be a bargain, and there may be damage that is not immediately evident. Because of their value, bionics are never discarded until they are totally destroyed . . . giving the phrase "loot the bodies" a whole new meaning.

Hand: Gives +1 DX for manual tasks and ST 12 for gripping and hand-to-hand damage purposes. $12,000. For ten times the cost, either DX+2 or ST 13 is available; for 50 times the cost, both are available. Point cost is 1/8 the cost to increase ST or DX for the entire body.

Arm: As for a hand, except that ST of a bionic arm, and the hand on the arm, is 14. $25,000. For ten times the cost, either DX+2 or ST 15 is available; for 50 times the cost, both are available. Two-handed feats require two bionic arms to get the benefit of the modifiers. You cannot buy both a bionic hand and a bionic arm, as the arm includes the hand, though the hand can be strengthened separately. Point cost is ¼ the cost to increase ST or DX for the entire body.

Leg: Each bionic leg increases Move and Jumping distance by 25%, rounded down. (On a jump, you must kick off from the bionic leg to get the bonus.) It also adds 2 to kicking damage for that leg. $25,000. Point cost is 10 points per leg.

Eye: A standard bionic eye corrects any weakness of vision but does not give any bonuses. Improved eyes, giving the advantages of Acute Vision (up to +5) or Night Vision, are available. In addition to the cash cost, character points must be paid for these advantages. Standard eyes are $35,000 each. Improved eyes must be bought in pairs to work properly: $45,000 each for +1, $60,000 each for +2, $100,000 each for +3, $150,000 each for +4, and $200,000 each for +5. Adding Night Vision to any eye costs $15,000. If only one eye has Night Vision, a patch must be worn over the other eye at night, or the conflicting signals will give the user a -2 to any Vision roll.

Ear: Standard bionic ears give normal hearing. Improved ears, giving Acute Hearing up to +5, are available. In addition to the cash cost, character points must be paid for this advantage. Bionic ears cost $20,000 a pair, plus $15,000 and 2 character points a pair for each +1 to hearing.

Internal Organs: Hearts, lungs, kidneys, livers, and other organs can be replaced by bionics; each organ replaced costs $8,000. If this eliminates a disadvantage such as Terminally Ill, then character points must be paid to buy it off.

Installing Bionic Parts

A roll against the lower of Surgery and Electronics (Bionics) is required to attach a bionic part. Bionic eyes are harder – a further -2 to the roll.

At TL8, a month of bed rest is necessary after a bionic operation, to allow the nerve/electrode splices to mesh. At TL9, this is two weeks; at TL10+, one week.

Damage to Bionic Parts

All bionic limbs have PD 1, DR 3. It takes 2 hits to cripple a bionic eye or ear, 4 to cripple a bionic hand, or 6 to cripple an arm or leg. Damage to a bionic part does *not* produce any stunning effects, temporary loss of DX, or other "pain" effects.

Repairs to Bionic Parts

Bionic parts will *not* heal, of course, and can only be repaired or replaced. Repair costs depend on the amount of damage the part has taken. If a bionic limb has lost half the hit points necessary to cripple it, the cost to repair it will be 25% the cost of the original part. If it has taken exactly enough to cripple it, repair is 50% original cost, and so on. However, if the bionic limb receives more than twice the amount of damage needed to cripple it, it is effectively destroyed and cannot be repaired at all; it must be replaced.

Both Electronics Operation (Bionics) and Mechanic (Bionics) skills are necessary to repair bionic parts; time to do a proper job is 2d-TL hours, with a minimum of an hour. Emergency repairs in the field may be attempted with either skill. Success will not restore lost HT to the parts, but might allow them to function again if they've been crippled. Such repairs should take at least one minute per skill roll.

Social Effects of Bionics

Those who receive bionic replacements will have to deal with their own differences – and with how others view them. Most worlds probably treat bionic parts no differently than we treat prosthetics today. In some places, becoming a robot in whole or in part might be considered a Social Stigma, especially on lower-tech or provincial planets. PCs might suddenly find themselves second-class citizens – or worse, considered property of another in order to be allowed to exist at all. They could suffer losses in Appearance or gain an Unnatural Feature (p. CI85), depending on the nature and sophistication of their bionics, and receive additional reaction penalties on a world where Intolerance of robots or cyborgs exists.

SF Wonder Drugs

Drugs are generally geared to the metabolism of humans (or whatever the major race is). Most will have no effect, or no good effect, on alien metabolisms. Xenovarieties of drugs, if they exist at all, might cost from 10% to 60% over list price, depending on how common the race is in the manufacturer's region of space.

Most societies will restrict certain drugs to doctors (licensing requirements vary, but usually Physician 14+ is the absolute minimum). These "restricted" drugs can generally be had on the black market, but at higher prices.

Drugs may come as pills, injectable liquids, aerosols, drug patches, etc. Most, but not all, are available in multiple forms. If the GM wishes to have drugs produce "magical" effects (for example, instantly healing 1d hit points), the best way to explain it would be that the drug is actually an injection of nanomachines. Such technology likely requires TL10+.

Drug Design

To design a drug for your campaign, decide on the following properties:

Effects. Drugs sometimes provide temporary advantages or disadvantages – for example, a pain-blocking drug might give the user High Pain Threshold, an aphrodisiac might cause Lecherousness, and a broad-band antibiotic might bestow Disease-Resistant. Other drugs provide unique effects, like healing a few points of HT or reversing pattern baldness.

Certain advantages are especially suitable for drug effects, including Acceleration Tolerance, Alcohol Tolerance, Alertness, Altered Time Rate, Collected/Composed, Combat Reflexes, Deep Sleeper, Disease-Resistant, Eidetic Memory, Extra Fatigue, High Pain Threshold, Imperturbable, Less Sleep, Longevity, No Hangover, Psionic Resistance, Rapid Healing, Recovery, Regeneration, Resistant to Poison, Single-Minded, and Unfazeable. Examples of disadvantages that may be *intended* drug effects include Amnesia, Berserk, Imaginative, Lecherousness, Overconfidence, Slave Mentality, Truthfulness, and Weak Will.

Side Effects. These are best modeled as disadvantages. Some side effects only take effect if the user fails a HT roll; this may be modified if he takes repeated doses before the duration wears off. Disadvantages that make good side effects include Absent-Mindedness, Bad Temper, Berserk, Delusions, Dreamer, Distractible, Edgy, Flashbacks, Gullibility, Impulsiveness, Laziness, Manic-Depressive, On the Edge, Overconfidence, Paranoia, Short Attention Span, Solipsist, and Weak Will.

Some drugs are *addictive.* If so, the GM should rate the drug as either mildly addictive (no modifier to withdrawal rolls), highly addictive (-5 penalty), or totally addictive (-10 penalty), and should decide how many doses in a specific period (such as 24 hours) require a roll to avoid addiction. The roll may be against HT if the drug is physically addictive, or Will if it causes psychological dependency. The user should roll again for each later dose taken within that time period, measured from the time of the *last* dose, until use stops. If addiction develops, the user needs a regular (usually daily) dose to avoid normal withdrawal symptoms. He gains the Addiction disadvantage, reducing his point total; determine how many points this is worth using the formula on p. B30.

Duration. This is often related to the user's HT. Good effects may last for a time equal to HT in hours, minutes, or some other increment. The side effects may last for a shorter or longer period than the benefits.

Legality. Some drugs are available to anyone. Others are legally sold only to licensed physicians, but are widely available on the black market.

Form. SF wonder drugs usually come in pill form, hypo injection, or both, but other possibilities (such as an inhaled gas or powder) are feasible.

Cost. This could be anything from a few cents to thousands of dollars per dose. Most wonder drugs cost $10-100 per dose.

Tech Level. Cheap, available drugs with impressive positive effects, few side effects, no chance of addiction, and long durations should be very high-tech. More limited, less remarkable drugs can be lower-tech.

Standard TL8+ Drugs

Some sample drugs are described below. Many more can be found in ***Bio-Tech*** and the ***Ultra-Tech*** books. As always, the prices given are suggestions; the GM is free to change them for his campaign. They *don't* necessarily drop as TL increases.

Adders (TL8)

This is a generic name for a group of drugs that temporarily add to ST, DX, IQ, HT, or Move. One dose adds 1 point. The effect usually only lasts for a few hours. After it wears off, the affected attribute suffers a penalty equal to the original bonus and lasting twice as long.

To obtain the effect desired, a user must make a HT roll at -1 for every dose taken. If the roll is successful, the attribute is raised by the number of doses taken, for a number of hours equal to the amount by which the HT roll was made (minimum 1 hour if HT was rolled exactly). If the roll fails, the attribute is raised by 1 for one hour, regardless of the dose, but the decrease after the hour is up will be the same as if the entire dosage had been effective. On a critical failure, the drug will *decrease* the attribute by the amount of doses taken, for one hour.

Once an Adder has been taken, no different type can be taken until the effects of the first wear off (or wholly unpredictable side effects may occur!). If more of the same Adder is taken within a 24-hour period, a new HT roll is made, at the penalty that would have been required if all those doses had been taken at once. The good effects, if any, are only those of the new dose, but the letdown period is calculated as though all the drug had been taken at the time of the latest dose.

Adder users often feel very good under the effects of the drug – similar to the Overconfidence disadvantage – and are at least mildly depressed after it's worn off. Some black-market adders, especially DX adders, are addictive.

These drugs are usually only available to doctors, though they are abundant on the black market and are often issued routinely to members of military and mercenary organizations. They come in pill form (takes 30 minutes to work) at $25/dose, or injectable form (works immediately) at $50/dose.

Anti-Agathics (TL10)

Anti-agathic drugs slow down the aging process. Each dose effectively stops aging for one year. (Actual aging is at a rate of about 1 week per year.) Unfortunately, once an individual stops taking the drugs, he must make all the aging rolls he skipped, at a rate of one roll per week. Thus, he rapidly ages to his actual chronological age, which often results in death.

Other versions exist in science fiction. One common variant simply *stops* aging for as long as it is taken, with no harmful backlash when use ends. Another version permanently alters the user's metabolism with a single dose, preventing any future aging – though often at the cost of equally permanent side effects.

Some societies reserve anti-agathics for leaders, key scientists, and so on. In others, it is available to anyone who can pay the price: $25,000 per dose and up. Black-market anti-agathics are cheaper, but may be less effective or have side effects.

Antirad (TL9)

This medication contains a number of different drugs, with the combined effect of partial protection against radiation. Antirad can be taken before radiation exposure (up to a week before), or within an hour afterward. One dose halves the effective amount of rads from a new exposure; 2 doses will halve exposure again, and so on (see pp. 104-106).

An Antirad user must roll vs. HT+3, *minus* the number of doses taken within the past week. A failure causes the permanent loss of 1 DX. Note that Antirad does *not* heal existing damage; it merely prevents new damage.

Available only to licensed physicians and medics, except when purchased in emergency medkits. Comes in injectable and pill form. $150/dose.

Genericillin (TL10)

This is a very powerful general-purpose antibiotic. It doesn't treat *all* diseases, but it's always a good thing to try. When an unfamiliar malady is encountered, Genericillin adds 1d-1 to the effective HT of anyone rolling to resist or shake off the disease (roll the HT bonus and record it the first time each new ailment is encountered). In general, it adds 4 to HT against most normal Earth diseases.

Cumulative doses have no side effects, except that after a few weeks of regular use, the whites of the eyes become slightly greenish. A dose remains active in the body for about a week.

Useful for humans only; poisonous to most other races (though some have equivalent antibiotics). Available only to licensed physicians and medics, except when purchased in emergency medkits. Comes in injectable form. $100/dose.

Gravanol (TL9)

This drug lets the user function under increased gravity. A dose of Gravanol lasts a week and eliminates any medical hazards of two G-increments of extra gravity. Thus, normal Earth humans using Gravanol can safely take up to 1.59 Gs with no HT effect. Extra doses don't give extra tolerance.

Unfortunately, Gravanol is highly addictive. Roll vs. HT after every full week of use, with a cumulative -1 per successive week after the first. Any failed roll means you are addicted. Since Gravanol is legal, highly addictive, and fairly cheap, *starting* with a Gravanol addiction is a 5-point disadvantage. However, the addiction is worth no points if acquired in play. A Gravanol addict needs a dose only weekly, not daily.

Comes in pill form; $70 per dose.

Hypercoagulin (TL8)

When injected into a patient with a bleeding wound, this causes instant coagulation and a cessation of bleeding within 1d+4 seconds. It restores 1 point of HT and prevents any further damage from loss of blood. The drug should be injected as close to the wound as possible. An injection prior to sustaining a wound will have no effect unless a wound is received within five minutes of the injection.

Overdoses can kill; for every additional dose within a 24-hour period, roll HT, minus the total number of doses taken. A failed roll means the patient's blood becomes so thick that his heart stops. Full medical facilities will be required to save his life. The drug is normally only available to licensed physicians, though two doses come in every emergency medical kit. Comes in injectable and aerosol forms. The aerosol version must be sprayed directly onto *each* wound, but there is no risk of overdose. $25/dose.

Revive Capsules (TL8)

These are small, easily breakable capsules. When held under the nose of a stunned or unconscious character and snapped open, the vapor inside will usually revive him completely (roll against HT+5 to regain consciousness, come out of stun, etc). No HT is regained, but the patient is awake. Revive capsules are widely available to the general public and can be purchased freely in drug stores in all but the most repressive societies (CR 6). Cost is $5/dose.

Note for lower-tech GMs: As early as TL5, "smelling salts" were used. At TL6, ammonia-inhalant capsules are found in first-aid kits. Either will give a HT roll to wake up.

Superstim (TL8)

This drug instantly restores 1d points of ST lost to fatigue. Roll vs. HT; the fatigue is banished for a number of hours equal to the amount by which the roll was made (at least one). The only side effect is this: when the time is up, the user gets all that fatigue back, plus 2 more.

For each dose taken after the first within 24 hours, the HT roll is at -1. Multiple doses of Superstim can cause the user to "crash" when he finally stops taking it. If ST would drop below 0, the extra points of fatigue are taken as lost HT instead. There are no other side effects.

Widely available. Pills (taking effect in 30 minutes) cost $25/dose. Injections (work immediately) cost $50 per dose.

Torpine (TL10)

Various miraculous healing drugs can be added to the campaign if the GM does not want to deal with long patient recovery times. One such drug is Torpine, which puts the user into a healing trance, accelerating his metabolism; he becomes unconscious for 24 hours. At the end of that time, all damage taken is totally healed. However, the user comes out of the trance totally exhausted from the demands put on his system; his ST is at 1. He will also be famished and must eat as soon as possible to fully regain his ST. Superstim will *not* restore this ST loss, but it can be used in an emergency to break the healing trance. If this is done, the amount of HT regained is proportional to the time spent in trance, but ST is still 1.

Because Torpine speeds the metabolism, each use is likely to add to the user's effective age. Roll vs. HT on coming out of the healing trance. On a critical success, the user doesn't age. On a success, he ages by a month. On a failure, he ages by a number of months equal to the amount by which the roll was missed. A critical failure ages him by two years!

Torpine is normally only issued to doctors (though it is available on the black market). Comes only in injectable form. $250/dose.

Ursaline (TL8)

This drug prevents the atrophy of bone tissue and muscles in low, micro- or zero gravity. A dose provides 2 weeks' protection and costs $50. Pill form only.

Artificial Tissue

Plastiskin (TL8)

A fleshlike plastic patch that holds wounded flesh together, taking the place of normal skin. (It even takes on the color of one's skin, so that only on close examination is it evident.) When the flesh beneath it heals sufficiently, the plastiskin patch falls off. Plastiskin is found in any TL8 first-aid kit; without plastiskin, TL8 first aid counts as TL7. Plastiskin can also be used to cover tattoos, etc., for disguises. Costs $10 per 6-inch-square patch.

Sensa-Skin (TL11)

Sensa-skin is true artificial tissue. It can be grown or formed into sections that, when applied to a living body, attach themselves and become a part of it. The subject is able to feel through the sensa-skin's surface, just as if it were his own skin.

Sensa-skin "cultures" can also replace missing portions of flesh for cosmetic purposes. Sensa-skin can grow hair, or simulate skin and flesh, or even chitinous armor, scales, feathers and the like – though such specialties usually cost several times more than regular sensa-skin.

Once sensa-skin is attached, it will not come off unless a special chemical neutralizer is applied. The same section can be reapplied after the neutralizer has worn off (in an hour). After a sensa-skin patch is left in place for the subject's HT×3 days, it becomes part of the body and can only be removed by surgery.

Sensa-skin has revolutionized disguise. Preshaped, molded facial masks and entire body suits of sensa-skin/flesh can completely change appearance. A human could actually become an alien with fur, a tail, even claws if grown into the sensa-skin "paw." Or a male could become a female with "real" breasts and so on – or vice versa. Therefore, sensa-skin has become highly valued among the criminal classes, as well as among espionage agents, as a quick, easy – and reversible (unless kept on too long) – alternative to plastic surgery.

To apply a section of sensa-skin correctly requires a Surgery or Physician roll at -2. Premolded shapes used as disguises may be applied with a successful Disguise roll.

There are some dangers in handling sensa-skin. Anyone attempting to apply a section – or just picking one up – must roll DX+6 (or DX if the wrapper is missing for some reason) to avoid attaching it to his own flesh, unless he's completely covered (no bare flesh at all). If he fails, it's instantly attached itself. Fortunately, it takes no skill at all to apply the neutralizing spray.

Use of a sensa-skin patch in first aid will restore an *additional* 2 points of damage, even if the first aid consists of little more than slapping the patch on (simple bandaging). The only roll required is the DX roll (above) to avoid attaching it to the wrong place.

Sensa-skin is $50 per six-inch-square "first-aid" patch (generally available), much more for specialized forms (usually available only to licensed surgeons).

Sensa-Skin Neutralizer (TL9): Small spray tube of a solution which will loosen and remove sensa-skin patches before they become permanently attached (within HT×3 days after application). Each shot will loosen a three-inch-square patch (or less). Ten shots per tube. $150.

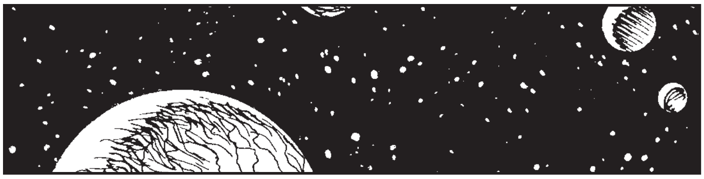
Medical Equipment

Pneumospray Hypo (TL7): A handheld injector, penlight size, that injects drugs using compressed air. It must be touching the patient to function. It can penetrate clothing with DR 0 or 1. It takes two turns to remove an empty vial (or pneumocharge) and replace it with a ready new one. Air cartridges are good for 100 injections. Negligible weight, $125. Replacement cartridges are $10. (Conventional hypodermic needles use the same rules, except that vial and air cartridge changes are replaced with needle changes; $125 buys 100 disposable units.)

Emergency Medkit (TL8): A belt pouch with 5 Revive capsules, 5 plastiskin patches, a pneumospray hypo, and 2 doses of Hypercoagulin. Gives +1 to First Aid skill. Has room for another 10 doses of whatever medication is desired. 1 lb., $300.

Medical Pouch (TL8): A doctor's bag, with room for twice the above, plus standard bandages, sedatives, stimulants, etc. (purchased separately). Has room for whatever other drugs the physician wants to add. Includes a full set of physician's and surgeon's tools for the TL. Cost and weight don't drop at higher TLs; the contents just get better. This kit is the minimum equipment required to use Surgery, Diagnosis, or Physician without penalty. Gives +2 to First Aid skill. A TL8+ Physician performs as TL6 without this much gear. 15 lbs., $700.

Medscanner (TL9): A compact, short-range scanner with dedicated medical computer, designed to make specific medical diagnoses when used by a trained doctor. Its effective range is only 1 yard (doubling at each TL over 9). A bioscanner can identify life forms and tell if they are sick or dying, but it won't tell exactly *why.* A medscanner will give detailed diagnoses on known races to anyone trained in its use. On a successful Electronics Operation (Medical) roll, it adds +3 to Diagnosis skill, +1 per TL over 9. A medscanner will also detect implants if the roll is made by 3 or better. 1 lb., $900.



Diagnosis Table (TL9): A 7' × 3' × 3' padded, computerized table with a full range of biological and medical scanners. The patient lies on the table; scan results are projected onto an overhead screen. Gives +5 to Diagnosis skill, as described above for the medscanner. Not a portable unit; the table must be installed in a sickbay on a ship or in a hospital. 250 lbs., $12,000, 80 cf. At TL10, halve the price, and it gives a +6 to skill. At higher TLs, the diagnosis table is rarely seen; the patient is usually just put in an automedic (below) for diagnosis.

Automedic (TL9): Looking like a gleaming ultra-tech coffin, the automedic will attempt to diagnose and heal anyone placed in it. No doctor is required; the patient is fully isolated and kept sedated. If the injury is one that a physician can deal with, the automedic rolls vs. the appropriate skill as though it were a physician. It is stocked with a full range of drugs and medical supplies, and has surgical waldoes to let it operate if necessary.

An automedic has a dedicated computer with skill 14 in First Aid and 13 in Diagnosis, Physician, and Surgery; add 1 to skill for each TL above 9. It can cure most ills and heal most wounds and injuries, but it cannot bring back the dead. It also has no imagination, so new diseases or strange problems may stump it – in which case it puts the patient into drug-induced suspended animation and calls for help!

Critical automedic failures are unpleasant to consider. Damaged or sabotaged automedics are deathtraps.

At TL9, 600 lbs., $50,000, 100 cubic feet. Drug pack refill (usually every 25 uses), 50 lbs., $5,000. Usual cost of automedic use, if you are placed in one in a hospital, is $3,000 per day.

At TL10, they take only 500 lbs., 75 cf. At TL11+, 400 lbs., 50 cf. Costs remains the same.

CHAPTER 7 ENVIRONMENTS

The universe contains a huge variety of different environments. Gravity, atmosphere, extremes of temperature . . . all can be fatal to the unprepared.

Gravity

Gravity is measured in "Gs," or "gees," with 1 G being Earth-normal gravity. When a character is created, his "home gravity" should be specified. If not, assume he is native to 1 G.

Changes in gravity affect *weight,* making things heavier or lighter; e.g., an object that weighs 1 lb. under 1 G weighs 2 lbs. under 2 Gs. ***GURPS Basic Set*** assumes 1 G whenever weight is an issue, such as in the rules for encumbrance, jumping, and throwing. All of these things must therefore be adjusted if local gravity is different from 1 G.

When calculating Move for characters, gravity changes *encumbrance.* Multiply each character's encumbrance by the local gravity *before* calculating his Move score. As well, calculate the change in the character's own weight and add this change to encumbrance – or subtract it, if gravity is below 1 G. (This means that encumbrance should be recalculated each time a different planet is visited. GMs who find this a waste of time may fill their universes with 1-G worlds.)

Gravity has no effect on *weapon use or damage*. Even though you can pick up heavier weapons under lower gravity, you can't fight well with them. And primitive weapons do the same damage under any gravity, because their *mass* is unchanged. The exception is zero gravity (see p. 100).

G-Tolerance and G-Increments

All creatures function best in their native gravity, but some creatures can better tolerate changes in gravity. The amount of change you can tolerate without problems is your *G-increment.* Normal humans (and other creatures) are assumed to have a G-increment of 0.2 G. This means that each change of 0.2 G in the gravity will have a cumulative effect, as described below. Round gravity down. For an ordinary person native to Earth, 1.19 G is treated as 1 G (no penalty), but 1.2 G is treated as a one-increment penalty.

An increased ability to tolerate changes in gravity is the *Improved G-Tolerance* advantage, described on p. CI26.

G-increments have to do with the way in which DX and HT change with gravity. ST changes are the same for everyone, regardless of their G-Tolerance, because they reflect actual weight! Characters native to worlds of different gravity will figure their G-increment from a different base level. For instance, if your native gravity is 1.3 Gs, you will suffer the same effects at 1.5 Gs that a normal Earthman would feel at only 1.2 Gs.

However, figure all other gravitational effects as for standard characters. Don't try, for instance, to figure out what a heavy-worlder's encumbrance would be on his home planet and work from there to find his movement on a light world. It all cancels out.

High Gravity

High gravity makes everything heavier. This increases encumbrance, as described above. For instance, suppose a person weighs 120 lbs. on Earth and has a load weighing 60 lbs. On Earth, this is simply 60 lbs. of encumbrance. But on Asparia, with a gravitational pull of 1.5 G, that load weighs 1.5 × 60 lbs., or 90 lbs. And the person also weighs 50% extra, or 180 lbs. So his total encumbrance is 150 lbs. – 90 lbs. of gear plus 60 lbs. of extra body weight. This means he will move slowly and fatigue rapidly. In very high gravity, your own body weight is enough encumbrance to fatigue you, and mechanical aids can be necessary just to get around. Exoskeletons (p. 62) and contragrav chairs (p. 67) may be common on high-G worlds.

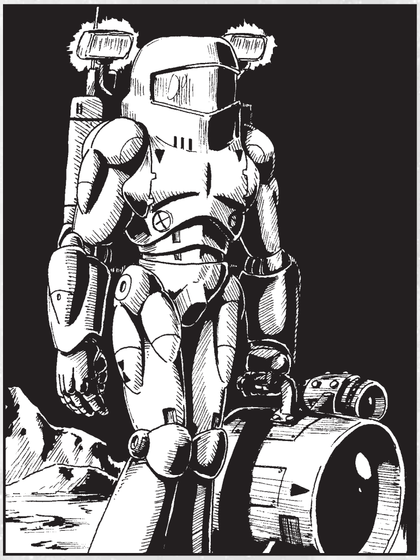
High gravity also affects other stats:

ST: Multiply the usual distance for jumping, etc., by the ratio of normal gravity to local gravity. Under 1.2 G, you jump (1/1.2), or 0.83, times as far. A similar rule applies to throwing things; see *Throwing Things in Varying Gravities* (p. 100).

DX and DX-based skills suffer as well, because everything falls too fast and your muscles are under extra strain. Reduce DX by 1 for each G-increment *unless* the character has the G-Experience advantage (p. CI25). In that case, reduce it by 1 for every *two* increments.

Weight and Mass

It is vital to know the difference between *weight* and *mass* when discussing gravity. Mass measures how much matter you have. Weight measures the force of gravity acting on that matter. Objects have no weight in zero G, but they always have mass. Since gravity is a constant 1 G on Earth, a given mass always has the same weight, so units of weight are often used to describe mass. Remember that this is a shorthand, and that mass is *not* weight – even when it is measured in units of weight. In a ***Space*** campaign, be sure you know whether "pounds" or "tons" are referring to weight or to mass. Only quantities that depend on weight (like jumping distances and the stall speeds of aircraft) are affected by gravity, not those that depend on mass (like vehicle accelerations and bullet damage).



Gunfire in Varying Gravities

Bullet ranges are affected by gravity. Divide listed Max range by local gravity to get local Max. Half-damage range is not affected by gravity, but will be very slightly less if air pressure is high.

Required ST to handle a weapon without recoil effects increases by 1 for each loss of 0.2 G, as the user's weight goes down. It does not change in increased gravity.

Ordinary guns recoil very badly in microgravity; Min. ST is increased by 5, and vented gases give the user a cumulative -1 to hit for each shot already fired, until the user moves away or waits a minute. Guns designed to be used in microgravity or zero G are sometimes available; they vent their gases to the side, which also stabilizes them. Prices are usually tripled.

In high gravity, something as minor as a stumble can lead to injury. If someone falls (a likely result of many sorts of failed skill rolls!), treat it as a 2-yard fall *at the local gravity.* Damage can mount quickly. Roll for location of the injury, ignoring torso results and rolling again.

IQ and IQ-based skills are reduced by 1 for every *two* increments of increased gravity, because of reduced blood flow to the brain and general fatigue. Exoskeletons don't help this (although the GM may allow more expensive models that do). Lying in a fluid bath (or riding a CG chair, p. 67) relieves the IQ problem, but you can't do much physical work that way.

HT is also reduced under high gravity, because the heart has to work harder. Reduce effective HT by 1 for every *two* full increments. This *does* mean the character has fewer hit points. These "lost" hits are immediately recovered if the traveler gets back to lower gravity.

Low Gravity

Low gravity makes everything lighter. Encumbrance will decrease as weight drops. Encumbrance may quickly reach zero, since the reduction of a character's body weight counts as *negative weight* for purposes of encumbrance. For instance, take the 120-lb. character described above. On Porter's Rock (0.5 G), his 60 lbs. of gear weigh only 30 lbs. And his 120-lb. body weighs only 60 lbs. He has "saved" 60 lbs. of body weight to apply against the 30 lbs. he is carrying. His encumbrance is -30 lbs.

Note that negative encumbrance does *not* mean negative weight! "Encumbrance" is an artificial concept which includes a character's body weight. "Weight" can never be negative. Even a helium balloon has weight.

However, negative encumbrance *does* give a Move bonus of +1 Move per *full* 3×ST pounds of negative encumbrance, to a maximum of +3 Move. For example, a 120-lb. human weighs 60 lbs. under 0.5 G; so if no gear is carried, his encumbrance is -60 lbs. If he is ST 10, this gives +2 Move.

Whenever taking advantage of this Move bonus, however, a character must make a DX roll (at a penalty for low gravity – see below) to avoid losing his balance in the unfamiliar gravity. If he misses it, he falls down. Moving at normal rates (as though on a world with standard gravity) requires no roll. Characters with the G-Experience advantage (p. CI25) may ignore this roll.

Low gravity also affects other stats:

ST for jumping, etc., works as described above for high gravity. Take the ratio of 1 G to your local gravity. Under 0.2 G, you jump 5 times as far. See *Throwing Things in Varying Gravities* (p. 100) for similar effects on throwing distance.

DX and DX-based skills are affected in various ways. For most purposes (sword fighting, throwing things), reduce DX by 1 for each increment of gravity *unless* the character has the G-Experience advantage (p. CI25). In that case, reduce it by 1 for every *two* increments. For activities that would not be affected by gravity, like sleight of hand, there is no penalty. And for a few things (a DX roll to catch a falling object, for instance), DX is *increased* by the above amount, because things fall more slowly in low gravity. The GM must decide whether low gravity helps or hinders a given effort.

IQ and *HT* are not affected by lower gravity.

Microgravity

Microgravity is taken here to mean any gravitational field of less than 0.2 G. In microgravity, nothing has significant "weight," but mass remains.

Encumbrance is rarely important in microgravity, unless the PCs are carrying their spaceship. HT is unaffected. (Characters with lowered HT from bad hearts or similar systemic problems may experience an effective increase in HT in near-zero gravity, at the GM's discretion.) Thrown objects may go a *long* way; see *Throwing Things in Varying Gravities* (p. 100).

Climbing Up and Down

When climbing long distances up or down stairs, ladders, trees, etc., use the Climbing rules on p. B89 but modify speeds as follows for variable gravity:

High Gravity

If gravity is more than 1 G, multiply the time required under 1 G by [(2 × local gravity)-1]. E.g., in 1.2 G, a climb takes 1.4 times as long, so a 10-second (1-G) climb takes 14 seconds.

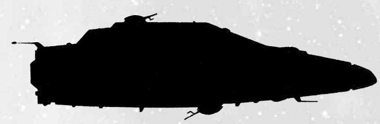
Low Gravity

Under less than 1 G, multiply the time that would be required under Earth gravity by the local gravity. E.g., in 0.5 G, climbs take half as long.

Microgravity and Zero G

At less than 0.2 G, climbing is more like controlled flying. Use the formula given above, but maximum speed is 5 yards per second (you are just grabbing a handhold occasionally to guide yourself). Long climbs use the same speeds as short ones.

In zero G, you don't climb at all; see *Zero Gravity* (p. 100).

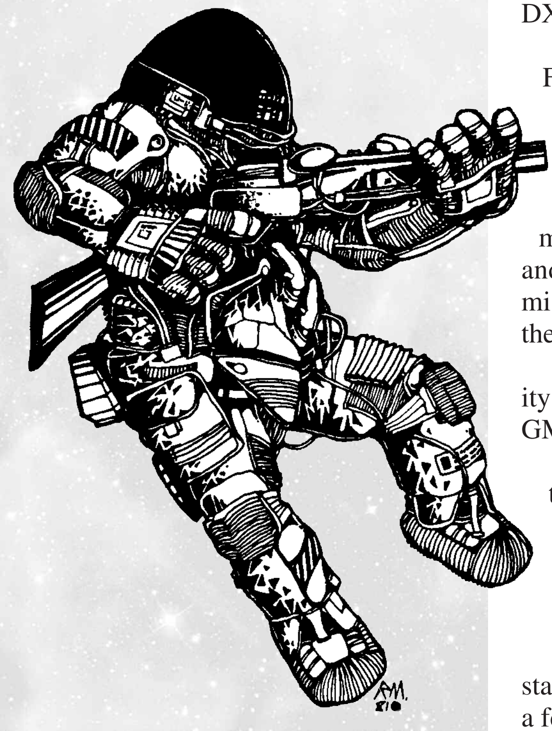


Falling People and Things

To compute falling damage under gravity other than 1 G, figure the damage that would have occurred under 1 G, per p. B131, then multiply it by the local gravity. E.g., a fall that is computed to do 12 points of damage (before DR is taken into account) would do 24 points of damage under 2 Gs, but only 6 points under 0.5 G.

Use a similar procedure for determining the damage done by falling objects.

Those interested in absolute realism should be aware that "terminal velocity" – the maximum speed at which an object can fall before air resistance (see p. 100) stops further acceleration – is increased in high gravity and decreased in low gravity. More importantly, terminal velocity is lower in a thick atmosphere, higher in a thin atmosphere, and unlimited in vacuum! So the "effective maximum fall" (200 yards for most objects; 50 yards for people, who have high air resistance) may vary widely. A general formula: terminal velocity is multiplied by 0.25 in *very dense* atmosphere, 0.5 in *dense,* 1.5 in *thin,* and 2 in *very thin.* It is unlimited in *trace* atmosphere or in vacuum.



A character's DX in microgravity depends on his Free Fall skill. Whenever a "normal" DX roll would be required, roll against Free Fall skill instead. When any DX-based skill is attempted, use the *lower* of that skill level or Free Fall skill.

Any microgravity maneuver except the most simple requires a roll against Free Fall skill, or the maneuver fails in some way. (Simple maneuvers would include pulling yourself hand over hand along ladders, walking with magnetic boots, or using ordinary hand items. Maneuvers requiring a skill roll include firing high-recoil weapons without flying backward, attempting to throw or catch items, acrobatics, etc.) Seriousness of the failure depends on how badly the roll is missed. If you are tossing a lifeline to a friend who missed his own Free Fall roll and who is now floating off into space, a missed roll simply means the line has missed him. But if your roll is a critical failure, you miscalculate and go floating into the void to join your companion.

GMs can use failed Free Fall rolls to set up situations in which skill and ingenuity will be tested. On the other hand, if the PCs all have high Free Fall skills (15+), GMs should dispense with all but the most critical rolls.

Note that in the microgravity of (for instance) an asteroid with a 10-mile diameter, it is easy to throw things entirely away (escape velocity is only 32 miles per hour), and a strong man could jump into orbit.

Zero Gravity

True zero gravity is found only in space, spaceships, and non-rotating orbital stations. These "free-fall" situations use the same rules as microgravity, above, with a few additions.

In free fall, things hang unsupported. A single person can move a very heavy object . . . very slowly! And *stopping* something in free fall is just as hard as starting it. If you have something to push against, you could start a ton of steel moving through space in zero G. And if that moving ton of steel traps you against your ship, it will crush you to death . . . very slowly.

In free fall, thrown objects fly in straight lines, forever . . . until they hit something.

Speed in zero G depends on how hard you can push off from a surface or massive object. You may launch yourself at any speed up to ST/2 yards per second. Launching requires a full turn during which you can do nothing else – unless you can make a Free Fall roll at -3 to skill. If you succeed, you may do something else with any free hand. (But all weapons fire is at -3, and high-recoil weapons may send you off in the wrong direction – see below.) Once moving, you continue to move at the same rate until you catch or hit something which stops you.

On the turn you hit or catch something, roll against Free Fall skill. If you miss the roll, you take an extra turn to recover. A critical miss means a hard landing; take 1d-2 damage (armor protects from all but 1 hit of this) and bounce back at half the collision speed, moving until you are stopped. You must make a HT roll or be stunned as well.

You may attempt to slow your movement or change direction by throwing an object or firing a high-recoil weapon (any weapon with a Rcl of -4 or worse). Each attempt requires a Free Fall roll. If you succeed, you slow down by 1 yard/second, or change direction by 60°. If you fail, you change direction randomly (GM determines in any sadistic manner). A critical failure starts you spinning; you may attempt a Free Fall-3 roll once per turn to right yourself.

Movement in zero G using vehicles, thruster packs, hand thrusters, etc., governed by the rules or skills appropriate for the item. Movement along a bulkhead, hull, or other surface in magnetic boots is at standard Move for characters with Vacc Suit skill, Move-1 for those without.

To use fists or a primitive weapon (such as a sword) in zero G, roll vs. the *lower* of Combat/Weapon skill or Free Fall skill to hit. If you hit, roll vs. Free Fall to avoid being sent floating away by the "equal and opposite reaction" of your strike.

Throwing Things in Varying Gravities

Calculate throwing distance according to the rules on pp.CI10-11 (*not* the simplified system on p. B90) *using the thrown object's weight in 1 G,* then divide this distance by the local gravity field for the distance the item can be thrown. For instance, throwing distances are doubled in 0.5 G and halved in 2 Gs. Whatever you throw, remember the "equal and opposite reaction" on the thrower in micro- or zero gravity (see *Zero Gravity,* this page).

Under *any* gravity, the distance you can throw an object straight up is exactly half the distance you can throw it horizontally.

Air Resistance

Air resistance can usually be ignored for thrown objects; the ranges given in ***GURPS*** normally take this effect into account for an Earth-normal atmosphere. However, when throwing things (especially low-density objects) in micro- or zero gravity, it becomes the dominant effect limiting range. Air resistance does not lend itself to simple rules of thumb, but the GM can cite this effect to limit throwing distances in very low gravity. For instance, you cannot throw a ping pong ball very far in atmosphere, even in zero G. Air resistance is proportional to the density of the air; the thicker the atmosphere, the more significant the effect.

Different Atmospheres

Atmosphere Types

The different types of atmosphere are described on pp. 156-157. We'll concern ourselves here with their effects on human adventurers. Note that the details of a poisonous atmosphere usually don't matter to someone without breathing gear: he dies. Only in case of a very minor suit leak or malfunction will exposure to a really poisonous atmosphere be survivable.

Ammonia: Corrosive and poisonous, but easily detected by its choking odor. Exposure to ammonia requires a HT roll; a failed roll costs one hit point. After 2 hits are lost, convulsive coughing begins (-3 to DX until clean air is reached). Each failed roll also reduces the victim's Vision roll by 1, as his eyes burn and water. Roll every minute for small concentrations, more frequently for large ones. Severe exposure requires the survivors to roll HT-2 or be blinded.

Carbon Oxides: Carbon dioxide (CO_2) is unbreathable, and is poisonous in large concentrations. A 15% concentration requires a HT roll every minute to stay conscious; the roll is at -1 for every added percent of CO_2. At 25%, roll vs. HT hourly and lose 1 HT for each failed roll.

Carbon monoxide (CO) is deadly. Its symptoms are headache and dizziness if present in tiny amounts, unconsciousness and death at higher concentrations. At concentrations over 0.1%, roll hourly vs. HT; each failed roll costs 1 IQ, HT, and DX. At concentrations over 0.2%, roll every ten minutes; halve this time interval *and* apply a -2 to the HT roll for each 0.1% over 0.2%. If a victim removed from the CO, he'll recover. If not, he will die with a cherry-red face.

Chlorine: Corrosive and deadly poisonous. Easily recognized by odor. A few breaths of 1% chlorine will kill. Even 0.005% is dangerous: Roll as for ammonia, but all HT rolls are made at an extra -2 (including the blinding roll), and a roll vs. HT-4 is required to avoid lung damage (1d of *permanent* HT loss!).

Fluorine: As for chlorine, but at a *further* -2 to all indicated HT rolls.

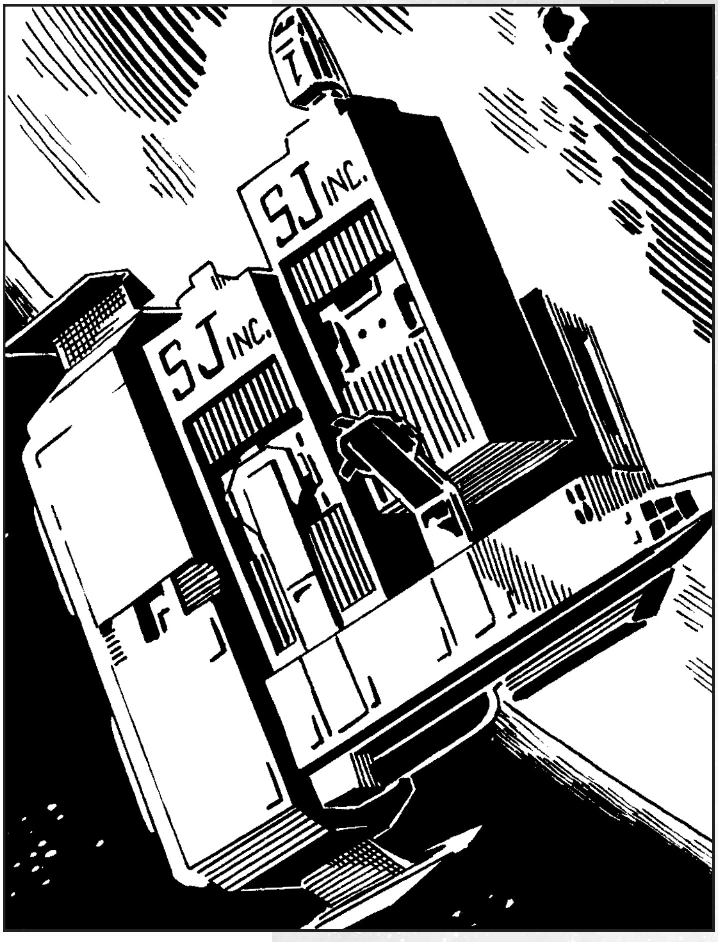
High-Oxygen: Oxygen in concentrations higher than Earth-normal is corrosive. An oxygen leak will make its victims feel bouncy and aggressive. At this level, there is no danger except overconfidence (all IQ rolls at -1). When eyes and nose start to burn, the level is becoming dangerous. Roll as for ammonia, but at +2 to all HT rolls and with no chance of blinding. Too much oxygen also greatly increases fire hazards.

Hydrogen: Not poisonous, but quickly diffuses through plastic or rubber, and is very explosive in the presence of oxygen. Definitely a hazard for careless space-dogs.

Nitrogen: Unbreathable but otherwise inert and harmless, except at high pressures (4-5 atmospheres), when it causes nitrogen narcosis. The effect is that of happy drunkenness: roll vs. IQ every 30 seconds to avoid. The sufferer will not realize he has become irrational, but any observer can easily tell!

Nitrogen Oxides: Corrosive compounds with a distinctive odor. Treat as for ammonia.

Oxygen-Nitrogen: This is the only atmosphere type on this list that humans can breathe without technological assistance. Even if the gas mixture is right, pressure differences (see below) may make it less than ideal. But if the atmosphere happens to be superrich in oxygen, IQ and ST may be slightly increased – or, at least, penalties caused by gravity may be ignored.



Health Problems in Micro- or Zero Gravity (Optional)

Lengthy exposure to micro- or zero gravity seems to cause health problems for humans and other species not native to such environments. Over the long term, human immune response degrades (complicated by the fact that some microbes seem to thrive in such conditions, while the effectiveness of antibiotics is reduced), and muscles and bones atrophy (especially in the lower spine and legs) at about 1% per month. The body's efforts to cope with all this can lead to cardiovascular and kidney problems.

At the GM's option, characters must roll vs. HT once per month spent in gravity under 0.2 G. Modifiers: +1 for G-Experience; -2 if the character lacks the space, time, or inclination to exercise regularly. Failure indicates the loss of 1 ST and 1 HT. Two-thirds of this loss (round up) will "heal" at the rate of 1 point per week spent in 0.2 G or higher; the rest is permanent. Drugs (see *Ursaline,* p. 95) or gene therapy may prevent such effects.

Polluted: This is an oxy-nitro atmosphere with contaminants. The effect of the contaminants may range from merely irritating (wear a filter mask or take 1 point of damage each day) to deadly (treat as poison gas of GM's choice). Not all types of pollution are immediately obvious to the explorer! If pollution is not detected with sensors (see p. 70), a Physician or (if a library is available) Research roll may be attempted, *once ill effects are noticed,* to determine the problem and suggest a solution. If the first roll fails, repeated attempts can be made daily, at a cumulative -1 per attempt. Some forms of contamination are subtle indeed, and there will be severe penalties to the rolls; these worlds can be death traps. Metal dust, microbes, allergens, complex biological poisons released in trace amounts by plants . . . scientifically minded GMs may come up with a wide variety of atmospheric hazards.

Sulfur Compounds: Compounds with *strong* odors. Usually a sulfur leak will be noticed long before it becomes dangerous. Otherwise, treat hydrogen sulfide as for fluorine (but flammable), sulfur trioxide as for chlorine, and sulfur dioxide as for ammonia.

Pressure Differences

Different levels of atmospheric pressure are described on pp. 156-157. Atmospheric pressure has the following effects:

Very thin or *trace* atmospheres might as well be vacuum (see below). Humans can't breathe them, even if oxygen is present. Vision rolls are at -1 (or more) unless the eyes are protected from evaporation and supplied with oxygen by goggles.

Thin atmospheres provide less oxygen. Those breathing them will move slower and fatigue more quickly; increase all fatigue penalties by 1. These atmospheres can also cause symptoms similar to altitude sickness; see pp. CII132-133. If a respirator (p. 61) is worn, these ill effects do not occur.

Dense atmospheres can be breathed with some discomfort, or a reducing respirator may be worn.

Very dense atmospheres require a reducing respirator to breathe; otherwise, there is a -1 to all HT rolls.

Superdense atmospheres, regardless of composition, require armored suits. If some of the constituents are poisonous, this presents a separate problem.

Space Sickness

Anyone entering free fall must roll vs. Free Fall+2. A failed roll means he becomes *spacesick:* disoriented and nauseated by the constant falling sensation. A spacesick character feels generally ill and has a -2 to all rolls. He gets one roll (HT or Free Fall, whichever is better) per day to recover. A critical failure on either the initial roll or the recovery roll increases the penalty to -5 and causes the character to choke as if drowning (p. B91).

Some people are especially prone to this disorder; this is the Space Sickness disadvantage (see p. CI84). A naturally spacesick person is spacesick the entire time he is in free fall – he doesn't roll to recover. He must roll vs. HT on entering free fall. On a success, all his rolls are at the -2 level; on any failure, he suffers the effects described above for a critical failure: choking and -5 to all rolls.

Other minor health effects of zero G include a distorted sense of smell and taste (-1 on those sense rolls), a puffy face, nasal congestion, and more bathroom visits for the first week or so as kidney filtration rates increase. Nonhumans may be affected differently.

Vacuum

The good Lord must like vacuum . . . so say spacers. After all, He made an awful lot of it. Vacuum in itself is not deadly (see sidebar, p. 105), so ship crewmen may survive briefly without air. They may even deliberately enter vacuum without protection or air – if they have to.

You can't hold your breath in vacuum, and you might rupture your lungs if you try. The only safe way to enter vacuum is to exhale and leave your mouth open. You can then operate on the oxygen in your blood for (HT) seconds if active, (HT×4) seconds if moving slowly, or (HT×10) seconds if passively waiting. Double these times if you hyperventilate first; quadruple them if you used pure oxygen. Halve these times if you were caught by surprise and didn't even have time for one deep breath.

Once out of breath, 1 point of fatigue is suffered per turn; when ST reaches 0, the victim falls unconscious. Four minutes later, he dies. There is a chance of brain damage (permanent -1 to IQ) if the victim is saved after more than two minutes without air; roll vs. HT to avoid this.

Extreme Heat

Temperatures that are merely uncomfortable can be dealt with as Earthmen always have: stay in the shade and don't move around too much. On planets where the climate is *hot* (see p. 157), increase fatigue by 1 whenever it is assessed at all. If the climate is *very hot,* increase fatigue by 2 if it is assessed. See p. B130 for further effects.

At TL8, vehicles can traverse deserts hot enough to melt lead. At TL9, permanent colonies can exist in such places. This is not likely to be needed except in very unusual circumstances (e.g., secret outposts, mines for very rare substances). In general, the environment within such a colony would be very comfortable but . . . if something goes wrong, everyone will die quickly. For suits and vehicles exposed to this kind of heat, use the rules under *Corrosive Atmospheres and Equipment Leaks* (sidebar, this page).

Extreme Cold

At TL7+, insulation is good enough to allow vehicles and colonies to withstand any degree of cold, even that of an iceball world in interstellar space, as long as there is a power plant to provide heat. Again, unless something goes wrong, the atmosphere in such a colony would be quite comfortable. But a malfunction wouldn't doom the inhabitants immediately; the temperature might drop gradually, giving time to make repairs or call for help. See *Freezing,* p. B130.

Acceleration

Constant acceleration or deceleration as experienced aboard a spaceship has the same effects on a living organism as the equivalent gravitational field (see p.00); e.g., 2 Gs of constant acceleration is equivalent to being on a world with 2 Gs local gravity. Exception: crews in grav-drive ships (see p. 29) are immune to acceleration effects. For detailed rules on the effects of *sudden* (rather than constant) acceleration, see pp. CII131-132 or pp. VE153-155.

Gravity Compensators

If a ship has gravitic generators that act to compensate for acceleration, simply ignore G forces up to the level for which they can compensate. E.g., if a vessel accelerates at 7 Gs and its compensators can handle 4 Gs, treat acceleration as 3 Gs.

Corrosive Atmospheres and Equipment Leaks

Corrosive atmospheres will eventually eat through even the best protection, leaving adventurers exposed to deadly gases.

The degree of corrosiveness governs the intervals at which the GM checks a suit or vehicle for failure. In a mildly corrosive atmosphere (high-oxygen, nitrogen oxides, or ammonia, for instance), this may occur once per week. In an extremely corrosive one (such as fluorine), the GM might check every hour. The presence of liquid water makes corrosive atmospheres even more dangerous, since acids can form.

At each interval, roll 3d for any exposed suit or vehicle. Subtract 2 for a vehicle with heavy compartmentalization, or 4 for total compartmentalization. Unless armor has been penetrated, a high DR will reduce the chance of a suit or vehicle leaking as follows: DR 30-99 gives -1, DR 100-299 (cDR 1-2) gives -2, DR 300-999 (cDR 3-9) gives -3, and DR 1,000+ (cDR 10+) gives -4. Use the suit's or vehicle's *lowest* DR. Other modifiers can be added. For instance, vehicles in bad repair are much more likely to leak. An immediate check is also required whenever a vehicle is damaged or badly shaken up. In the case of damage that penetrates DR, roll at +6.

A modified result of 14-16 means a slow leak, a 17 is a fast leak, and an 18 indicates explosive "blowout." Specific results of each leak depend on the type of gas; see main text. Even a trace of fluorine, for instance, will send its victims to the hospital in minutes.

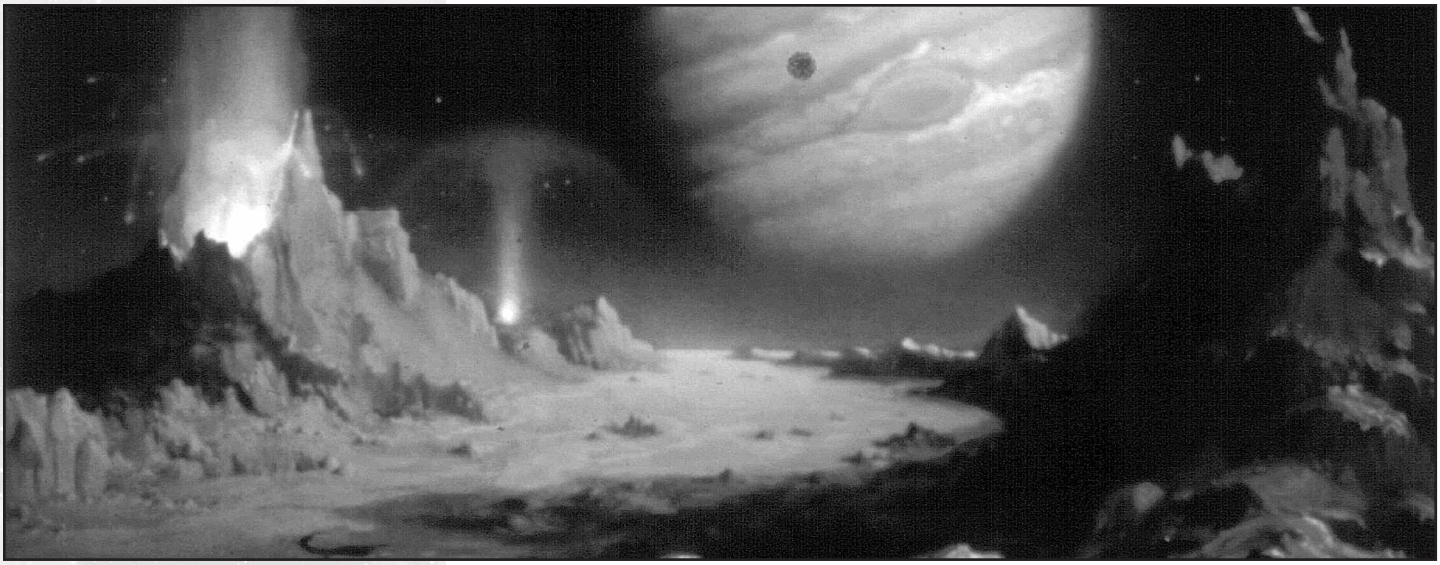
In a superdense atmosphere, any uncorrected leak will blow out at the next check interval. At any other pressure, just add 3 to the next roll for a slow leak or 6 for a fast one.

If the outside pressure is Earth-normal or less, vehicle cabin pressure can be kept above outside pressure, so outside air can't leak in. But this is impossible with denser atmospheres!

Some leaks can be detected by eye or nose, some can be detected by vehicle leak-detection gear or pressure sensors, and some just come as a fatal surprise to the occupants.

Patching a vacc suit leak requires 3 seconds and a Vacc Suit roll (all vacc suits have an exterior patch kit, easy to reach). If the first attempt fails, repeated attempts can be made at a cumulative -1 per attempt.

Patching a vehicle requires a Mechanic roll, modified as the GM sees fit.



Rapid Decompression

If a ship loses a lot of air to a meteor strike, or if a respirator suddenly goes bad, a spacer may find himself trying to adapt to rapidly falling pressure. Popping ears are a sure sign of a pressure change (IQ+4 to notice for anyone with space experience, IQ for anyone who has received even a basic passenger briefing). If your ears keep popping, pressure is still going down. If the situation is not stabilized quickly, the spacer must get to a pressure suit, escape pod, etc., or be in vacuum.

Pressure loss is a terrifying thing on board ship. The GM may require all aboard to make a Fright Check (see p. B93); again, experienced crew should roll at +4.

Radiation

Starfarers may be exposed to radiation due to hostile environments (thorium mines, venturing too close to a quasar), accidents (solar flares, nuclear engine failures), or acts of war. However, radiation detectors are simple and cheap even at TL6. Anyone who expects to be exposed to radiation can prepare in advance and thus know exactly how much he took.

Radiation exposure is measured in *rads.* The more rads you take, the more likely you are to suffer ill effects. The GM should keep track of each character's radiation injuries, noting each dose and the date on which it was received. Each one heals separately from all others received; after a month, it starts healing at a rate of 10 rads per day. However, 10% of the original radiation injury will never heal.

For example, suppose someone spends a day in a "hot" environment and accumulates a 200-rad dose. After 30 days, that particular injury starts to heal. After another 18 days, at the 20-rad level, that injury stops healing.

Some typical radiation doses:

One-megaton fission air burst or space burst at 2,000 yards: 6,600 rads.

Fallout on ground 1 hr. after one-megaton fission ground burst: 300 rads/hour after 1 hour, 120 rads/hour after 2 hours, 36 rads/hour after 5 hours, 7 rads/hour after 1 day.

Radiation from a solar flare or fission plant accident: 1,000 rads/hour or more.

Every time a character receives a substantial dose of radiation, and once per day spent in an environment that delivers a dosage of at least 1 rad per day, he should roll vs. HT on the *Radiation Effects Table* (below) using his *current total accumulated dose.*

Radiation Effects Table

Accumulated Dose	HT Mod.	Critical Success	Success	Failure	Critical Failure
1 to 10 rads	+0	None	None	A(6d)	B
Up to 20 rads	+0	None	A(6d)	B	C
Up to 40 rads	+0	A(6d)	B	C(1 HT)	D
Up to 80 rads	-1	A(5d)	B	C(2 HT)	D
Up to 160 rads	-3	A(4d)	B	C(3 HT)	D
Up to 4,000 rads	-5	A(3d)	B	C(4 HT)	D

Note: The HT modifier applies to all HT rolls the victim makes, whether for radiation, contagion, spell resistance, etc.

A: *Radiation burns.* Chronic "somatic" damage – -2 HT for a week. Roll the indicated number of dice; if all come up sixes, the victim will develop cancer and die within a year. Starting a few hours after his irradiation and lasting through seven days, the victim has Low Pain Threshold (see p. B29); if he had High Pain Threshold to start with, then it is nullified for the duration. Radiation also causes "genetic" damage, but little is known about its likelihood. Human women, who never produce new ova, are more vulnerable than men, who constantly produce new spermatozoa. And who knows for aliens? (Suggested rule: the offspring of a human female who has taken over 250 rads ever, or a human male who has taken over 100 rads in the last week, may suffer whatever birth defects the GM wishes to impose.)

B: *Haematopoietic syndrome.* In addition to radiation burns, other effects occur within a day: nausea and vomiting lasting 24-48 hours and loss of 1d ST, DX, and IQ. Afterward, the victim rolls vs. HT daily: on a critical success, he recovers 2 points of ST, DX, and IQ; on a success, he recovers 1 point of each; on a failure, he makes no improvement; on a critical failure, he relapses – he loses 1 point of ST, DX, and IQ. As long as the victim's ST, DX, and IQ are depressed, he also suffers from Hemophilia (see p. B28).

C: *Gastrointestinal syndrome.* In addition to the above effects, other symptoms manifest within 1-3 weeks: *permanent* loss of the indicated HT, as well as all body hair. The victim then starts to lose 1 hit point per day, rolling vs. HT daily; on a critical success, the hit point loss stops and normal recovery can occur (hair grows back). As long as hit points decline, the victim is at risk from opportunistic infections (treat as Weak Immune System, p. CI85). He is also subject to bouts of nausea, vomiting, diarrhea, fever, and prostration; roll vs. HT hourly, or whenever the victim tries to do anything other than rest quietly, to avoid collapse for the rest of the day. If HT goes below 4, the victim's teeth and nails also start to fall out.

D: As C, except that even a critical success on the HT roll won't stop the daily HT loss. Death is certain.

A dose of over 4,000 rads induces *cerebrovascular death:* Within an hour, the victim loses 2 hit points and 2 IQ, and rolls vs. HT to stay conscious. Repeat every hour. Other symptoms include diarrhea, vomiting, dizziness, low blood pressure, stupor, incoherence, hyperexcitability, loss of coordination, and uncontrollable trembling. Unconsciousness is followed by convulsions and then death (when IQ or HT reaches zero).

Any single dose of 200+ rads also causes sterility and blindness for a few months; a dose of 500+ rads makes it permanent.

Hit Location

In some circumstances, only a part of the body may be irradiated. To assess the effects, convert the body part's dose into an "equivalent whole body dose": divide a dose to the head or limbs by 15, one to the torso by 8, and one to the vitals by 4. A *very* localized radiation injury may cause the slow necrosis of the body part; over the course of months, the blood vessels fail and gangrene sets in.

Effects on Nonhumans

The above effects apply to mammals. Effects on other species may vary. For non-mammalian terrestrial life, divide effective dose as follows:

Crustaceans/Molluscs/Worms:	By 2.
Fish:	By 3.
Reptiles/Amphibians:	By 4.
Avians:	By 5.
Insects:	By 80.
Arachnids:	By 100.
Protozoans:	By 1,000.

The effects on plant life vary: a tree may die from a 60-rad dose, but grasses can survive 2,000 rads or more.

The effects on aliens are also up to the GM – consider the environment they evolved in. Some species may be *more* vulnerable to radiation than humans.

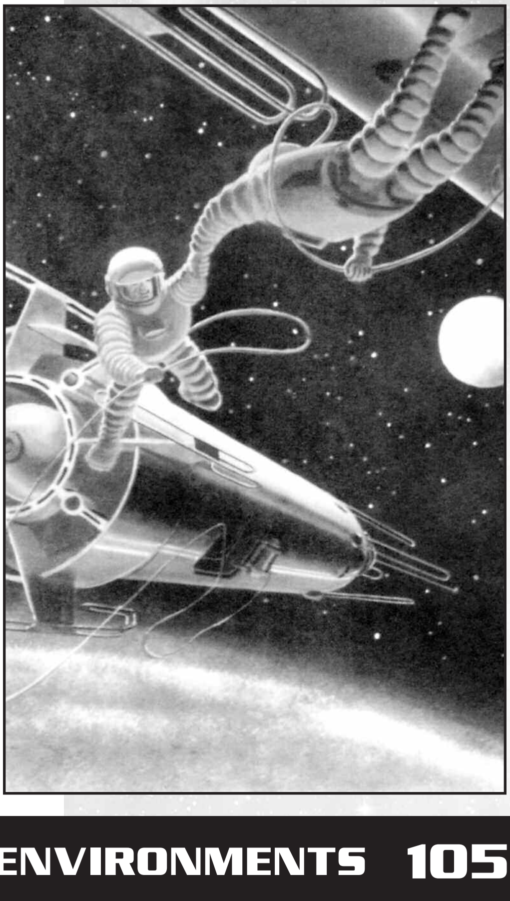
Explosive Decompression

"Blowout," or *explosive decompression,* happens when an area suddenly goes from normal pressure to little or none. This could occur, for instance, when a ship loses all its air to a meteor strike, or when someone is tossed out the airlock.

Fifty years of pulp fiction to the contrary, explosive decompression does not turn its victims inside-out and quick-freeze them. What *does* happen is that body fluids begin to boil away or sublime. Small blood vessels rupture and mucous membranes dry out. The eardrums pop violently. The victim takes 1d of damage, but *does not die* until he runs out of breath, as described under *Vacuum* (p. 103). However, if rescued, he must make the following rolls or suffer the indicated *permanent* ill effects:

- HT+2 for each eye to avoid blindness.
- HT to avoid -1 DX due to "bends" from boiling blood (see also p. CII132).
- HT-1 to avoid permanent Hard of Hearing disadvantage.

If the victim is not rescued, then within a few hours his brain will dehydrate to the point where it cannot be read using brain-taping technology (see p. 90). His body will eventually dehydrate completely; the remaining fragile, powdery husk will weigh only a few pounds. DNA (for cloning; see p. 89) may be recoverable after any period of time the GM deems reasonable; at TL7, *we don't know* how long DNA would last in space . . .



Fallout

Small radioactive particles, such as those produced by a ground-burst explosion, produce fallout. NBC suits don't stop the radiation from fallout, but they keep the wearer from *ingesting* fallout. If you swallow or breathe fallout particles, you will get a continuing radiation dose from *inside.* Intensity of the dose, and time for the fallout particles to decay to harmlessness, depends entirely on the situation. But it's always unhealthy!

Protection from Radiation

Any material between you and the radiation source will help cut down on radiation. The thicker and denser the material, the better the protection factor (PF). A PF of 100 simply means that only 1/100 of the gamma radiation will get through the shield. (Radiation types other than gamma are easy to screen out, and may be ignored if you have enough shielding to affect gamma radiation at all. The exception is cosmic radiation and solar flares – see below.)

Half an inch of lead, 1.5 inches of steel, or 750 yards of air has PF 2; a yard of water has PF 8; a yard of earth has PF 27; a yard of concrete has PF 64; a yard of steel has PF 17 million. A cDR 1 ship hull has PF 10. Each doubling of cDR increases PF by a factor of ten: cDR 2-3 gives PF 100, cDR 4-7 gives PF 1,000, cDR 8-15 gives PF 10,000, etc.

Most fully sealed suits of armor have PF 2, or PF 10 if they have DR 100 or more. Vacc suits (p. 62) and NBC suits (p. 61) can have a thin layer of metal which gives extra PF against gamma rays, but such suits should *not* be worn for solar flare protection, because flare radiation sets off secondary radiation in metal and rad damage is *multiplied* by the PF.

Radiation Treatment

TL6 offers no real radiation treatment. At TL7, drugs are available that can halve your effective rad dosage if a dose ($500) is taken 1-3 hours in advance. Also at TL7, *chelating* drugs are available to get radioactive fallout out of your system; a dose ($500) halves damage after 3 days and eliminates the fallout entirely after a week. This has no effect on radiation already absorbed!

At TL8, advanced chelating drugs ($500/dose) encapsulate and remove fallout in 12 hours. Braintape technology can save a victim; anyone who survives the initial radiation exposure can still have his brain read, unless the dose was 5,000 rads or better. Each increase in TL raises this limit by 1,000 rads (higher doses scramble nerve tissue beyond that TL's ability to read).

At TL9, Antirad drug (p. 94) is available.

At TL10, expensive treatments ($3,000) are available to reduce your lifetime rad history by 10% per treatment. Each treatment takes about 3 days; they cannot be repeated more often than once per month.

At TL11, these antirad treatments reduce lifetime history by 25% per treatment.

At TL13, chrysalis machines (p. 91) can cure radiation *entirely.*

In *any* setting where cloning for spare parts is viable and deemed ethical (see p. 89), replacing your organs and bone marrow will reduce your lifetime history by 75%.

Radiation Effects on Electronics: EMP

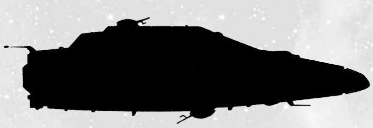
The electromagnetic pulse (EMP) from nuclear and antimatter weapons can permanently scramble computers and other delicate electronic equipment. Spacecraft computers are generally hardened as a matter of course (since there is a constant radiation risk in space) but unprotected electronics near a bomb detonation can easily be knocked out.

For simplicity's sake, assume that EMP is proportional to the momentary rad dosage produced by a nuclear blast. Unlike rad dosage, however, EMP from multiple blasts does not accumulate – it is figured separately for each blast. It is possible for the combined rad dose from several blasts to kill all the humans in an area but for no single EMP to be large enough to kill the computers. This could be a significant plot point . . .

The higher the TL, the more resistant even unshielded electronic gear becomes. Rad levels equivalent to an EMP kill are as follows:

TL7	100 rads
TL8	200 rads
TL9	500 rads
TL10	2,000 rads
TL11+	10,000 rads

TL6 electronic gear (with primitive vacuum tubes) may be *immune* to most EMP effects!



Radiation Detectors

Film Badge (TL6): Turns dark in the presence of radiation; shows doses from 0.1 to 200+ rads. Should be checked and changed often. $100 per box of 100.

Radiation Alarm (TL6): Triggered by a preset radiation level, adjustable from 0.1 to 2 rads/hour at TL6, sensitive down to 0.01 rads/hour at TL7+. Sets off a loud alarm. Does not tell the actual radiation level. $100.

Wristwatch Rad Counter (TL7): Has a display to indicate radiation level in rads per hour. Costs $500 (or $550 with built-in alarm, as above) at TL7, $100 at TL8+. May also be built into a helmet visor, vehicle dashboard, etc.

CHAPTER 8 STARSHIPS

The ship-design system presented here gives the GM the tools he needs to create ships customized for his campaign. Before using it, the GM should decide which technologies exist (see Chapter 2) and determine which components are (and *aren't*) standard for his campaign. Everything here is a suggestion; costs and efficiencies can be varied to change campaign balance or to provide interesting distinctions between worlds. For instance, contragravity – given here as TL12-13 – could have been invented at TL9-10 in the GM's universe, or not exist at all. The warp drives of Salusia may be 10% more massive than those listed here, but 20% faster . . . and repairable only by Salusian engineers. And so on.

Units and Abbreviations

cDR: A measure of spaceship Damage Resistance. One point of cDR equals DR 100.
cf: A cubic foot. Hull size and cargo capacity are measured in cubic feet.
cHP: A measure of hull hit points. One cHP equals 100 hit points.
Gravity (G): A measure of acceleration equal to the surface gravity of Earth, or 9.8 meters per second per second (about 21.9 mph per second). Earth gravity is "1 G."
ksf: A measure of hull or turret surface area equal to 1,000 square feet.
M$: A "megabuck" or "megacredit"; one million $.
MW: A megawatt, a unit of power. Used for power requirements or power output. Equal to 1,000 kilowatts (kW).
MWs: Megawatt-second, a unit of energy equal to the output of a 1-MW plant for 1 second. Used to describe the amount of energy held by energy banks.
Space (Spc).: A unit of 500 cf; a convenient measure of internal volume.
Ton: A measure of mass and weight; 2,000 pounds.

A "k" following a number indicates thousands, an "M" indicates millions, and a "G" indicates billions (be careful not to mistake it for G for "gravity"!). Thus, "16k" means 16,000, "25M" means 25 million, and "7G" means seven billion (but "7 Gs" means seven gravities).

Suggested Hull Sizes

What one background may call a "destroyer" another may refer to as a "battleship" – terminology is up to the GM. Here are a few suggestions:

Lifeboat	5,000-10,000 cf
Fighter	5,000-20,000 cf
Shuttle	5,000-50,000 cf
Scout	20,000-100,000 cf
Light Freighter	50,000-500,000 cf
Patrol Boat, Corvette	100,000 cf+
Destroyer/Frigate	500,000 cf+
Passenger Liner	500,000 cf+
Bulk Freighter	1 million cf+
Cruiser	2 million cf+
Colony Ship	.5 million cf+
Battleship	20 million cf+
Carrier	50 million cf+
Dreadnought	100 million cf+

How Big Is My Hull?

A ship's actual dimensions can vary greatly. For a rough idea of the hull's length, look up its Size Modifier in the Size column on the table on p. B201. This assumes a fairly average cylindrical ship, or a collection of disks, pods, and cylinders. Length may be 1.5 to 3 times that if it is long and skinny, dartlike, or a flattened disk or wedge. Diameter will be 2/3 that if the ship is ovoid or spherical.

Designing a Ship

First, come up with a general concept and mission for the ship. Who's building it and for what purpose? Is it an interplanetary craft or a starship? A merchantman or a warship? The ship should fit the GM's assumptions about technology in his universe, such as which space drives are available and which superscience technologies exist, if any. This system can also be used for space stations and satellites; just read "ship" as "station" and do not install a space drive.

Next, decide on the ship's TL. This design system allows ships to be built at TL8 and up.

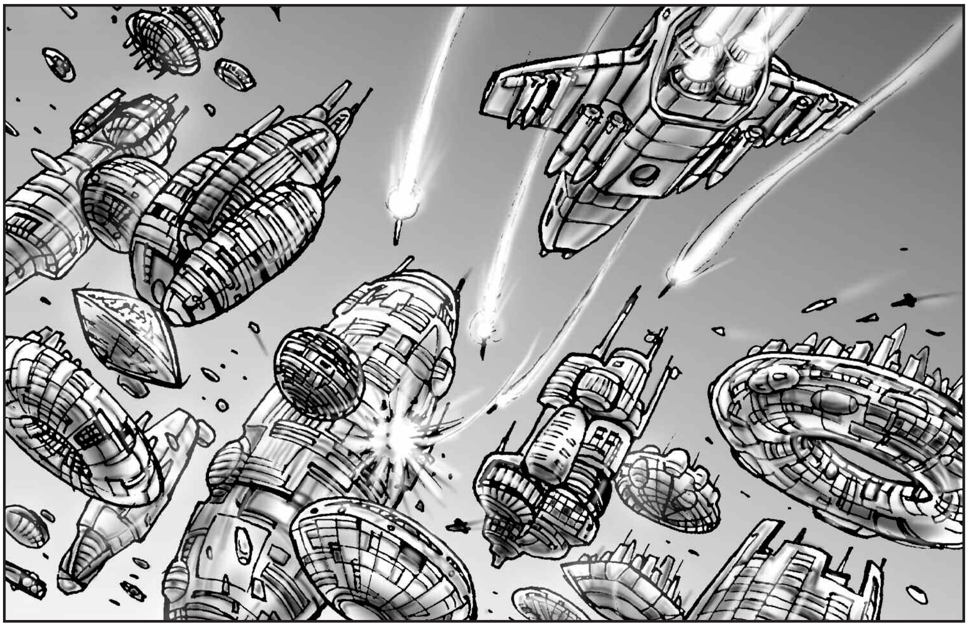
EXAMPLE: The GM wants to design a fast interstellar freighter suitable for a party of adventurous space merchants or smugglers. The ship is built to carry passengers and cargo from one star system to another, and can be operated by a small crew. The superscience technologies used are hyperdrive, reactionless thrusters, and artificial gravity. The GM decides the ship is built at TL10: the "*Tanstaafl*-class star freighter."

Design Sequence

The following is a step-by-step spacecraft design process. Calculations are simple and can easily be done on scrap paper. A calculator is useful but not essential. Before beginning, refer to *Units and Abbreviations* (sidebar) for the terminology used in this design system.

Step 1: Design the hull and record its characteristics.
Step 2: Designate turrets.
Step 3: Select armor tonnage. Calculate its cost, cDR, and PD.
Step 4: Consider sensor masking features.
Step 5: Determine internal spaces.
Step 6: Estimate mass.
Step 7: Fill all internal spaces with component systems.
Step 8: Calculate basic statistics.
Step 9: Calculate performance.
Step 10: Finalize design.

As design choices are made, keep a running total of the ship's mass (in tons) and cost (in M$).



Step 1 – Hull Design

The hull is the frame of the ship. A hull is more than a shell. It comes with decks, cables, stress bracing, etc.

Select a standard hull volume from those listed on the table below. See the *How Big is My Hull?* (p. 108) for an approximation of ship dimensions.

Decide whether the ship is *streamlined* (SL) or *unstreamlined* (USL). Streamlined ships are sleek lifting bodies (often dart-, teardrop-, wedge-, or disk-shaped) and may fly within a planetary atmosphere. Unstreamlined ships cannot make a safe atmospheric reentry without contragravity (if it exists). They may be cylindrical, spherical, or just about any other shape.

Based on the hull's volume, note hull area (in ksf), structural mass (in tons, varies with TL), hull cost (in M$, varies with streamlining), Size Modifier, and Maximum Turrets (the maximum number of weapons turrets that can be added).

Hull Table

Hull	Area	Structural Mass (tons)					Cost (M$)		Size	Max
Volume	(ksf)	TL8	TL9	TL10	TL11	TL12+	USL	SL	Mod.	Tur.
5,000	2	4	3	2	1.5	1.0	0.1	0.24	+6	0
10,000	3	6	4.5	3	2.2	1.5	0.15	0.36	+6	1
20,000	5	10	7.5	5	3.8	2.5	0.25	0.6	+7	1
50,000	10	20	15	10	7.5	5	0.5	1.2	+8	2
100,000	15	30	22	15	11	7.5	0.75	1.8	+8	3
200,000	25	50	38	25	19	12	1.2	3	+9	5
500,000	40	80	60	40	30	20	2	4.8	+10	8
1,000,000	60	120	90	60	45	30	3	7.2	+10	12
2,000,000	100	200	150	100	75	50	5	12	+11	20
5,000,000	170	340	260	170	130	85	8.5	20	+12	34
10,000,000	280	560	420	280	210	140	14	34	+12	56
20,000,000	440	880	660	440	330	220	22	53	+13	88
50,000,000	810	1.6k	1.2k	810	600	400	40	97	+14	160
100,000,000	1.3k	2.6k	2k	1.3k	980	650	65	160	+14	260
200,000,000	2k	4k	3k	2k	1.5k	1k	100	240	+15	400
500,000,000	3.8k	7.6k	5.7k	3.8k	2.8k	1.9k	190	460	+16	760
1,000,000,000	6k	12k	9k	6k	4.5k	3k	300	720	+16	1,200
2,000,000,000	10k	20k	15k	10k	7.5k	5k	500	1.2k	+17	2,000
5,000,000,000	18k	36k	27k	18k	14k	9k	900	2.2k	+18	3,600
10 billion	28k	56k	42k	28k	21k	14k	1.4k	3.4k	+18	5,600
100 billion	130k	260k	190k	130k	95k	65k	6.5k	16k	+20	26k
1 trillion	600k	1.2M	900k	600k	450k	300k	30k	72k	+22	120k
10 trillion	2.8M	5.6M	4.2M	2.8M	2.1M	1.4M	140k	340k	+24	560k

EXAMPLE: We choose a modest 200,000 cf hull, perhaps 100 yards long (see *How Big is My Hull?,* p. 108). We want *Tanstaafl* to take off and land on a planet; so since contragravity is unavailable, we decide she is streamlined. The area of a 200,000 cf SL hull is 25 ksf, structural mass is 25 tons at TL10, and cost is $3 million. The ship can have up to 5 turrets.

Step 2 – Turrets

Turrets are rotating superstructures attached to the hull, normally used to mount weapons. A hull can have as many *small* turrets as its Max Turrets value (from the *Hull Table,* above). It can always have fewer turrets, or none at all.

There are three basic sizes of turret: *small* (available in single-, double-, triple-, and quad-mount versions), *medium* (in single, double, or triple mounts), and *large* (single mounts only). Each medium turret counts as 4 small ones; each large turret counts as 10 small ones. Turrets must be streamlined if the hull is streamlined.

Hull Options

Compartmentalization

Compartmentalization is the degree to which the interior of a ship is divided into "compartments" that can be sealed to prevent the spread of fire or toxic gases, or to keep a hole from depressurizing the entire ship. It comes in three levels:

Standard: Most walls and doors are DR 6, 20 hit points; pressure walls and doors, where encountered, are DR 12, 40 hit points. This is the default: no extra mass or cost.

Heavy: Most walls and doors are DR 8, 30 hit points. Pressure walls and doors are more common and are DR 16, 50 hit points. This adds 10% to the hull's structural mass and costs M$0.01 per ton of extra mass added.

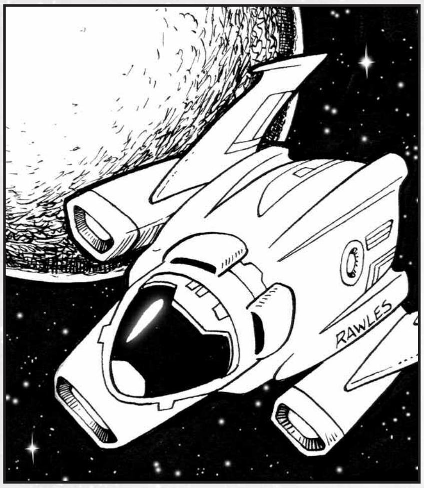
Total: Every door is a pressure door unless the designer specifies otherwise. All walls and doors are DR 16, 50 hit points. This adds 20% to the hull's structural mass and costs M$0.01 per ton of extra mass added.

Other Hull Options

Biomechanical Hull: What if the ship were alive? Some cultures may take animals or plants (especially spacefaring life forms) and genetically or cybernetically modify them into ships. A living ship may get sick or have a mind of its own, but it can also heal hull damage naturally (1% of cHP per day on a successful HT roll). Multiply hull cost by 1.5. A biomechanical ship rarely has more than cDR 1-2 armor. For a different, more organic look at living starships, see ***GURPS Bio-Tech.***

Living Metal Hull: At TL13+, a hull can use nanotech "living metal," packed with active self-repair nanomachines. It heals 1% of cHP per hour. Double hull cost.

Robotic Ship: For a ship run completely by an AI, with no crew, double hull cost (cumulative with the above modifiers) to include built-in servos that let the robot maintain itself, etc.



Buying a Ship

The outright purchase of a starship is likely to be beyond the means of even a Filthy Rich character. However, several PCs may pool their wealth for a down payment on a ship; the Ship Owner advantage (pp. 46-47) is one way to handle this. As well, PCs who will have no home but their ship may use *all* of their starting money (not just 20%) to buy that ship. For more information, see *Finances* (p. 113).

Buying It Used

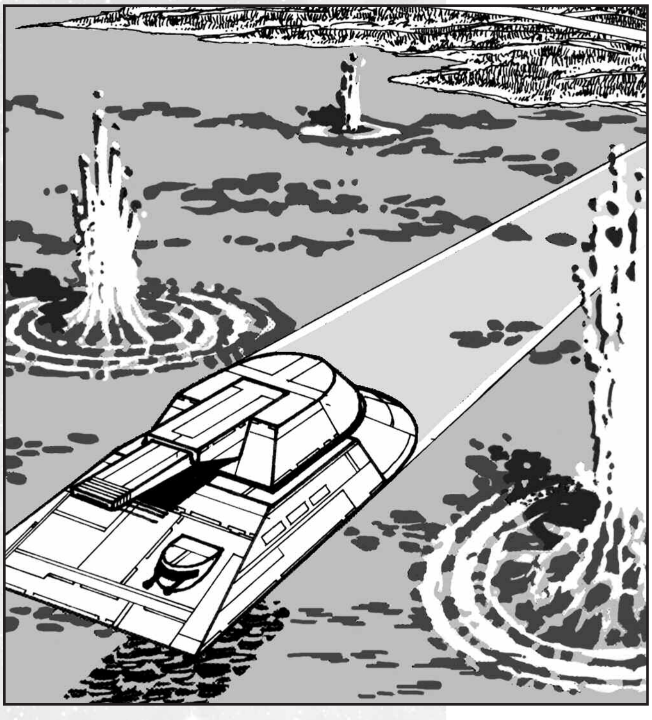
In a culture where star travel is common, used ships will be common. As with used cars in the 20th century, let the buyer beware! Most used-ship salesmen have high Acting and Fast-Talk skills. A roll on Shipbuilding (Starship), or an appropriate Engineer or Mechanic skill, may be required to detect hidden flaws. Then the buyer must decide whether to walk away or to bargain the price down.

Availability of used ships is entirely up to the GM. An apparent bargain on a used ship is a great way to start an adventure.

Typically, used ship prices might be around 90% of new for a modern ship in good shape, 50-80% for a battered but spaceworthy ship of modern design, 30-40% for an obsolete or nonstandard ship in good shape, and 10-20% for an obsolete or nonstandard ship with no guarantees.

Outdated military ships are often available at surprisingly low prices; many navies consider a ship "outdated" as soon as somebody can build a better one. These are more likely to have hidden damage. In some jurisdictions, military ships must be disarmed before they are sold. In others, they come with weapons intact.

And some used ships are *stolen* . . .



Turret Table

Turret	Structural Mass (tons)					Cost (M$)	
Size	TL8	TL9	TL10	TL11	TL12	USL	SL
Single Small	0.8	0.6	0.4	0.3	0.2	0.02	0.048
Double Small	1.2	0.9	0.6	0.45	0.3	0.03	0.072
Triple Small	1.6	1.2	0.8	0.6	0.4	0.04	0.096
Quad Small	2	1.5	1	0.75	0.5	0.05	0.12
Single Medium	4	3	2	1.5	1	0.1	0.24
Double Medium	6	4.5	3	2.2	1.5	0.15	0.36
Triple Medium	8	6	4	3	2	0.2	0.48
Single Large	20	15	10	7.5	5	0.5	1.2

Record the combined mass (which varies with TL) and cost (which varies with streamlining) of all turrets installed.

EXAMPLE: *Tanstaafl*'s 200,000 cf hull can have a maximum of 5 small turrets (*or* one medium and one small). Since she is not a warship, we give her only two quad small turrets. At TL10 and for a streamlined hull, their combined mass is 2 tons, combined cost is M$0.24.

Step 3 – Armor and Screens

Armor

Ships are armored to protect against radiation, micrometeors, harsh atmospheres, and enemy weapons. Adding heavy armor will slow a ship down (due to the extra mass) but make it more "survivable."

Computing Total Area

Calculate the ship's total surface area. This is the hull area (see *Hull Table,* p. 109) plus 1 ksf per small turret, 4 ksf per medium turret, or 10 ksf per large turret.

EXAMPLE: To *Tanstaafl*'s 25 ksf hull area, we add 1 ksf for each of her small turrets, giving a total area of 27 ksf.

Choosing Armor cDR

Spaceship armor is rated in *cDR* (multiples of DR 100). A streamlined ship *must* have at least cDR 1. An unstreamlined ship may have cDR 0, but most civilian vessels have cDR 1-2 regardless. Ships likely to face enemy fire (warships, pirate vessels, etc.) may be better armored, or may rely on high agility, defensive weapons, or countermeasures.

To decide how much armor a ship needs, think like those who commissioned it. What kinds of threats did they expect it to face? Take a look at the damage inflicted by ship's weaponry (see pp. 142-143), take a guess at the kinds of weapons the ship is likely to face, and buy reasonable protection against those weapons. Enough armor to protect from the maximum damage of those weapons will usually add too much mass (and be boring from a gaming perspective . . .); instead, choose a cDR in the neighborhood of the weapons' *average* damage roll. This will make the ship "survivable" against a few hits.

If force screens exist (see below), their cDR is additive with that of armor. Bear this in mind when selecting armor cDR. A warship could get by with light armor if it had a heavy force screen.

EXAMPLE: *Tanstaafl* is a streamlined civilian vessel, so we choose cDR 1.

Armor Mass and Cost

Armor Mass: Multiply the ship's total area (in ksf) by the chosen cDR and by the Mass (in tons) shown on the *Armor Table* for the ship's TL. This gives the armor mass.

Armor Cost: Multiply armor mass by M$0.012 to get armor cost.

Passive Defense (PD): Armor PD is 0 if cDR is 0, or 4 if cDR is 1+.

Armor Table

TL	TL8	TL9	TL10	TL11	TL12	TL13+
Mass	12.5	7.5	5	3	2	1.25

EXAMPLE: *Tanstaafl*'s armor mass is 27 (total area in ksf) × 1 (cDR) × 5 (mass at TL10) = 135 tons. Cost is 135 (tons) × M$0.012 = M$1.62. PD is 4.

Option: Separate Turret/Hull cDR

Turrets can have different armor from the hull. To do this, work out hull armor using only the hull's area and turret armor using only the turrets' area. In some settings, turrets are designed with lighter armor than the hull itself (saving a bit of weight). For a quick way to design this kind of ship, just add *half* the total turret area to the ship's hull area and armor the combined area normally; this gives the turrets exactly half the hull's cDR.

Force Screens

At TL11+, superscience force screens may be available. These give the effect of armor – while the power is on. A force screen is assumed to consist of an external screen generator grid connected to the ship's power plant. When activated, it projects an energy barrier around the ship that absorbs or deflects incoming attacks. See Chapter 5 for descriptions of how force screens work, and Chapter 2 for advice on how their exact effects can be adjusted to fit a campaign.

To add a force screen to a ship, follow these steps:

Screen cDR: Select the screen's cDR, using the same guidelines for choosing armor cDR.

Screen Power, Mass, and Cost: To get the screen's power requirement in megawatts (MW), multiply its cDR by the ship's total surface area (in ksf). To get its mass (in tons), multiply the power requirement by the Mass shown on the *Force Screen Table.* To get its cost (in M$), multiply mass by 2.5 for "expensive" screens (per ***GURPS Vehicles***) – or by 0.25 for "cheap" screens (for settings where screens are common).

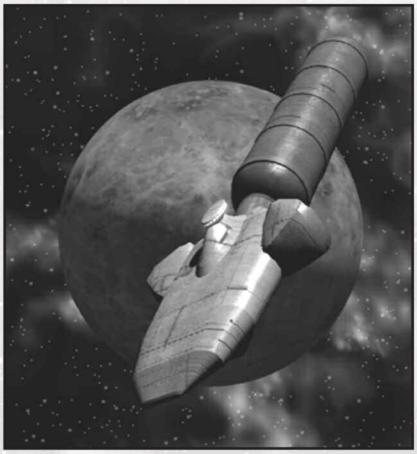
Force Screen Table

TL	11	12	13	14	15+
Mass	0.4	0.2	0.1	0.05	0.025

EXAMPLE: Suppose *Tanstaafl* was TL11, force screens were available, and we chose one with cDR 3. It would require 3 × 27 (area) = 81 MW, mass 81 (power) × 0.4 (TL11) = 32.4 tons, and cost (assuming "cheap" screens) 32.4 (mass) × 0.25 = M$8.1.

Step 4 – Sensor Masking

A vessel may optionally be given *stealth* to make it harder to detect with active sensors (like radar), and *emission cloaking* to be mask it from passive sensors (like infrared). Each feature comes in two levels: *basic* and *radical;* a vessel may not have both basic and radical versions of the same feature. At TL10+, a ship may also be made invisible to the naked eye by installing an *intruder chameleon system.*



Standard Designs

Most starships are built to order from existing hull plans. If your requirements are neither outlandish nor locally illegal, you can probably find plans for an appropriate ship; a set of plans would be about a 1-gig database, $1,000+. Or the shipyard may offer use of *their* standard plans, at a discount. It is up to the GM whether to provide standard plans. The more common space travel is in your universe, the greater will be the variety of plans available.

Buyers may specify reasonable variations from the plans on armor, surface features, compartmentalization, weapons, and non-vital interior components. Changes in hull size or drives should add to the cost, at the GM's discretion.

Usual time to build a ship at a Class V port is hull volume/1,000 days, with a minimum of 6 months. Doubling the price will halve the time (and minimum). Tripling the price cuts the time by two-thirds (minimum 2 months). Four times the price, and a reaction roll of Very Good or better (using influence or bribery, as necessary), cuts the time to the actual minimum, volume/4,000 days, with a six-week minimum and work around the clock. Military shipyards on a war footing use this speed. Special items may take extra time to install. Anything not available locally must be imported.

Smaller shipyards also take longer. A Class IV port will take twice as long on any hull over 200,000 cf and three times as long on anything over 1M cf (if they will handle it at all). A Class III port isn't really equipped for shipbuilding at all. It can build a ship of up to 10,000 cf, but takes four times as long. It can't build larger ships.

The price for a ship built to standard plans is simply the sum of the prices of all its systems and components.

Custom-Building

If plans are not available, it will take a month to draw up complete plans (regardless of ship size – although a very complex design may take more time, at the GM's option). The fee for this is usually $1 per ton of final empty mass, with a minimum of $10,000. Triple this if the designer will not have the right to sell the plans as "standard" after he finishes.

PCs with Shipbuilding (Starship) skill at the appropriate TL can prepare their own plans. A shipbuilding program will help! The GM makes a single skill roll. A failure wastes the month, but they can start over. A critical failure produces a plan that is so subtly flawed that the builders won't notice . . . but the GM can provide a catastrophe when the ship is first flown.

An advantage of custom-built ships is that nobody can tell from the outside exactly what they are like. A successful roll on Shipbuilding (Starship) skill will allow a determination of capacity, a good guess about power plant, and a wild guess about weaponry (turrets are obvious; their contents aren't!).

Refitting and Repairs

A used ship may not suit the buyer's exact needs, and will require refitting. A ship that takes damage will require repair. Either situation requires a shipyard (see p. 171). Within the guidelines given there, the GM judges whether the yard can do the required work.

Cost of refitting is the cost of all new equipment added, plus 30%. Old equipment may have some salvage value, especially if the PCs are good negotiators.

Cost of repairs is the cost of all equipment destroyed, plus 10%, plus half the cost of damaged but not destroyed items.

In terms of cHP, it takes 50 man-hours of work and a roll against Mechanic skill to repair one cHP of damage; all normal modifiers apply (see p. B54). Treat this as a "minor" repair if the hull or turret has not actually been disabled (which occurs at 0 or less hit points), "major" otherwise (an extra -2 penalty). Hiring a mechanic costs at least $20 per person per hour. Repairs can be rushed – see *Heroic Performance* (p. 49) for details.

Time for extensive repairs or refitting is generally equal to half the time it would take that shipyard to build a ship of mass equal to the mass of gear being replaced or installed. This may be modified by extra payments, as described under *Standard Designs* (p. 111) – and, of course, by the GM's judgment.

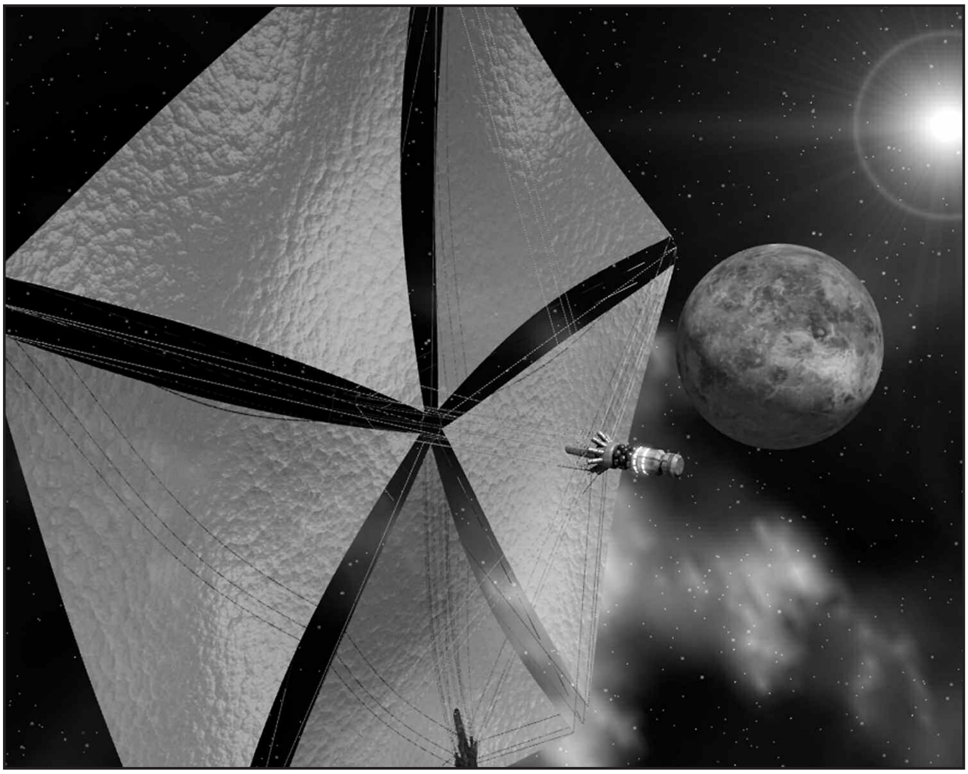
Basic emission cloaking subtracts (TL-4) from rolls to detect the ship with a passive sensor scan, while basic stealth subtracts (TL-4) from active sensor scans. Radical cloaking or stealth doubles this penalty to -2 × (TL-4). Intruder chameleon systems give -10 to spot the ship visually (-6 if it is moving).

Mass and Cost: If the ship one of these features, calculate its mass by multiplying the number shown on the *Sensor Masking Table* by the ship's total surface area (see *Armor and Screens,* p. 110). Find cost by multiplying mass by M$ 0.3 if basic, M$1.5 if radical, or M$1.33 if intruder.

Sensor Masking Table

Feature	TL8	TL9	TL10	TL11	TL12+
Basic Stealth	0.5	0.25	0.25	0.25	0.25
Radical Stealth	1	0.5	0.5	0.5	0.5
Basic Emission Cloaking	1	0.5	0.25	0.25	0.25
Radical Emission Cloaking	2	1	0.5	0.5	0.5
Intruder Chameleon	–	–	0.3	0.15	0.075

EXAMPLE: We decide *Tanstaafl* has no sensor masking. But suppose it had basic stealth. It would mass 27 (area) × 0.25 (TL10) = 6.75 tons, cost 6.75 × 0.3 = M$2.025, and at TL10, give a -6 penalty to active sensor scans to detect the ship.



Step 5 – Internal Spaces

Hull spaces are a measure of usable internal volume. An unstreamlined ship has spaces equal to hull volume divided by 500. A streamlined ship has spaces equal to hull volume divided by 625. If the ship has turrets, hull space is reduced by 1 space per small turret, 2 spaces per medium turret, and 20 spaces per large turret.

Turrets have their own internal spaces, however. Each small turret has one space per mount (i.e., 1 to 4 spaces). Each medium turret has 10 spaces per mount. Each large turret has 100 spaces.

EXAMPLE: *Tanstaafl* has a streamlined 200,000 cf hull; 200,000/625 = 320 spaces. Subtracting 2 for her two small turrets gives the ship 318 hull spaces. Two small quad turrets give the ship 8 turret spaces.

Step 6 – Hull Mass and Estimated Mass

Hull Mass: Add together *hull, turret, armor, force screen, and sensor masking mass,* as calculated in Steps 1-4. Record the total as the *Hull Mass.*

Estimated Mass: A working approximation of the ship's final mass. It is useful when deciding what components to place in the hull; it will be ignored after the ship is designed. Feel free to set whatever value seems correct. A good estimate is [(sum of hull and turret spaces) × 5] + Hull Mass, but the multiplier for hull and turret spaces can be varied up or down from 5 if much of the ship is likely to be devoted to systems with a higher or lower average mass (see *Step 7 – Systems,* below).

EXAMPLE: *Tanstaafl*'s Hull Mass is 25 tons (hull) + 2 tons (turrets) + 135 tons (armor) = 162 tons. Estimated Mass is [318 (hull spaces) + 8 (turret spaces)] × 5 tons + 162 tons (Hull Mass) = 1,792 tons.

Step 7 – Systems

A "system" is a set of components grouped together in modular fashion, like a bridge or a hyperdrive. Each system is rated for the *spaces* it takes up. Select systems whose total spaces are sufficient to fill the ship's hull spaces. Weapons, cargo, magazines, and sensors may also be placed in turret spaces. Keep a running total of remaining space; when it's gone, no more systems can be installed inside the hull.

Every ship should have bridge or cockpit, sensor, and power systems Others are more-or-less optional, although life support, drives, and quarters should be installed in nearly all vessels.

Where systems are available at different TLs, the TL is given after the name; e.g., "Super Thruster/10" means a TL10 super thruster. If no TL is given, assume the system is available at TL8+. Systems are also rated for other statistics:

Spc: The spaces the system takes up.

Mass: The system's mass in tons.

Cost: The system's price is millions (M$).

Pow.: The power consumption in megawatts (MW). If this entry is omitted, the system requires no power. If listed as "Neg.," it is negligible – as long as the ship has a working power plant, sufficient power is available.

In some cases, a system is partially designed by the ship's builder: select a size in spaces, which then determines mass, cost, and power. Some systems have additional statistics, like thrust, power output, and fuel consumption; see the individual description for details.

Bridge

All ships require at least one bridge component. Large ships often add a second one (frequently of smaller size) as backup.

Small Bridge: A rudimentary bridge system. Includes a small airlock (not necessarily in the bridge, but usually nearby), two control consoles, a computer, and communication and navigation systems, plus life support (air and heat) for two man-days (TL8), three man-days (TL9), or four man-days (TL10+).

Medium Bridge: A typical bridge system for an average freighter or small warship, designed with four bridge consoles and doubly redundant avionic and computer systems, plus life support for four man-days (TL8), six man-days (TL9), or eight man-days (TL10+).

Large Bridge: A more advanced bridge system. It has work space for ten crew (not all stations need be manned, though), better computers, and triply redundant avionics, plus life support for 10 man-days (TL8), 15 man-days (TL9), or 20 man-days (TL10+).

Finances

In most human societies, only the sleaziest seller expects to be paid in cash. Indeed, offering a cash payment will probably amaze a legitimate seller. Ships are just too expensive. The customary way to buy a ship is to finance it through a bank (or a moneylender). The bank pays the seller when the ship is delivered, the buyer gets the ship, and the buyer makes payments to the bank for a long, long time. A very wealthy seller, or a government, may "carry the note" itself.

All rates are negotiable, and depend on local economic conditions, the apparent wealth, honesty, and importance of the buyer, the need and greed of the seller, and the negotiating skill of the players themselves. Typically, a down payment of 10-20% is required (directly to the seller). If the ship is new, half this payment is made on order (nonrefundable, of course) and the rest on delivery.

Interest rates on the balance typically range from 8% to 16%. GMs inclined toward realism may work out actual amortization tables. A quick-and-dirty replacement: At 8% compound interest, pay 1% of the amount financed, every month, for 12 years. At 12%, pay 1.5% of the amount financed, every month, for 9 years. At 16%, pay 2% of the amount financed, every month, for 6 years. These payments include principal and interest; at the end of the period, the ship is paid off.

Example: A ship costs M$11. The down payment is M$1; the remaining M$10 is financed at 8%, with a payment of 1% ($100,000) every month. The ship will be paid off in 12 years.

The bank will require you to keep the ship insured, and may attempt to set other limits on your use of it, to protect their huge investment.

Buyers who come into money can always pay off the remaining principal amount (this is where an amortization table will come in really handy).

Buyers who default on their payments may have the ship repossessed. This can get interesting, especially if there isn't anywhere much to run. Defaulters are favorite targets for bounty hunters. Some moneylenders take more direct measures (hidden programs in the ship's computer, or even hidden bombs) to insure that they get paid on time.

Now . . . how will the proud owners earn the money to make those payments? That's what the campaign is all about . . .

Getting a Ship Without Buying It

In many campaigns, a prime goal of the PCs will be to get – or keep – their own starship.

They can be members of a military or other government service which assigns them a ship. Of course, the service will also assign them specific duties, unless they are special agents or assigned to detached duty.

They can be employed by a corporation that provides a ship. Again, however, most adventuring will be limited to that which serves the company's purposes (usually pursuit of profit).

If they join a pirate or other criminal gang, they may be supplied a vessel and allowed some measure of freedom. But they must give the organization a healthy cut of any profits, and will have to make themselves available for special services from time to time. The latter will usually be dangerous and always be illegal.

PCs can be free traders or work as crew on a ship owned by an NPC. Owners will rarely allow the PCs to take the ship off on profitless adventuring, but some might allow PCs a say in the ship's next destination or purpose.

The PCs could steal a ship. This might be one they've purchased but are unable to meet payments on, one they've leased, or one they've hijacked. This should be played out as an adventure. If FTL communications exist, those who steal a ship might find it difficult to get far enough away to evade capture. And some rental companies, as well as those to whom ship payments are due, take precautions. The engines (or life support!) may be rigged to shut down after a certain period of time. If the computer is sentient, it may become a dangerous opponent if the ship is stolen. It should require high skill to deactivate such precautionary measures.

Adventurers might be fortunate enough to find a ship that they can claim as salvage, either adrift in space or abandoned on a planet. This is also best played out as an adventure.

The PCs might accept a very dangerous job with a ship as the payment. This might be a freelance mission for an intelligence agency or the military, a private firm, or even a criminal organization. Or perhaps for that very rich NPC who needs a favor: "Rescue my daughter from the Death Planet and this ship is yours!"

Or the group can get along without a ship, by buying (or working) whatever passage they need. They might also put down a deposit and *lease* a ship. Some major starports might have rent-a-ship centers. They must return the ship in time or suffer penalties (financial at least; worse if they've kept the ship overtime without a valid reason).

Cockpit: A one-person cockpit designed for short-range spacecraft like fighters and shuttlecraft. It includes a control console, an ejection seat, a computer, and communication and navigation systems. Unlike a bridge, there is no room to stand up and walk around, nor is an airlock included: access is through a hinged canopy or a hatch. A cockpit includes life support (air and heat) for two man-days (TL8), three man-days (TL9), or four man-days (TL10+), plus 40 cubic feet of extra space usable for personal cargo or later upgrades to the system. Two-seater spacecraft should have two cockpit systems.

Bridge Table

System	Spc.	Mass	Cost	Pow.
Cockpit/8	0.5	2.5	1.1	neg.
Cockpit/9	0.5	1.4	0.66	neg.
Cockpit/10+	0.5	0.9	0.4*	neg.
Small Bridge/8	1	2.9	1	neg.
Small Bridge/9	1	1.8	0.56	neg.
Small Bridge/10+	1	1.3	0.3*	neg.
Medium Bridge/8	2	5.7	2.1	neg.
Medium Bridge/9	2	3.6	1.1	neg.
Medium Bridge/10+	2	2.6	0.6*	neg.
Large Bridge/8	4	9	3.2	neg.
Large Bridge/9	4	5.8	1.7	neg.
Large Bridge/10+	4	4.4	0.9*	neg.

* At TL10+, a bridge or cockpit computer may be upgraded to *sentient* status (see p. 66). This adds M$0.5 to cost for a cockpit or small bridge, M$1 for a medium bridge, and M$1.5 for a large bridge.

EXAMPLE: We select a medium bridge for *Tanstaafl;* 316 hull spaces remain.

Sensors

Sensors enable a ship to see where it is going and detect other spacecraft. Every mobile ship requires at least one sensor system for navigation. No ship requires more than one, but ships often install extras as backup in case of damage.

Basic Sensors: A set of active and passive electromagnetic sensors adequate for most vessels.

Enhanced Sensors: A set of more expensive, longer-ranged sensors suitable for warships or scout ships.

Advanced Sensors: A longer-ranged (but bulkier) version of enhanced sensors.

FTL Sensors: Available in some settings, usually only those with warp drive. FTL sensors send out an active pulse that can reach maximum range and return more or less instantly.

Sensor Options: Add-on systems include *planetary survey* sensors (allow use of Planetology skill from orbit) and *astronomical* sensors (to gather precise astronomical data). At the GM's option, *special sensors* for detecting FTL-related phenomena may exist (see p. 40).

Sensors are rated with a Scan value. This is the skill modifier when making sensor scans with active sensors/passive sensors/radscanner. See *Sensors* (p. 123).

Sensors Table

Component	Spc.	Mass	Cost	Pow.	Scan
Basic Sensors/8	1	12	4.6	0.5	32/31/–
Basic Sensors/9	1	12	3	0.75	33/32/28
Basic Sensors/10	1	11	2.4	1.5	35/34/30
Basic Sensors/11+	1	11	2.1	3.4	37/36/33
Enhanced Sensors/8	1	12	23	1	34/33/–
Enhanced Sensors/9	1	12	15	1.5	35/34/30
Enhanced Sensors/10	1	11	12	3	37/36/32
Enhanced Sensors/11+	1	11	11	6.8	39/38/35
Advanced Sensors/9	4	52	31	6.8	39/36/33
Advanced Sensors/10	4	39	28	15	41/38/36
Advanced Sensors/11+	4	39	28	30	43/40/39
If FTL Sensor	×2	×2	×20	×2	+32/0/0
Add-ons:					
Astronomical/8+	neg.	0.1	0.5	neg.	–/–/–
Planetary Survey/8	neg.	0.12	0.25	neg.	–/–/–
Planetary Survey/9+	neg.	0.06	0.12	neg.	–/–/–
Special Sensor/10+	neg.	0.1	1	neg.	–/–/–

EXAMPLE: We give *Tanstaafl* a Basic Sensors/10 system; 315 hull spaces remain.

Drive, FTL

FTL drives enable faster-than-light travel under the ship's own power. Three examples are provided in this system; for descriptions of how they work, see Chapter 2. Feel free to further customize their statistics in accordance with the guidelines in that chapter.

Hyperdrive: Lets the ship enter hyperspace. The number of drive spaces and the TL determine the drive's "hypershunt rating"; a ship's hypershunt rating must equal or exceed its mass to enter hyperspace. The GM should decide if faster travel is possible if hypershunt capacity exceeds the ship's mass; in some campaigns it is. Otherwise, hyperdrive speed is fixed and an overpowered drive is only useful when you need to carry an especially heavy cargo. Determine how many spaces of hyperdrive are needed by dividing Estimated Mass by 400 (TL10) or 800 (TL11+), rounding up. This should be sufficient for FTL travel at the base hyperdrive speed set by the GM (e.g., 0.2 pc/day). If extra speed is possible, the ship's actual speed will be (hypershunt capacity/loaded mass) times the base speed.

Jump Drive: Allows the ship to perform an FTL jump from one special "jump point" to another. The drive is rated for "jump capacity" based on its TL and the number of drive spaces installed. If the ship masses more than total jump capacity, it cannot jump. Determine how many spaces of jump drive are needed by dividing Estimated Mass by 1,000 (TL10) or 2,000 (TL11+), rounding up.

Warp Drive: Enables the ship to move at FTL speeds in normal space. The drive is rated for "warp thrust," determined by its TL and the number of spaces of warp drive installed. The speed of the ship under warp drive will be its (warp thrust/loaded mass) in parsecs per time period. The time period is normally "per day," but the GM can adjust warp speed to fit the campaign by changing the time increment to weeks, hours, minutes, or even seconds! To determine how many warp drive spaces are needed for a given speed, divide the ship's Estimated Mass by 80 (TL10) or 160 (TL11+) and multiply by the desired multiple of the base speed.

Warp drive is generally more effective than hyperdrive or jump drive. In a universe where multiple stardrives exist, the GM may wish to have warp drive systems appear two TLs later; i.e., at TL12-14 instead of TL10-12.

Jump drive and hyperdrive have a very high power consumption to jump or to "skip" into hyperspace (see below). This extra energy should be provided by installing energy banks (pp. 127-128).

STL Colony Ships

If FTL drives have not yet been discovered, man can still reach the stars in slower-than-light colony ships. These vessels are typically massive, designed to carry hundreds or thousands of colonists. Since it will be years before they reach their destination, STL colony ships are designed in one of three ways:

Sleeper ships. Colonists are frozen in suspended animation (p. 91). This is the most economical method, as more colonists and supplies can be contained in a ship. Such ships might be computer-controlled, with hundreds or thousands of freeze tubes, holds full of the equipment the colonists will need, and shuttlecraft to get them down to their new home. The down side is that suspended animation may not be feasible, and probably requires at least TL9 technology.

Generation ships. The original "colonists" will raise children and die aboard their ship as it slowly makes its way across the void. It will be a later generation that actually colonizes the new world. Hence the name "generation ship."

Genebank ships. The "colonists" are frozen sex cells, or even genetic codes stored only as information. Sophisticated biotechnology and robotics are required at the end of the voyage to convert them to a human population. If braintapes (p. 90) and forced-growth technology (p. 89) are available, the task is a little easier, since the ship doesn't need to raise and educate a batch of infants before settlement begins.

Any of these ships might reduce the *shipboard* time that elapses if it could travel near the speed of light (see p. 27). Doing this will usually require reactionless thrusters, though. Even so, trips would take many years.

Ethnic, religious, or cultural minorities might choose to leave the solar system as colonists. And some colonists will leave Earth involuntarily. Colony worlds might also be the Botany Bays of the future, where criminals or social undesirables are sent. Either way, the colonists on a generation ship can never go home.

An adventure could involve a party that discovers a lost generation ship drifting in space. Boarding it, they might encounter an entire self-contained world which the descendants of the original colonists believe to be their planet.

The invention of practical FTL stardrives makes slow colony ships obsolete. However, if many such missions were sent out, there may be hundreds of scattered human worlds in the galaxy – or the remains of those that failed.

At the GM's option, some FTL drives use reaction mass or other consumables (see *Drive, Maneuver,* p. 116, for examples). If so, assign a mass and cost for the consumable and a consumption in tons per space of drive. Consumption is per jump or skip (if jump drive or hyperdrive) or per time period (if warp drive).

Once you know how many spaces of FTL drive are being installed, consult the *FTL Drive Table.* Rating, power, mass, and cost are given *per space.* Rating is the drive's hypershunt capacity, jump capacity, or warp thrust rating, measured in tons.

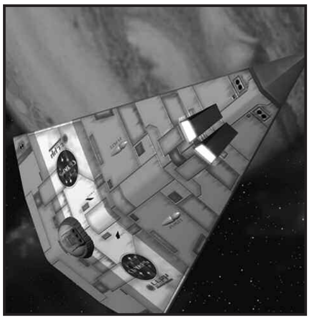
FTL Drive Table

System	Rating	Pow.	Mass	Cost
Hyperdrive/10	400	4*	4	0.16
Hyperdrive/11	800	8*	4	0.32
Hyperdrive/12+	800	8*	4	0.032
Jump Drive/10	1,000	**	4	0.14
Jump Drive/11	2,000	**	4	0.28
Jump Drive/12+	2,000	**	4	0.028
Warp Drive/10	80	8	4	0.04
Warp Drive/11	160	16	4	0.08
Warp Drive/12+	160	16	4	0.008

* To enter hyperspace also requires 360 MW of power *times the hypershunt rating* for *one second.*

** A jump requires 3,600 MW *times the jump capacity* for *one second.*

EXAMPLES: *Tanstaafl* uses a Hyperdrive/10 for FTL travel. We divide 1,792 (her estimated mass) by 400 (hypershunt rating of a TL10 hyperdrive) to find we need 4.48 spaces, which we round up to 5. A 5-space Hyperdrive/10 has a hypershunt capacity of 2,000 tons, masses 20 tons, requires 20 MW power, and costs M$0.8. In addition, to skip into hyperspace requires 360 MW × 2,000 (hypershunt capacity) = 720,000 MW! This power is only needed for one second, though. She has 310 hull spaces left.



Warp Cores

Warp drives require a single "warp core" system *in addition to* the drive itself. Install one warp core (provides no thrust) per warp drive system, regardless of size:

System	Spc.	Mass	Cost
Warp Core/10	0.5	2	0.02
Warp Core/11	0.25	1	0.02
Warp Core/12+	0.25	1	0.002

Drive, Maneuver

A maneuver drive propels the ship through normal space at slower-than-light speeds. A ship will need a maneuver drive if it has no FTL drive or if its FTL drive has significant limitations (such as not functioning close to a planet's gravity).

There are many different kinds of maneuver drives to choose from, but most campaigns will have only a few types in common use at any given TL. Maneuver drives fall into two broad categories, *reaction drives* and *reactionless drives,* each with many subtypes. See Chapter 2 for technological descriptions of each type.

If the ship needs a maneuver drive, select one from the options available in the campaign and refer to the appropriate table below to determine its statistics. Each is rated for its thrust (in tons) and (if a reaction drive) its reaction mass consumption.

A ship's acceleration in gravities is (thrust of maneuver drive/loaded mass). To determine how many spaces of maneuver drive are needed, divide the ship's Estimated Mass by the thrust shown on the table, multiply by the desired acceleration in Gs, and round off.

Auxiliary Craft

An auxiliary is any craft that is carried aboard a larger one. This can include escape pods, lifeboats, shuttles, space fighters, the captain's gig, and a variety of special-purpose craft, with or without FTL capability. Here is a sample design:

Lifeboat (TL10)

Carried to allow the mother ship to be abandoned in case of catastrophe. Most are not capable of interstellar travel – they will merely allow the passengers to survive until help arrives. A typical lifeboat is the Tri-Tachyon Short-Haul, capable of carrying 30 passengers for three days or so. It is a streamlined lifting body, capable of landing on most planets.

Hull: 5,000 cf SL Hull. 8 spaces. cDR 1.
Systems (Spaces): Small Bridge/10 (1), Basic Sensors/10 (1), Standard Thruster/10 (1), Fission Power/10 (1.5), Fission Core/10 (0.5), Passenger Seats/10 (2), Cargo Hold (1).
Statistics: EMass 22.3 tons. LMass 26.3 tons. Total Cost $M3.412. Scan 35/34/30. cHP 30. Hull Size Modifier +6. cSM -4.
Performance: sAccel 0.3 G. Air speed 547 mph.

Consumables

Fuel and Reaction Mass

Antimatter: Fuel for an antimatter power plant (lasts 2.5 years at TL11, 5 years at TL12+), per MW of output: $1,000 at TL11, $500 at TL12, $250 at TL13+. Price per ton: $100 billion at TL9, $10 billion at TL10, $1 billion at TL11, $500 million at TL12, $250 million at TL13+.

Argon: $170/ton.

Cadmium: $24,000/ton.

Fissionables: A two-year fuel supply of fissionables (e.g., uranium rods) for a fission reactor, per MW of output: $80,000 at TL8, $8,000 at TL9+.

Hydrogen: $350/ton.

Hydrogen/Oxygen Fuel: $95/ton.

Nuclear Pellets: $25,000/ton at TL8, $2,500/ton at TL9, $500/ton at TL10+.

Water: $20/ton (may be free on some planets, more expensive on others).

Food

For ships without total life support, 2 lbs., 0.04 cf, and $6 per man-day. A full cargo space of supplies (12,500 man-days) is 12.5 tons and $75,000.

Reaction Drives Table

System	Thrust	Mass	Cost	Pow.	Consumption
Chemical Fuel					
Chemical Rocket/8	330	4	0.2	0	2,300HO
Fission Drive					
Fission Drive/8	27	4	0.8	0	94H
Ion Drives					
Slow Ion Drive/8	0.004	4	0.4	0.64	0.0039A
Fast Ion Drive/8	0.02	4	0.8	26	0.0023C
Fast Ion Drive/9	0.02	4	0.4	26	0.0023C
Nuclear Pulse Drives					
Nuclear Pulse/8	100	4	0.8	0	35N
Nuclear Pulse/9	100	4	0.4	0	35N
Fusion Drives					
Slow Fusion/9	0.08	4	0.8	0	0.024H
Slow Fusion/10	0.4	4	0.8	0	0.12H
Fast Fusion/10	13	4	0.8	0	22W
Optimized Fusion/9	0.0013	4	0.8	0	0.000003H
Optimized Fusion/10	0.013	4	0.8	0	0.00003H
Bussard Ramjet/9	0.000013	4	1.6	0	none
Bussard Ramjet/10	0.00013	4	1.6	0	none
Antimatter Drives					
Slow AM Thermal/9	16	4	0.8	0	2.7W*
Fast AM Thermal/9	200	4	0.8	0	85W**
AM Pion Drive/9	0.004	4	0.8	0	0.000000034H***
AM Pion Drive/10	0.02	4	0.8	0	0.00000017H***
Light Sails†					
Light Sail/8	0.037	50	50	0	0
Light Sail/9	0.63	50	50	0	0
Superscience Drives					
Fusion Rocket/9	80	4	0.8	0	14W
Fusion Rocket/10	160	4	0.8	0	27W
Antimatter Rocket/10	200	4	0.8	0	17W**
Super Bussard Ramjet/10	6.5	4	3.2	0	none
Total-conversion Drive/??	††	††	††	††	††

Thrust, mass, cost, power, and consumption (in tons per hour) are *per space* of drive. Half-space drives are possible.

Notes:

* Plus 0.00000035 tons antimatter per space per hour.

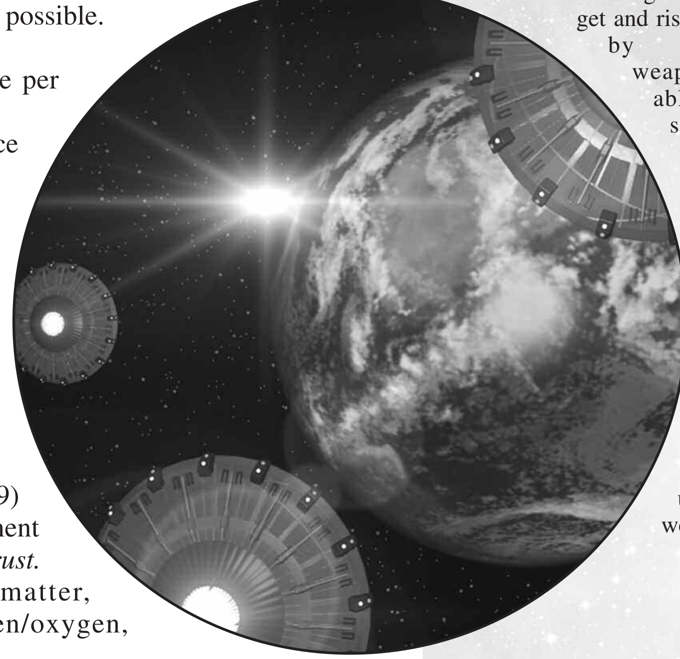
** Plus 0.000000034 tons antimatter per space per hour.

*** Plus an equal tonnage of antimatter.

† A light sail may not be larger than two spaces at TL8 or 1.5 spaces at TL9+. Thrust assumes a 1 AU distance from a star with the luminosity of the sun. Divide thrust by the square of the distance (e.g., at 3 AU, thrust is 1/9 that listed) and multiply it by the luminosity ratio if a different star. Sail area is 15 square miles/space at TL8, 240 square miles/space at TL9+.

†† Treat as a reactionless thruster (pp. 28-29) of the same TL, but replace the power requirement with a fuel requirement of 0.00012H *per ton of thrust.*

Abbreviations: A = argon, AM = antimatter, C = cadmium, H = hydrogen, HO = hydrogen/oxygen, N = nuclear pellets, W = water.



Missile Warheads

Missiles can be given one of the following warheads:

Kinetic (TL8): The basic space-missile warhead, this is simply a dense rod that smashes into the target. A kinetic missile relies on the high relative speed gained from its own motor or from the launching ship's maneuvering. If reactionless thrusters are not available, kinetic weapons get *most* of their speed from the launching ship's maneuvering; their own drives are used mainly for steering. Use the base cost on p. 127.

Nuclear (TL8): A fission, fusion, or antimatter explosive (the latter are not strictly nuclear, but possess equivalent effects). Nuclear weapons are usually fused for proximity bursts. Typical yields are in the 10-kiloton range (light warhead) or 1-megaton range (heavy warhead). Most nuclear weapons give a "one hit, one kill" capability to even small ships, unless very heavy armor is available. At TL8, add M$0.042 per light missile or M$0.064 per heavy missile. Halve this extra cost at TL9-14; halve it again at TL15+.

X-ray Laser (TL9): These warheads detonate a small nuclear weapon to energize an X-ray laser beam – in fact, this is the only way that such weapons can be built in the foreseeable future. The warhead consists of a nuclear bomb, an array of beam-generating laser rods, and a targeting system. Instead of physically intercepting the target, the missile stands off at a distance of several hundred miles, orients itself on the target, and detonates. The nuclear blast destroys the missile but also pumps energy into the laser array; as the rods vaporize, they produce powerful X-ray laser beams directed at the target. X-ray laser warheads thus free missiles from having to close on their target and risk being shot down by point-defense weapons. Only available for heavy missiles; add M$0.11 at TL9, M$0.064 at TL10, or M$0.041 at TL11+.

Nuclear and X-ray laser warheads may be very hard to find (LC -1) if law, treaty, or doctrine strictly controls the availability or use of nuclear weapons in space.

Reactionless and Grav Drives Table

System	Thrust	Mass	Cost	Pow.
Standard Thruster/9	4	4	0.2	4
Super Thruster/9	10	4	1	10
Standard Thruster/10	8	4	0.16	8
Super Thruster/10	20	4	0.8	20
Standard Thruster/11+	80	4	0.16	8
Super Thruster/11+	200	4	0.8	20
Mega Thruster/13+	4,000	4	32	400
Grav Drive/12	4,000	4	0.8	8
Grav Drive/13+	8,000	4	0.16	16

Thrust, mass, cost, and power are *per space* of drive.

EXAMPLE: Looking at the TL10 maneuver drives available in the campaign, we decide that TL10 super thrusters suit *Tanstaafl*'s needs. Thrust is 20 tons per space and we want an acceleration of 1 G, so drive spaces required are [1,792 (Estimated Mass)/20 (thrust)] × 1 (Gs) = 89.6, rounded to 90. The Super Thruster/10 therefore masses 90 × 4 = 360 tons, costs 90 × 0.8 = M$72, uses 90 × 20 = 1,800 MW, and develops 90 × 20 = 1,800 tons of thrust. She has 220 hull spaces left.

Power Cores

Fission drives must also possess a fission power core. Slow and fast fusion drives and Bussard ramjets (but *not* superscience drives) must also possess a fusion power core. Antimatter pion drives built at TL9-12 must also possess an antimatter power core. These power cores must be of the same TL as the drive. See *Power Cores* (p. 121) for statistics.

Reaction Mass/Fuel Tanks

A ship that uses a reaction drive requires tanks. Each one-space tank system is an ultra-light, self-sealing tank (or shielded storage compartment) with appropriate feed or pump mechanisms.

To determine how many hours a particular reaction drive will operate on a full tank, divide the tons of reaction mass that one space of tank can carry (see below) by the total consumption of the drive (see *Reaction Drive Table,* p. 117). To increase the drive's endurance, add additional tankage.

Antimatter Bays: Antimatter requires special storage arrangements. These are functionally identical to fuel tanks, but substantially heavier. Antimatter bunkers are rated for the number of tons of antimatter they can contain per space. Antimatter storage capability is speculative; the standard antimatter bay assumes that antimatter remains very difficult to store; the high-capacity bay assumes that a more efficient system is found (perhaps a gravitic system).

Mass of Reaction Mass/Fuel

Argon . . . . 7.7 tons/space
Cadmium . . . . 110 tons/space
Hydrogen . . . . 1 ton/space
Hydrogen/Oxygen fuel . . . . 3.5 tons/space
Nuclear pellets . . . . 12 tons/space
Water . . . . 15 tons/space
Antimatter (TL9) . . . . 0.0001* tons/space
Antimatter (TL10) . . . . 0.00025* tons/space
Antimatter (TL11) . . . . 0.0005* tons/space
Antimatter (TL12) . . . . 0.001* tons/space
Antimatter (TL13+) . . . . 0.002* tons/space

* A "high-capacity" antimatter bay stores ten times the tonnage of antimatter per space, but is more expensive (see below). The TL at which high-capacity antimatter bays appear is up to the GM.

Airlocks

An *airlock* is a room with a heavy door at either end. One door leads to space; the other leads to the ship. An airlock allows people to enter or leave the ship in space without decompressing the whole ship. Airlocks are designed so that both doors can't be opened at once. Typically, they have the same PD as the ship's hull and half the DR. Controls are automatic, and can be operated either at the lock or from the bridge; there is also a manual lever for emergencies.

Standard airlock doors are designed so that a ship can mate airlocks directly with a station, or so that an auxiliary can mate directly with a larger ship. Docking requires a Piloting roll by the pilot of any craft that is actively maneuvering. The larger craft will *usually* hold its course as the smaller one docks (only the pilot of the smaller craft rolls), but if both vessels are maneuvering, both pilots must roll.

Airlocks may also be located between compartments of a ship, for extra safety or to separate compartments with different atmospheres; see *Pressure Doors* (p. 119).

A ship is assumed to have one airlock per bridge installed, but may acquire more by installing entry modules (p. 128).

Passage Tubes

A *passage tube* is a flexible tube that connects the airlocks of two ships in space. It holds pressure, allowing the occupants to travel between the ships without vacc suits. Usually 100 feet long and about 8 feet in diameter; hooks to standard fittings around exterior airlocks. Takes about an hour to unstow and rig in free fall (30 minutes with two or more working), which requires a Mechanic (Starships) roll.

EXAMPLE: What if *Tanstaafl* had a three-space nuclear pulse drive instead of her reactionless thrusters? Three nuclear pulse drives have a combined fuel consumption of 105 tons of pellets per hour. A tank holds 12 tons of pellets per space; 12 divided by 105 gives us 0.11 hours per space. If we wanted *Tanstaafl* to thrust for a day, we'd need 24 hours/0.11 hours = 218 spaces of tankage, filling most of the hull!

Reaction Mass/Fuel Tank Table

System	Mass	Cost
Tank	0.025	0.17
Antimatter Bay	25	0.5
Hi-Cap. Antimatter Bay	25	10

Mass and cost are *per space* of *empty* tank or bay. Half-spaces are possible, storing half as much reaction mass or fuel.

Gravity Generation

Space is a zero-g environment, but humans are physically and mentally accustomed to living in a gravity field. A ship or station designed for lengthy occupation by humans (or other races with similar needs) should be given some form of gravity.

Spin Gravity: This system simulates gravity by mechanically spinning a portion of the ship. An outer spinning hull may surround a stationary inner hull, or spinning cages may be installed. A spin-gravity section should have a spin radius of at least 100 yards per G. To contain this, a ship needs a volume of at least [8 × spin radius (in yards) cubed] cf if unstreamlined, or [1,000 × spin radius (in yards) cubed] cf if streamlined. Going part-way to the center of rotation will reduce gravity proportionally; living quarters will usually be located where gravity is closest to the home gravity of the occupants.

Spin gravity does not behave quite like real gravity – if you move in the direction of the spin, gravity increases; if you move in the reverse direction, gravity drops. Individuals unused to spin gravity are at -2 DX. Double this when jumping, throwing, or using low-speed missile weapons like bows; halve it in an extremely large spin-gravity habitat (10 times the above radius). Each week, a HT roll should be made to adapt to this environment and eliminate the penalties. Those with the G-Experience advantage (p. CI25) halve all penalties; those with the Motion Sickness disadvantage (p. CI82) double all penalties and get no HT roll to adapt.

Artificial Gravity: This system uses superscience to generate gravity. The field in the ship can be adjusted (via controls in quarters, bridge, or engine room) from 0 to 3 Gs in all or in part of the ship. One artificial gravity component is needed per 100,000 cf (at TL10) or 500,000 cf (at TL11+) of hull volume.

Gravity Systems Table

System	Spc.	Mass	Cost	Pow.
Spin Gravity	1*	2*	0.1*	0.1*
Artificial Gravity/10	1**	30**	0.1**	†
Artificial Gravity/11+	1***	18***	0.1***	†

* Per 20 yards (or fraction) of spin-section radius. Note that the ship will not be able to turn without turning off spin gravity first: the spinning segment acts as a gyroscope. Counter-rotating segments can eliminate this effect, but require extra moving parts and heavy hull reinforcement: multiply listed mass by 2, cost by 5. Space and power are unchanged.

** Per 100,000 cf or fraction of hull volume.

*** Per 500,000 cf or fraction of hull volume.

† Requires 0.037 MW *per 1,000 cf of hull volume.*

EXAMPLE: *Tanstaafl* will use an Artificial Gravity/10 system. As the ship is 200,000 cf in size, the system requires 2 spaces, masses 60 tons, costs M$0.2, and uses 7.4 MW. She has 218 spaces left.

Pressure Doors

Spaceships have internal pressure doors so that a single hole won't depressurize the whole ship. Those with standard compartmentalization (p. 109) have pressure doors only at strategic points (1 in 6 chance if unknown), those with heavy compartmentalization have significantly more (3 in 6), and those with total compartmentalization replace *all* internal doors with pressure doors.

Standard pressure doors are actually a set of *two* heavy hatches with a small compartment between them, forming an airlock (see p. 118); pumping is provided by the life-support system. Single sliding doors are used in some settings; these are compact and easier to open against a pressure differential, but they only work while the ship has power (there will be a manual lock – "dog" – and lever in case of power loss, but access is often difficult; see below).

If the pressure on both sides is the same, paired hatches take one second per hatch to negotiate. Sliding doors take only a second while the power is on, but it takes an extra 5 seconds to undog and open a sliding door manually, or to close and dog an open one. It also takes 5 seconds to undog it partially and listen for escaping air.

All pressure doors have indicators that show the air pressure on the other side, but these have been known to malfunction. A sign of a true spacer is the cautious way he opens pressure doors at all times. If there is air on one side of a pressure door and vacuum on the other, a manual override must be tripped before it can be opened.

In the case of double hatches, opening the first hatch from the vacuum side or second hatch from the pressurized side is easy; the pressure difference helps push it open. Roll DX-2 (or Free Fall-3 in micro- or zero gravity) to avoid being sucked through (or *blown out* from the vacuum side). With one hatch open, the airlock limits air loss to the small volume between hatches (unless it has been sabotaged!); this air will escape in 1 second. Opening the other hatch against the pressure difference is difficult; roll ST-6, but two people can combine ST for the attempt.

In the case of sliding doors, the constant air flow makes things more difficult. Roll as above to avoid being sucked out, but at DX-4 or Free Fall-6. If this roll is made, fully opening the door takes 1d+5 seconds. Others nearby may also have to roll. Unless overridden, a failsafe mechanism will automatically close the door if air is rushing through it. This takes 1 second, and anyone in the doorway must roll DX-4 or Free Fall-6 to avoid being caught.

Continued on next page . . .

Pressure Doors (Continued)

If a pressure door fails (*both* hatches in an airlock), the compartment starts to depressurize. This means no more than 10% of the ship if compartmentalization is total, no more than 20% if heavy, but up to 50% of the ship if standard. It takes only about 20 seconds for a large compartment to empty to vacuum.

If any kind of pressure door is stuck open, a ST+2 roll and 1d+5 seconds are required to push it closed and dog it tight. Two people may combine ST for this. If the door won't close, fleeing to a further compartment will make the job easier, but the door leading to another compartment will probably have to be manually opened first! Air flows less quickly out of each compartment in series, giving a +2 to any door-closing attempt for each extra compartment in the way. Closing any door from the vacuum side is suicide unless you have your own air supply!

Contragravity

This superscience technology allows the ship to "screen" itself from some or all of the gravitational pull of a planet or other body. In practice, this means its weight is reduced to zero for takeoff or landing; thus, only a small amount of thrust is needed. Note that since *mass* is unaffected, the ship's space performance will be unchanged.

A ship with sufficient CG lift can hover in midair, or float gently up or down into orbit. To do this, it needs enough CG lift to neutralize its *weight* under the local gravity field. A half-space light contragravity (LCG) system can neutralize up to 1,000 tons. A one-space heavy contragravity (HCG) system can neutralize up to 5,000 tons. In both cases, this is weight under local gravity – a ship on a 2 G world will need twice as much CG!

If the GM wishes to make contragravity less effective, simply reduce the weight it can neutralize.

Contragravity Table

System	Spc.	Mass	Cost	Pow.
Light Contragravity/12	0.5	1	0.05	2
Heavy Contragravity/12	1	5	0.25	10
Light Contragravity/13+	0.5	0.5	0.01	2
Heavy Contragravity/13+	1	2.5	0.05	10

Tractor and Pressor Beams

These devices can generate a gravity field at a distance, pulling objects toward or pushing them away from the ship.

Tractor Beam (TL11): Each tractor beam system generates a ST 10,000 attractive force. Multiple systems can work together.

Pressor Beam (TL12): Similar to a tractor beam, but generates a ST 10,000 repulsive force.

Combination Beam (TL12): Usable as either a tractor beam or a pressor beam, but not as both simultaneously.

Tractor and Pressor Beams Table

Type	Spc.	Mass	Cost	Pow.
Tractor Beam	1	11	0.025	10
Pressor Beam	1	11	0.025	10
Combination Beam	1	11	0.028	10

Power Plant

Any ship needs a power source. Power is measured in *megawatts* (MW). As a comparison, the Niagara Falls power plant produces some 500 MW.

Add up the power requirements (in MW) of all systems installed so far. If the ship has both an FTL drive and a maneuver drive, use whichever power requirement is *higher.* That is how much power is needed to operate the ship; other requirements are typically trivial by comparison. An exception is any ship that will carry a lot of passengers (like a cruise ship or colony ship); large quantities of habitat modules (pp. 124-125), life support (p. 124), and passenger quarters (p. 123) use significant power. When designing a ship like that, install *all* other systems first, then come back here at the end of Step 7 and install a suitable power plant.

There is no need to provide power for hyperskips or jumps, or for beam or railgun weapons – these get their energy from energy banks (p. 26). However, the output of the power plant will determine how rapidly an energy bank can be restored.

Select a power plant from the table below (see *Power Plants,* p. 26, for descriptions) and install one with sufficient output to provide the required power.

Power Plant Table

System	Output	Mass	Cost	End.
Fission Power/8	2	4	0.8	2
Fission Power/9	8	4	0.32	2
Fission Power/10	8	4	0.16	2
Fusion Power/9	8	4	1.6	200
Fusion Power/10	40	4	0.4	200
Fusion Power/11	40	4	0.2	200
Antimatter Power/11	80	4	0.16	2.5
Antimatter Power/12	160	4	0.16	5
Antimatter Power/13	160	4	0.16	5
Total Conversion/14	400	4	0.24	infinite
Cosmic/16	800	4	0.016	infinite

Output, mass, and cost are *per space* of power plant. Power plants may also be taken in half-space increments with half the listed output, mass, and cost.

End.: The operating endurance of the plant, in years. Fission and antimatter plants can be refueled; fusion plants *cannot* be refueled.

EXAMPLE: *Tanstaafl*'s sensors use 1.5 MW, her maneuver drive needs 1,800 MW, her FTL drive requires 20 MW, and her artificial gravity uses 7.4 MW. We won't use the FTL drive and maneuver drive simultaneously, so the effective power requirement is 1,808.9 MW. We choose a 45.5-space Fusion Power/10 system, providing 1,820 MW, giving us 11.1 MW extra capacity. It masses 182 tons and costs M$18.2. *Tanstaafl* has 172.5 hull spaces left.

Power Core Systems

For each TL8-12 power plant installed (*regardless* of size), also install *one* "power core" system of the same type. It contains vital engineering room control space and, at TL8-10, core life support machinery. Note that TL13+ power plants do not require power cores.

Power Core Table

System	Spc.	Mass	Cost	Note
Fission Core/8	1	4	0.61	For Fission Power/8
Fission Core/9	0.5	1.3	0.09	For Fission Power/
Fission Core/10	0.5	0.9	0.03	For Fission Power/10
Fusion Core/9	2.5	11	5	For Fusion Power/9
Fusion Core/10	0.5	1.4	0.31	For Fusion Power/10
Fusion Core/11	0.5	1	0.15	For Fusion Power/11
Antimatter Core/9	2.5	10.4	2.01	For Antimatter Power/9
Antimatter Core/10	.05	2.2	0.41	For Antimatter Power/10
Antimatter Core/11	0.5	2	0.28	For Antimatter Power/11
Antimatter Core/12	0.5	0.5	0.14	For Antimatter Power/12

EXAMPLE: *Tanstaafl* has a Fusion Power/10 power plant, so it needs a single Fusion Core/10 system. *Tanstaafl* has 172 hull spaces left.

Solar Panels

Solar panels are an alternative to reactors, producing power from starlight. Solar panels are assumed to produce their rated power in vacuum at light levels equal to those 1 AU from Sol. This varies with stellar luminosity and with the square of the distance to the star (e.g., doubling the distance cuts output by a factor of 4), so solar power is almost useless to ships at the edge of a system with a Sol-sized star. Around another star, multiply output by the relative luminosity.

System	Mass	Cost	Output	Area
Solar Panel/8	12	1.44	1.9	48 ksf
Solar Panel/9	12	1.8	4.8	60 ksf
Solar Panel/10	12	2.4	6.4	80 ksf
Solar Panel/11	12	2.88	7.7	96 ksf
Solar Panel/12+	12	4	9.6	120 ksf

Bridge Systems

The heart of a bridge is its crew stations. Each station is a seat facing a console that consists of a computer terminal and various multifunctional displays. In most ships, these can be reconfigured to enable any station to perform any bridge crew function – pilot, navigator, communications, gunner, sensors, etc. – although the GM can rule that this is not possible in a particular ship design. A bridge also includes the following systems (singular in a cockpit or small bridge, doubled in a medium bridge, tripled in a large bridge):

Computer: A hardened mainframe computer, Complexity TL-4. The bridge crew stations have terminals that can access this computer; handheld models carried by crew and desktop models installed in staterooms can also interface with the computer if the proper passwords are known. See *Computers* (p. 64) for detailed rules.

Navigation Electronics: Precision navigation and inertial navigation systems that allow accurate normal-space navigation. Special systems for FTL navigation (if required) are subsumed in any FTL drive.

Flight Recorder: A tough "black box" flight recorder (like those on modern aircraft) that records voice transmissions and instrument readouts. It is designed to survive a crash.

Advanced Radar/Laser Detector: This sensor can detect and locate any operating radar or ladar sensor (such as an AESA) within twice that sensor's range. For this reason, a ship that wants to avoid detection will turn off its active sensors and rely solely on its passive sensor arrays (PESA).

Fire-suppression System: Automatic fire and explosion extinguishers that use nontoxic inert gas to smother fires within microseconds.

Ejection Seats: Cockpit systems (only) include an ejection seat. If the ship is likely to crash, the seat can blast the occupant out in less than a second – depressurizing the ship in the process – and (in atmosphere) deploy a parachute. A successful Parachuting skill roll is needed to land without injury.

Communications

Shipboard communications systems work much like the communicators described in Chapter 4, but have greater range and flexibility. Each bridge or cockpit system has the following equipment, installed one per cockpit or small bridge, two per medium bridge, three per large bridge:

Radio Communicator: A basic multi-frequency broadcast communicator capable of sending and receiving radio signals over great distances. Transmissions may be scrambled (encrypted), but will be received by all radios within range.

Microwave Communicator: A tight-beam directional communicator. The signal can only be picked up by microwave receivers within a 20° cone around the beam.

Laser Communicator: Encodes the signal onto a modulated laser beam; only another lasercom can receive its signal, and only if directly in the path of the beam. This makes transmissions secure, but the laser communicator can only be used to talk to a receiver whose precise location is known – no broad-band transmissions are possible. Clouds will block a laser beam, though, so ship-to-surface communication can be difficult.

IFF Transponder: This sends out an automatic identification code (via communicator). Civilian systems are factory-sealed – they can be switched off and on, but the signal can't be altered; military systems can be reprogrammed to give false identities. Of course, a ship that claims to be a 50,000 cf scout but appears on radar as a 50,000,000 cf cruiser would attract suspicion . . . but the cruiser could get away with claiming to be a bulk transport.

Communication Range Table

TL	Radio	Laser	Microwave
8	1 mil.	0.2 mil.	1 mil.
9	10 mil.	2 mil.	10 mil.
10+	50 mil.	10 mil.	50 mil.

Communicator ranges are in *millions* of miles.

FTL Radio

Availability and stats of this item are *entirely* up to the GM, depending on what has been decided for communications in the campaign (see p. 35). An FTL radio might be built into every bridge as a standard system (no extra cost) . . . or be the size of a city. If FTL radio is available, then small, self-powered *distress beacons* will also be available. GMs who want FTL radio but who do not want to make up a new system can assume that a ship's stardrive contains the "booster circuits" necessary to convert a normal signal into an FTL signal.

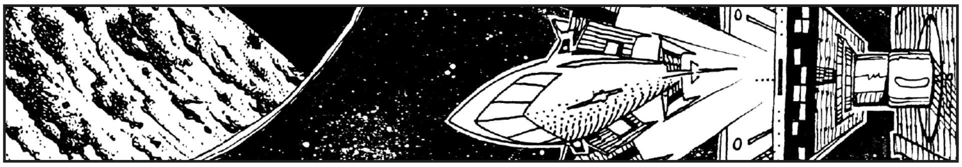
Mass, cost, output, and area are *per space* of solar panels. Panels are assumed to be retractable; it takes about 10 seconds to deploy a panel or retract it. Panels are very fragile, and would be destroyed almost instantly during combat. They will not survive acceleration greater than 0.1 G. Space dust and debris will also damage the panels if the ship is moving very rapidly. Thus, panels are rarely deployed under any of these conditions.

Crew and Passengers

Typical crew requirements are given below, but note that these are *averages;* actual requirements can vary a great deal. Military ships will have larger crews, to allow for multiple shifts and to replace losses in combat. Transports often run with a bare minimum of crew to save money. A civilian yacht might not have anyone with these titles, but somebody needs to do the job. Ships with minimal crews call for talented crewmen, since several jobs are doubled up.

In general, crew should have a skill level of at least 12 in the skill(s) appropriate to their positions. Good computers can make up for a lot, though (especially at high TLs); a luxury yacht may be capable of interstellar travel even though nobody aboard knows anything about piloting, astrogation, or the engine room!

If the GM feels a ship is under-crewed, he should assess penalties to appropriate skill rolls, especially in stress situations when one spacer has to be in three places at once.



Command: At least one captain, plus one command officer per 5-10 non-command crew. The officer who supervises engineers will usually be an engineer himself; the same goes for other specialties. On small ships, the commander may double as the pilot or gunner.

Engineering: Take the square root of the sum of the tonnage of the power plant and drives, divide by 60 and round down.

Gunners: On average, one for each turret. Hull weapons may be grouped into batteries of identical weapons which can be controlled by a single gunner; a gunner can also divide his time between several different batteries (using only one per turn). A weapon cannot be fired in combat unless it has an operator. However, this may be a gunner, a non-gunner operating at default, or a computer.

Life Support: One full-time life-support tech if there are over 20 people aboard; one more for every full 100 people added. On small ships, engineering deals with life support.

Maintenance & Damage Control: One full-time mechanic (who should have Vacc Suit skill) if there are over 10 people aboard; one more for every full 50 people or 200,000 cf of ship, whichever is *more.*

Medical Officer: One full-time medic if there are more than 20 people aboard (or 10 for over a month), plus another medic or assistant per additional 50 people aboard. A ship should have at least one medic per surgery (p. 129). Automeds (p. 96) can replace medics.

Passenger Service: A passenger ship will have crew whose job is to look after the passengers. As a rule, there will be at least one such crewman for every full 50 cargo or steerage passengers, 20 standard passengers, 10 first-class passengers, or 2 luxury passengers.

Pilot: At least one, unless the ship is being trusted to a piloting computer. All but the smallest military ships will have a specialist astrogator. On very small ships, the pilot usually runs the sensors.

Service: One full-time service person – cook, yeoman, morale officer, etc. – if there are over 20 people aboard; one more for every 50 people added.

Specialists: Large ships, especially military vessels, will have full-time officers and specialists for communications, sensors, etc. There may also be landing teams, security staff, science crew, cargo specialists, etc.

Optional Crew: Entertainers of various sorts will be found on luxury liners – sometimes more entertainers than passengers. They may or may not have any actual "crew" skills. *Marines* and *fighter pilots* aren't really ship crew at all. Marines usually get steerage accommodations; fighter jocks usually have the equivalent of standard quarters.

Multiple Shifts: Most military and some civilian ships carry three times as many crew so that they can operate around the clock (in three 8-hour shifts).

Backup Crew: Extra crew members may be carried in freeze tubes, to be awakened in an emergency. This is especially common on military vessels.

Quarters

Every manned ship or station designed for long-term operation requires quarters of some sort. Ships intended to operate for less than a day, like fighters, lifeboats, or shuttles, can omit quarters – the crew just remain seated. Install enough quarters for the estimated crew and passengers. Standard passengers and most crew often endure double-occupancy; first-class passengers and officers should have rooms of their own.

Quarters are not strictly necessary for long voyages – if there is sufficient life-support capacity, cargo space can be used and passengers carried as "steerage" in the hold. This is uncomfortable (and somewhat unsanitary), and is usually resorted to only in emergencies or when shipping refugees, slaves, or animals.

Bunk Room: A room with 5 bunk beds (each with a small locker), intercom, controls for light and temperature, and shared sanitary facilities.

Cabin: A furnished room capable of housing one or two people. Contains bed, chairs, desk, closet, and a toilet, sink, and shower. There is also an intercom and controls for light and temperature.

Luxury Cabin: A furnished room with fittings superior to those of an ordinary cabin. Can house one or two people.

Freeze Tubes: Available at TL9+. Each space contains 10 suspended-animation capsules, each capable of holding one person. See *Suspended Animation* (p. 91) for rules.

Passenger Seating: Ships designed for short-term operations, like shuttlecraft, may install passenger seating instead of quarters. Each space devoted to passenger seating provides 15 seats. The system's built-in air supply also provides 15 man-days of life support at TL8, 22.5 man-days at TL9, or 30 man-days at TL10+.

Quarters Table

System	Spc.	Mass	Cost	Pow.
Bunk Room	1	0.5	0.0005	neg.
Cabin	1	1	0.003	neg.
Luxury Cabin	2	2	0.01	neg.
Freeze Tube/9*	1	5	0.55	neg.
Passenger Seats/8	1	1.4	0.009	0.0075
Passenger Seats/9	1	1.4	0.012	0.0075
Passenger Seats/10	1	1.4	0.016	0.0075

* Also available in half-space versions: 5 tubes, half mass and cost.

EXAMPLE: We decide *Tanstaafl*'s the crew will consist of a captain, a pilot, an operations officer, two gunners (one per turret), and two engineers. We install 7 cabins for the crew (if we decide we need more crew, they can double up) and 8 for passengers. We also add a half-space of freeze tubes (5 tubes) just in case we want to carry extra passengers in cold sleep. This leaves 156.5 spaces.

Sensors

Each sensor system includes an array of two or three standard sensor types: AESA, PESA, and (at TL9+) a radscanner. In some campaigns, these sensors may have different limitations or capabilities. As a default, here is what they do:

Active Electromagnetic Sensor Array (AESA): A multi-mode sensor that works as a radar, imaging radar, and ladar. In radar mode, it detects objects within its range and shows them as "blips" with inexact size and shape. In imaging radar or ladar mode, it has only half its range but better resolution: objects appear as actual silhouettes, permitting identification of known ships and exact determination of size. In any mode, it will also function as a rangefinder, feeding targeting data to weapons consoles.

Passive Electromagnetic Sensor Array (PESA): An array of infrared thermal imaging and low-light telescopic sensors. A PESA gives the bridge crew a visual picture of objects within its sensor range.

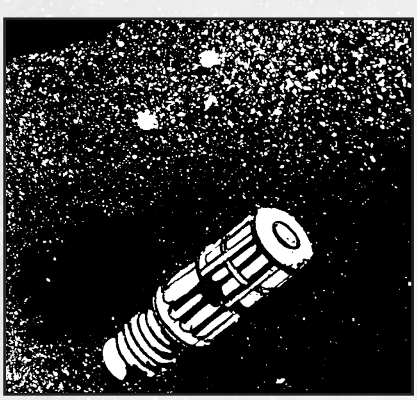
Radscanner: This is a multifunctional energy scanner that can detect and scan for various types of radiation, such as radio, neutrino, or radar emissions. It can detect the neutrinos emitted by power plants – this is a good way to tell a scout ship from a dreadnought . . . It is capable of detecting radiation from all directions simultaneously.

Detection Range

To determine the range at which an object can be easily detected with PESA or AESA, look up the sum (Scan + object's Size Modifier + 10) in the *Size* column of the *Size and Speed/Range Table* on p. B201; the number in the adjacent *Linear Measurement* column is the range.

Sensor Masking: When using AESA to look for an object with stealth, subtract (TL-4) for partial stealth or (TL-4) × 2 for radical stealth from the total before calculating the detection range.

When using PESA to look for an object with emission cloaking, subtract (TL-4) for partial cloaking or (TL-4) × 2 for radical cloaking from the total before calculating the detection range.



Using Tractor Beams

These beams use gravity control to exert an attractive force over a distance, pulling the target to the beam generator or vice versa. They are normally used for cargo handling, small-craft recovery, and minesweeping; ingenious spacers find other uses for them. Use of even one tractor beam gives a +1 bonus to Piloting skill for a micro- or zero-gravity rendezvous, but a critical failure on any tractor beam use tears the beam generator out of the mounting.

Tractor beams have ST 10,000 per module; multiple modules can combine their strength. Each can exert 100 tons of thrust on an object in space, or lift 100 tons in a 1-G gravity field. They are not long-ranged: effective strength is halved every 100 yards. Double this distance at each TL above 11. Tractor-beam operation is a P/E Professional skill, defaulting to Gunner (Beams)-2 or DX-4. In space combat, a tractor beam can be used as a beam weapon at point-blank range; it has sAcc -7. A hit will immobilize a vehicle with equal or less thrust (it cannot maneuver, and may be docked with against its will).

Pressor Beams (TL12+): Pressor beams are exactly like TL12 tractor beams, except that they work in reverse, pushing instead of pulling (assume they can impart 100 tons of thrust). They improve at higher TLs, always having the same cost and weight as a tractor beam. They are less versatile, but have their uses. In space combat, they are treated as tractor beams, but a hit instead forces ships out to short range or deflects missiles.

Combination Beams (TL12): These can work as either tractor or pressor beams, but not both at once.

Life Support

A manned ship should have at least one space of life support if it is intended to operate for more than a couple of days. Thus, short-range shuttles or fighters do not need life support.

Life-support systems are rated for the number of people they can support per space of system. Two types are available:

Full systems provide air, heat, and water, but not food – which should be carried as cargo for long voyages.

Total systems *do* provide food; they include hydroponics or food vats of some kind.

When deciding how many spaces of life support are needed, it is safe to count two people per cabin or luxury cabin and five people per bunk room. Life support is not required for passengers in freeze tubes. Excess life-support capacity allows extra passengers to be carried in "steerage" (see explanation under *Quarters,* above).

A life-support system can be overloaded if necessary. Roll 3d after each day overloading, at +1 per full 10% by which the number of people aboard exceeds system capacity. On an adjusted roll of 13 or more, the system begins to break down, losing 10% of its *current* capacity for each point by which the roll was missed. A Mechanic (Life Support) roll can be attempted once per day; if it succeeds, it will restore 10% of *full* capacity. But note that once the life-support system begins to fail, the effect snowballs. If the ship remains overloaded, life support will eventually reach 0% and fail. At that point, all the oxygen in the air will be used up within a few hours, and everyone will die. Those in cold sleep are unaffected if life support fails . . . as long as the power stays on.

Life-Support Table

System	Mass	Cost	Pow.	Capacity
Full Life Support/8	5	0.01	0.2	20 people
Total Life Support/8	2.5	0.005	0.05	5 people
Full Life Support/9	5	0.025	0.5	50 people
Total Life Support/9	2.4	0.012	0.12	12 people
Full Life Support/10	10	0.05	1	100 people
Total Life Support/10	5	0.025	0.25	25 people
Full Life Support/11+	5	0.25	0.05	500 people
Total Life Support/11+	2.5	0.12	0.012	125 people

Mass, cost, power, and capacity are *per space* of life support. Life support may be taken in half-space increments if desired. Power requirements for life support are usually relatively slight; if a ship lacks sufficient leftover power output to manage them, go back and add a few more spaces of power plant.

EXAMPLE: With 15 cabins (a potential 30 people), we decide to install 1.5 spaces of Total Life Support/10 (good for 37 people, which is useful emergency capacity). This requires 1.5 spaces, 7.5 tons, M$0.0375, and 0.375 MW. *Tanstaafl* has 155 spaces left.

Habitat Modules

Colony ships and space stations may contain large urban or green areas. Each module described below is about the size of a city block and includes lighting, temperature control, and air circulation.

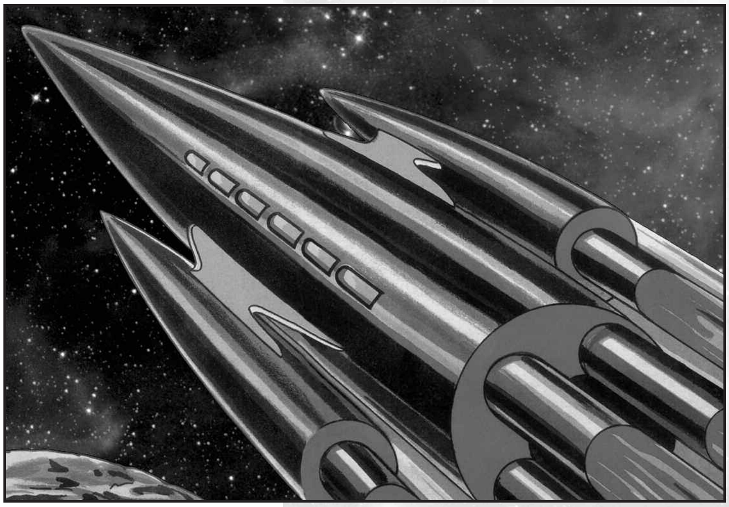
Farm: An acre or so of open space with a few buildings devoted to agriculture and food processing. Up to 10 people or robots can work it efficiently; each worker can grow sufficient food to feed 10 people. Using crop rotation, the farm can act as total life support (see above) for about 100 people.

Factory: A large industrial park containing warehouses and robotic factories, capable of operating efficiently with a few dozen workers or robots.

Housing: One or more apartment buildings or a few dozen houses, plus surrounding grounds, walkways, etc., providing long-term accommodation for up to 100 people in conditions much more "open" than quarters.

Park: A landscaped green space, possibly with entertainment or exercise facilities (pools, stream, playgrounds, etc.). In a pinch, it can provide camp grounds for about 100 people.

Plaza: A mall or concourse area with a dozen or so medium-sized establishments, plus substantial open space for several hundred people to congregate around them.



Habitat Modules Table

System	Spaces	Mass	Cost	Pow.
Farm	10,000	20,000	0.5	0
Factory	10,000	50,000	10	10
Housing	10,000	40,000	1	0.1
Park	10,000	20,000	0.2	0
Plaza	10,000	30,000	1	0.1

Weapons

If space conflict is ongoing or likely, ships may be armed. In some cultures, only naval or Patrol vessels (and criminals) will be equipped with weaponry. In others, yachts and traders may legally mount weapons to defend against pirates . . . or the competition.

Weapons are grouped into three broad categories: *beam weapons, guns,* and *missiles.* For simplicity, beams and guns have been classed as *light* (Lt., occupying 1 space), *medium* (Md., 10 spaces), *heavy* (Hv., 100 spaces), *extra heavy* (EHv., 1,000 spaces), *super-heavy* (SHv., 10,000 spaces), and *ultra-heavy* (UHv, 100,000 spaces). GMs should feel free to extrapolate intermediate-sized or even larger weaponry.

Weapons can either be placed in hull mounts ("fixed" weaponry installed in hull spaces) or built into turrets. A *small turret* can mount one (single), two (double), three (triple), or four (quad) light weapons or missile bays. A *medium turret* can mount one (single), two (double), or three (triple) medium weapons. A *large turret* can mount one heavy weapon. Larger weapons can only be installed in hull mounts.

Option: Weapons and Surface Area

Realistically, a significant limit on hull weaponry is surface area (too many holes in the hull affect structural integrity). Each weapon mounted in the hull requires a certain amount of hull area; this "area requirement" is shown on the table below. Total area requirements for all hull-mounted weapons cannot exceed the ship's hull area minus the surface area of any turrets.

Weapon Types

Missile Bay: A launch bay capable of firing one missile per space-combat turn. Missiles deliver a great deal of damage (especially if given nuclear warheads), but are expensive on a per-shot basis, and can also be shot down. Each missile bay can hold up to 8 heavy *or* 40 light missiles.

Railgun: An electromagnetic "mass driver" that accelerates projectiles to high speeds. It does great damage, but its slugs move at a crawl compared to energy beams, which limits their effectiveness to close-range engagements or firing at non-maneuvering targets like space stations. At longer ranges, a ship will usually be somewhere else before the shot reaches it.

Laser: A space-combat laser fires high-energy pulses of coherent light, usually in the ultraviolet frequency. Lasers are quite accurate and reasonably long-ranged, but have extreme power consumption relative to their armor-penetrating ability.

Particle Beam: P-beam weapons fire focused beams of neutral subatomic particles moving at speeds approaching light speed. They are somewhat less accurate and more power-hungry than lasers, but deliver a more energetic punch: a hit inflicts both physical and radiation damage. Also known as a *NPAW* (neutral particle accelerator weapon) or *blaster.*

Teleport Projectors

The standard teleport projector consists of a room containing a number of platforms, each about a yard across, or perhaps a single large cargo platform. As a default, maximum range of a projector is assumed to be 10,000 miles. Conservation-of-energy issues related to teleportation are assumed to have been solved: an orbiting spaceship can teleport someone up from a planet below, or vice versa, if it has proper coordinates; excess energy goes into hyperspace or is otherwise dealt with.

The GM should decide if a teleport projector is a send-only device or if it can also snatch objects and teleport them *to* the projector. Other limitations can be applied by the GM as well. For example, a 'port could cause dizziness (HT roll to avoid -2 ST and DX for 20-HT seconds after teleporting), or teleportation might not work in a gravity well. One common limitation is that it cannot penetrate a force screen.

A teleport projector requires exact destination or pickup coordinates, usually supplied by shipboard sensors. Setting the coordinates and activating the machine takes 10 seconds and a roll vs. Electronics Operation (Teleportation), at -1 per 1,000 miles of range and +4 if teleporting from one teleport projector to another, cooperating projector. Failure when transporting someone out means the coordinates are a little off (GM's option – this could mean a few yards or a few *hundred* yards); failure when trying to pick someone up means the projector fails to lock on (try again after 10 seconds). Critical failure results in some sort of disaster, which may be annoying, gruesome, or just strange.

X-Ray Laser: A laser that operates at X-ray frequencies. It has more penetrating ability and greater range than ordinary (UV) lasers.

Antiparticle Beam: A particle beam weapon that accelerates antimatter particles. When the antiparticles impact the target, both they and an equal quantity of matter are annihilated, producing additional radiation and explosive damage. Also called an *APAW* (antimatter particle accelerator weapon) or *pulsar.*

Disintegrator: A superscience weapon that destroys matter on the subatomic level – with explosive results. The "rubber science" details are up to the GM. Although listed as TL15, GMs could easily have it appear at an earlier TL (anywhere from TL12 to TL14). Also called a *matter disruptor* or *disruption beam.*

Combat statistics for all these weapons are found in Chapter 9 (see p. 142).

Weapons Table

Weapon	Area Req.	Spaces	Mass	Cost*	Power
Missile Bay	0.2	1	1	0.003	0
Lt. Railgun/8	0.2	1	3.3	2.5	20
Md. Railgun/8	0.5	10	33	25	660
Hv. Railgun/8	1.5	100	330	250	2,000
Lt. Laser/8	0.2	1	5	0.9	100
Md. Laser/8	0.5	10	50	9	1,000
Hv. Laser/8	1.5	100	500	90	10,000
EHv. Laser/8	5	1,000	5,000	900	100,000
SHv. Laser/8	15	10,000	50,000	9,000	1,000,000
UHv. Laser/8	50	100,000	500,000	90,000	10,000,000
Lt. P-Beam/8**	0.2	1	5	0.9	290
Md. P-Beam/8**	0.5	10	50	9	2,900
Hv. P-Beam/8**	1.5	100	500	90	29,000
EHv. P-Beam/8**	5	1,000	5,000	900	290,000
SHv. P-Beam/8**	15	10,000	50,000	9,000	2,900,000
UHv. P-Beam/8**	50	100,000	500,000	90,000	29,000,000
Lt. X-Ray Laser/10	0.2	1	5	0.6	400
Md. X-Ray Laser/10	0.5	10	50	6	4,000
Hv. X-Ray Laser/10	1.5	100	500	60	40,000
EHv. X-Ray Laser/10	5	1,000	5,000	600	400,000
SHv. X-Ray Laser/10	15	10,000	50,000	6,000	4,000,000
UHv. X-Ray Laser/10	50	100,000	500,000	60,000	40,000,000
Lt. APAW/12	0.2	1	5	7	1,400
Md. APAW/12	0.5	10	50	70	14,000
Hv. APAW/12	1.5	100	500	700	140,000
EHv. APAW/12	5	1,000	5,000	7,000	1,400,000
SHv. APAW/12	15	10,000	50,000	70,000	14,000,000
UHv. APAW/12	50	100,000	500,000	700,000	140,000,000
Lt. Dis.Beam/15	0.2	1	5	3.2	1,000
Md. Dis.Beam/15	0.5	10	50	32	10,000
Hv. Dis.Beam/15	1.5	100	500	320	100,000
EHv. Dis.Beam/15	5	1,000	5,000	3,200	1,000,000
SHv. Dis.Beam/15	15	10,000	50,000	32,000	10,000,000
UHv. Dis.Beam/15	50	100,000	500,000	320,000	100,000,000

* *Halve* the cost of beams and guns (but not missile bays) one TL after they first appear; halve it again two or more TLs later.

** P-beams may be given the same options as hand blasters (see p. 82); "tight-beam" and "plasma" are the most practical.

All weapons include dedicated targeting computers running Complexity 4 targeting programs as a "backup" system. More sophisticated programs may be run from the bridge computers.

EXAMPLE: We decide to give *Tanstaafl* eight light lasers, four in each quad turret. Since we are at TL10 but lasers are TL8, they will cost only ¼ as much. They occupy all of our turret spaces, but we still have 155 hull spaces left.

Compatibility with GURPS Vehicles

GURPS Vehicles offers a complete design system suitable for all types of vehicles, including starships, but it is also time consuming and complex. To make ***Space*** more accessible, this chapter presents a modular design system that allows one to construct ships from standard-sized hulls and components. All structures and components were created using the rules in ***Vehicles,*** *Second Edition* (with the addition of some new drives and habitat modules). Final weight in pounds, area in square feet, and cost in dollars were converted to tons, thousands of square feet (ksf), and millions of dollars (M$). Power is given in megawatts (1 MW = 1,000 kW), energy in megawatt-seconds. Volume was simplified by using components grouped into 500-cubic-foot ("one-space") system modules, often with some added empty space to give round numbers. Experienced GMs may use ***Vehicles*** to design their own systems or to create custom-built designs.

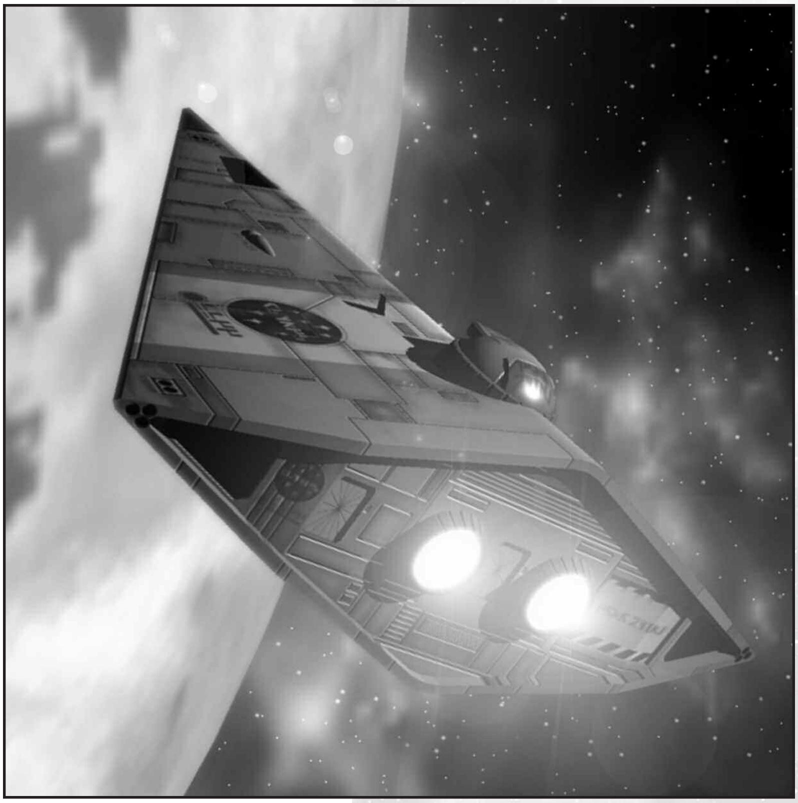
Vehicles can be used to extend the hull table to include nonstandard hull designs. Standardized hulls were built as vehicle bodies in multiples of 500 cubic feet, using medium frames and standard materials. Streamlined hulls used the "lifting body" and "very good streamlining" features. Turrets were built as full-rotation turret subassemblies with medium frames and standard materials. Basic landing gear was subsumed in streamlining to keep things simple.

The armor formula assumes "expensive metal" armor, and converts numbers to tons and M$. Other armor types are possible, as described in ***Vehicles.*** Briefly, "advanced" armor multiplies *final* weight by 0.6 and *final* cost by 2, while "standard" armor multiplies *final* weight by 1.6 and *final* cost by 0.5.

Ships designed with ***Vehicles*** can be used with the ***Space*** system fairly easily. Calculate cDR by dividing DR by 100, cHP by dividing hit points by 100, etc. Several simplifications were made to streamline ***Vehicles*** to fit this book: most numbers were rounded to two significant figures, while power requirements under 0.05 MW were treated as negligible on the scale ships were built at.

Ammunition

Missile bays and railguns require ammunition.



Missile Bay Ammunition

Missile Type	Mass	Cost
Reaction Drive		
Lt. Missile/8	0.3	0.044
Lt. Missile/9	0.27	0.03
Lt. Missile/10	0.2	0.032
Lt. Missile/11	0.2	0.03
Hv. Missile/8	1.4	0.068
Hv. Missile/9	1.4	0.054
Hv. Missile/10	0.9	0.12
Hv. Missile/11	0.9	0.12
Reactionless Drive		
Lt. Missile/9	0.3	0.035
Lt. Missile/10	0.2	0.036
Lt. Missile/11	0.15	0.023
Hv. Missile/9	1.5	0.2
Hv. Missile/10	1	0.18
Hv. Missile/11	0.9	0.2
Grav Drive		
Lt. Missile/12	0.15	0.024
Lt. Missile/13	0.15	0.016
Hv. Missile/12	0.9	0.18
Hv. Missile/13	0.8	0.15

The drive technology used will determine mass and cost; for combat performance, see the *Missile Table* (p. 143). If both reaction drives and reactionless drives exist, each has its own advantages at TL9-10. At TL11, reactionless is better, while at TL12+, grav drives are superior. Cost assumes conventional "kinetic-kill" warheads; for other options, see *Missile Warheads* (p. 117).

Mass and cost are *per missile;* the missile takes up space in a missile bay. Extra missiles can be carried as cargo. Missile ammunition will not be accessible during combat, but can be reloaded into missile bays between battles (this takes about one man-hour per eight heavy or 20 light missiles). Stored as cargo, each light missile takes up about 6 cf (83 per cargo space), and each heavy missile takes up 30 cf (16 per space).

Railgun Ammunition

Magazine for	Shots	Mass	Cost
Lt. Railgun/8+	450	16	4.6
Md. Railgun/8+	45	16	4.6
Hv. Railgun/8+	5	16	4.6

Shots, mass, and cost are *per space.* Railgun ammunition consists of dense tungsten or depleted-uranium projectiles at TL10-, hyperdense projectiles at TL11+.

Energy Banks

A rechargeable energy bank is used to provide energy to systems whose transitory power requirements far outstrip the capacity of ordinary power plants: hyperdrives (when making a hyperskip), jump drives (when making a jump), and beams and railguns (when firing). Ships with any of these systems should be built with energy banks.

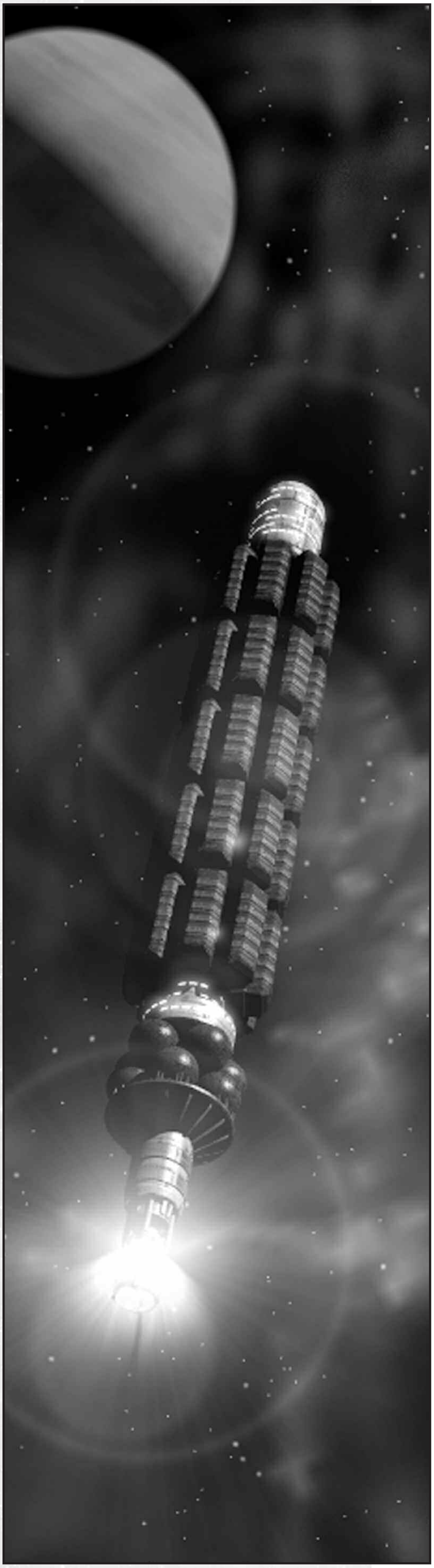
Stardrive Energy: To determine how much energy is required for jump drives or hyperdrives, find the "jump" or "skip" energy requirement of the stardrive (see pp. 115-116). Multiply this by the number of jumps or skips that can be made before recharging (usually one, but sometimes more). This gives the energy required in megawatt-seconds (MWs).

Light Sail Operations

A light sail is basically a large, ultra-thin steerable mirror that lets a ship use light for propulsion. The ship maneuvers by tilting the sail, with stellar gravity assisting in course changes.

Light sails are very fragile. When furled, a light sail provides no thrust, but is safely inside the ship. When unfurled, a light sail is large enough that it can automatically be hit in combat – but unless using a nuclear warhead, this will have little effect. By directing fire against shroud lines (cSM 0), the sail can be cut away. This requires 10 cHP damage per space of light sail. An unfurled light sail is not protected by ship cDR.

It takes an hour to unfurl or furl a light sail; a successful Piloting (Light Sail) roll can cut this to 15 minutes. A ship with an unfurled light sail cannot use any other kind of thrust or come within 200 miles of any world with an atmosphere without destroying the sail.



Beam/Gun Energy: The simplest way to determine beam weapon energy is to add up the megawatts of power required for *all* beam weapons and multiply this by the number of turns that the ship can sustain the barrage. This gives the megawatt-seconds of energy required. (This also makes record-keeping easier, as a simple "number of shots" can be recorded.)

After the total energy requirement in MWs is known, divide this by the energy stored in a single bank to find the number of spaces of energy bank needed. Round up to the nearest half or whole number. If the rounding up results in extra MWs of storage, just convert it into additional weapon shots.

Energy Bank Table

TL	Mass	Cost	Storage
8	25	5	450,000/45,000
9	25	5	675,000/67,500
10	25	5	900,000/90,000
11	25	5	1,125,000/112,500
12	25	5	1,350,000/135,000
13	25	5	1,575,000/157,500
14	25	5	1,800,000/180,000
15	25	5	2,025,000/202,500
16	25	5	2,250,000/225,000

Mass, cost, and energy storage (in MWs) are *per space* of energy bank. Energy banks are also available in half-space increments. Two numbers are given for energy storage: the higher one is for superscience power cells, the lower one is for energy storage using advanced room-temperature superconductor loops.

If using a power plant to recharge an energy bank, each MW allocated to this purpose recharges one MWs of stored energy per second. The ship can be designed with excess capacity for use in recharging, or it can simply shut down some power-using systems (e.g., the main drive) to divert power to this task.

EXAMPLE: The *Tanstaafl* requires 720,000 MWs for its hyperdrive, and we decide we only need one hyperskip between recharges, so 720,000 MWs it is. She also has eight light lasers that use a total of 800 MW. Taking a look at the table for energy banks, we see that at TL10, a single energy bank provides 900,000 MWs per space. After subtracting 720,000 MWs, that leaves 180,000 MWs, and with that we could power the eight lasers for a total of 225 turns. This seems like more than enough. We install a single-space energy bank: it will provide enough energy for one hyperskip and 225 laser shots. She has 154 hull spaces left.

Accessories

Automed Bay: This system contains a number of automeds (p. 96): two at TL9, three at TL10, five at TL11+.

Chrysalis Bay: Contains three chrysalis machines (p. 91).

Complete Workshop: A workshop with tools and spare parts for using all of Armoury, Electronics, Engineer, or Mechanic skill. Up to three people can use it at once; gives +2 skill.

Entry Module: An entry module consists of a passage tube (p. 118) and either a four-person (small module) or eight-person (large module) airlock (p. 118).

Hall, Bar, or Conference Room: A large room with tables. Usable as a restaurant, bar, conference room, etc. It can hold up to 50 people (smaller lounges and conference rooms are included in stateroom volume) and includes furnishings.

Lab: An equipment-filled laboratory designed for a specific Scientific skill (pp. B59-62). It gives a +2 bonus in situations where using lab equipment is helpful but not necessary, or no bonus in situations where a laboratory *is* necessary.

Spacedock Hangar: A pressurized hangar bay designed to house smaller craft within the ship. Its airlock doors or landing pad elevators open into space, but the hangar is sealed off and possesses air pumps that allow it to be evacuated or filled with air in a matter of minutes. Each space provides sufficient hangar facilities for storing 250 cf of vehicles (e.g., to carry a 5,000 cf shuttle would require 20 spaces of spacedock). The volume of the spacedock system can be divided up among several smaller hangars, if desired.

Surgery: A well-equipped surgery, including an operating table (fully gyrostabilized for shipboard use) that allows one person to be operated on at a time.

Teleport Projector: A sophisticated teleportation chamber. The basic model can be designed to transport either six people or 250 cf of cargo instantaneously through space; see *Teleport Projectors* (p. 125) for details. Multi-space projectors can be either separate projectors or larger models – decide when the ship is being designed. The device has a default TL of 15, but as it is superscience technology, the GM can make it available at a lower TL, if desired.

Vehicle Bay: A snug conformal bay designed to house one *specific* model of ship or vehicle. To enter the craft, one uses a door (or slide, or whatever) that leads directly into the craft; the craft exits through a small set of hangar doors. The spaces required for a vehicle bay are equal to the craft's volume in cf times 0.0021. (Round fractional sizes up to the nearest half or whole space.)

Accessories Table

System	Spc.	Mass	Cost	Pow.
Automed Bay/9	0.5	0.6	0.1	neg.
Automed Bay/10	0.5	0.75	0.15	neg.
Automed Bay/11	0.5	1	0.25	neg.
Chrysalis Bay/13	0.5	1.6	0.45	neg.
Complete Workshop	2.5	15	0.06	neg.
Entry Module, Small	0.5	2	0.007	neg.
Entry Module, Large	1	3	0.011	neg.
Hall, etc.	10	0.2	0.03	neg.
Lab	2	10	1	neg.
Spacedock	var.	1*	0.005*	
Surgery	0.5	0.14	0.05	neg.
Teleport Projector/15	1	12	30	
Vehicle Bay	var.	0.5*	0.003*	

* Mass and cost are paid only once, regardless of the number of spaces making up the spacedock or vehicle bay, and represent the mass and cost of the hangar doors and air pump.

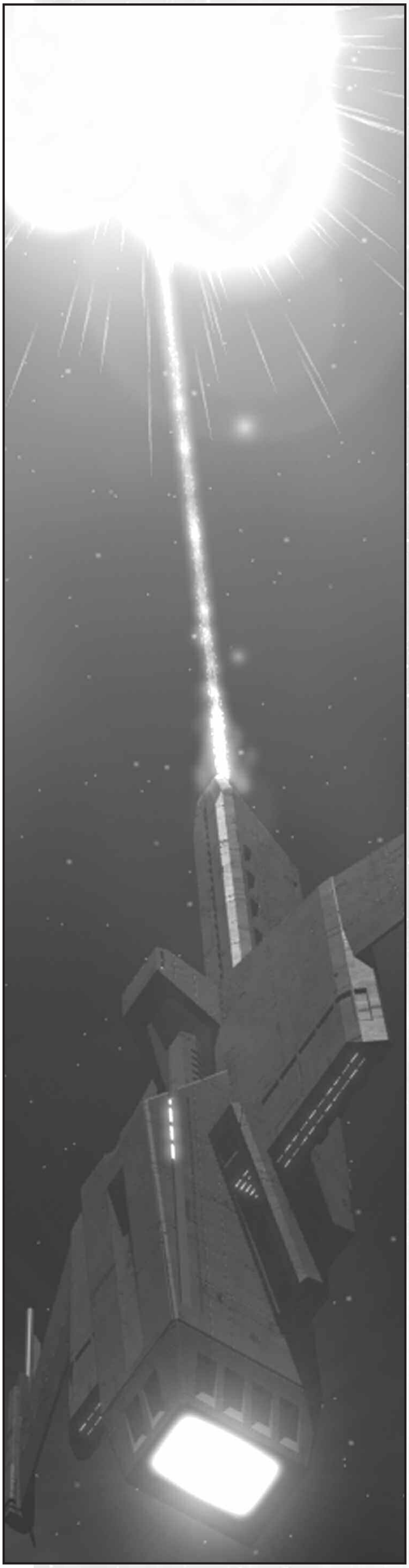
EXAMPLE: As the ship does not have a medic, we decide to install an Automed Bay/10. We also add a Small Entry Module. *Tanstaafl* has 153 hull spaces left.

Cargo Capacity

Any leftover space in the vehicle may either be left as "empty space" or designated as a cargo hold. Each space of cargo hold has room for 500 cf of cargo. Necessary cargo doors or ramps are included. Multiple spaces of cargo can either represent a single large hold or a number of smaller holds – decide which. Holds in ½-space increments (250 cf) may also be installed.

An empty cargo hold has no mass or cost.

EXAMPLE: We decide that *Tanstaafl*'s 153 remaining hull spaces are two cargo holds: one 150-space cargo hold and one three-space "ship's locker" to store crew and passenger personal gear.



Step 8 – Statistics

Total Empty Mass (EMass): Add together the mass of the hull, turrets, armor, screens, surface features, and all installed systems. This is the ship's *empty mass.* Do *not* include the mass of ammunition, fuel, or reaction mass.

Total Loaded Mass (LMass): This is equal to EMass plus these additions:

- The mass of cargo carried. If exact numbers are unknown, assume five tons per space of hold (i.e., about 20 lbs./cf), which allows for cargo holds that are not fully packed, container mass, etc. A density of 12-18 tons per space of hold is reasonable if hauling dense, heavy loads, but acceleration will be much lower.
- The mass of occupants. Assume 0.1 ton per person. As a rule of thumb, this can be simplified to 1.5 tons per passenger seat system, 0.5 tons per space of bunk room, 0.2 tons per cabin or luxury cabin, and 2 tons per space of freeze tubes.
- *Half* the mass of fuel or reaction mass (pp. 118-119). This is because the tank will be partially used during the flight. Calculating LMass using a half-tank is a reasonably accurate way of approximating more complex rocket equations.
- The mass of ammunition (p. 127).
- The mass of ships or other vehicles carried in spacedocks or vehicle bays.

Total Cost: Add together the cost of the hull, turrets, armor, screens, surface features, and all installed systems to get the ship's cost.

Size Modifier (SM): See the Size Modifier column in the *Hull Table* (p. 109).

cSM: Used in the space combat system, this is (Size Modifier-10).

ASig: This is the ship's active sensor signature. It is equal to cSM, minus (TL-4) if ship has partial stealth or 2 × (TL-4) if it has radical stealth. Add +6 to ASig if a light sail is unfurled.

PSig: This is the ship's passive sensor signature. It is equal to cSM, minus (TL-4) if ship has partial emission cloaking or 2 × (TL-4) if it has radical emission cloaking.

Hull cHP: One cHP is equal to 100 hit points. A hull's (or turret's) cHP are equal to its area in ksf times 15.

EXAMPLE: *Tanstaafl*'s hull mass was 162 tons and the mass of all its systems is 728.25 tons, so it has EMass 890.25 tons. For loaded mass, we add 765 tons for cargo (153 spaces × 5 tons) and 4 tons for occupants (15 cabins and a half-space of freeze tubes), giving LMass 1,659.25 tons. *Tanstaafl*'s total cost is M$106.5195. Her Size Modifier is +9. Her cSM is (+9 - 10) = -1. Her ASig and PSig are also -1. She has Hull cHP 375 (hull area 25 ksf × 15).

Ground-to-Space & Space-to-Ground Performance

Escape!

A ship with an acceleration greater than the local surface gravity can blast straight up and escape. The time required to escape is 19 minutes/(sAccel - planet's surface gravity); both sAccel and gravity are in Gs. Contragravity negates some or all of the subtraction for the planet's gravity (e.g., a 1-G contragrav system could cancel up to 1 G of gravity).

Takeoff

Below TL13 or so, the best way for a ship to take off directly from the surface when its sAccel is less than the planetary gravity is to *fly* into space. This requires a streamlined ship, which must accelerate to orbital velocity. For planets, this is 17,800 mph × the square root of (M/R), where M is the planet's mass in Earth masses and R is its radius in Earth radii.

If a ship's rated air speed is higher than orbital velocity, it can fly into orbit in under an hour without experiencing any difficulties. If lower, it can still reach orbit if it has a space acceleration that can operate for long enough before running out of fuel:

Time to Orbit (in seconds) = [Orbital Speed (in mph) - Air Speed (in mph)]/[21.8 × sAccel (G)].

A streamlined ship with reactionless thrusters (which operate as long as there is power) will rarely have any trouble accelerating into orbit – it's just a matter of time.

Escape velocity (the speed needed to leave orbit) is 1.414 times the orbital velocity. Use the same formula to see if a ship can reach it, substituting escape velocity for the orbital velocity.

Assisted Takeoff

There are other ways to get a ship into the air: laser launch, catapults, "beanstalks," or skyhook systems. All require very extensive launch facilities. They might be suitable for merchants on regular routes, or for shuttles to non-landing starships, but not for explorers.

Landing

If a ship can take off from a world, it can land there. It is also possible to land "dead-stick," with no power at all, simply gliding in and decelerating. This gives a -4 to Piloting rolls.

Step 9 – Performance

Space Acceleration (sAccel): This measures how rapidly the ship can accelerate (including its ability to decelerate and maneuver). A ship's sAccel in Gs is equal to the tons of thrust provided by all maneuver drive systems that will be used simultaneously divided by the ship's LMass in tons.

Burn Endurance: For reaction-drive ships only. Measured in hours, this is the mass of fuel or reaction mass in tanks (in tons) divided by the drive's fuel or reaction mass consumption (in tons/hour).

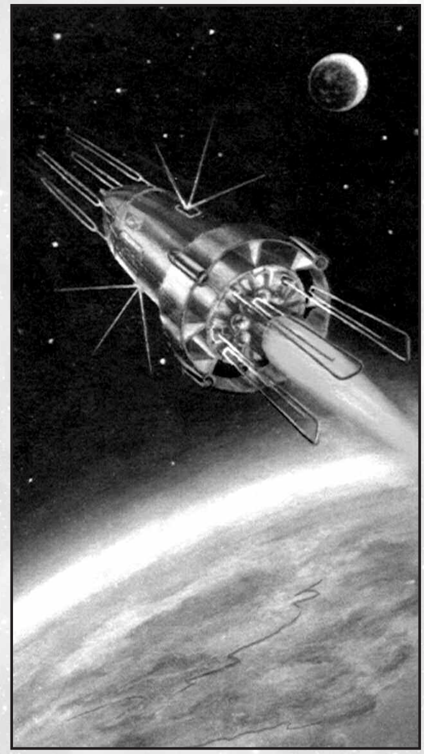
FTL Performance: If the ship has an FTL drive, calculate its performance capabilities based on the ship's LMass and FTL drive rating (see *Drive, FTL,* p. 115).

Top Air Speed. A streamlined ship, or one with contragravity, may fly in atmosphere. If so, calculate the ship's drag as equal her total surface area (in ksf) × 200. Her top air speed in mph for normal cruising (i.e., not when accelerating into or out of orbit) is the square root of [15,000,000 × (thrust/drag)].

EXAMPLE: *Tanstaafl*'s maneuver drive has 1,800 tons of thrust. Dividing that by her LMass (1,659.25 tons), we get sAccel 1.08 G. Her hyperdrive's hypershunt capacity is 2,000 tons, which is more than enough to carry her into hyperspace (and which optionally multiplies base FTL speed by 2,000/1,659.25 = 1.2). As she is streamlined, she has a top air speed. Her drag is 5,400 (27 ksf × 200), her thrust 1,800 tons, so air speed is the square root of [15,000,000 × (1,800/5,400)] = 2,236 mph.

Option: Variable-Mass Performance

GMs may wish to calculate multiple sets of performance figures for ships whose mass can change dramatically; e.g., with near-empty vs. full cargo holds or spacedocks.



Creating Deck Plans

Ship designs can be used to create deck plans to facilitate boarding actions, hijackings, and other adventures. ***GURPS*** uses a one-yard hexagonal grid for maps. Assuming headroom of about 8-9 feet and some room under the decks (about 25% of each space), a space can be represented by six hexes. GMs should feel free to swap space around a bit for aesthetic effect.

Step 10 – Finalization

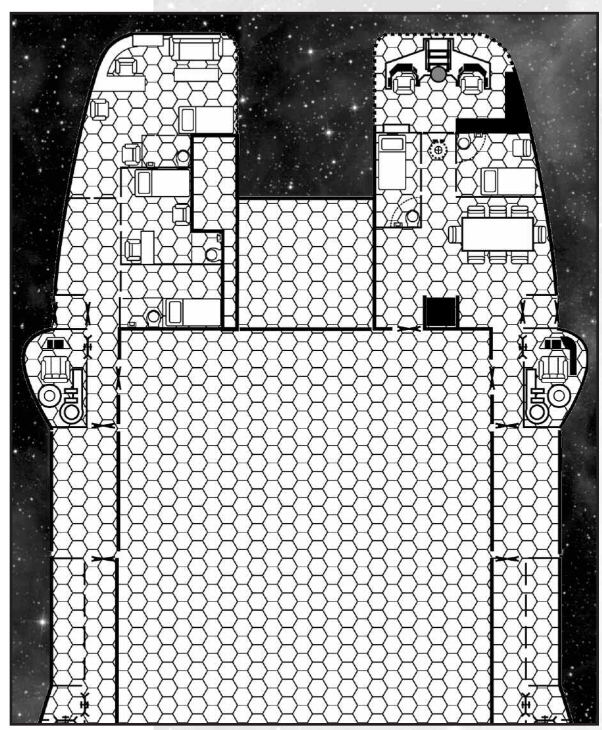
The ship design is now complete. A new ship is usually categorized by size and function; e.g., "heavy cruiser" or "tramp freighter." A *class name* for the first ship of her type to fly is also assigned. Later ships generally follow the same theme; e.g., all battleships in the *Ares* class are named after human (or alien) war gods.

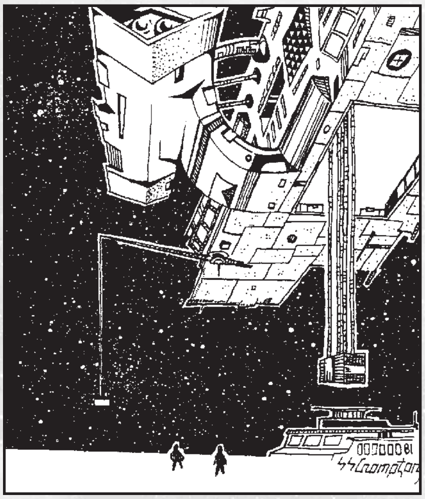
Traveling

Speeds with Maneuver Drives

The fastest way to get anywhere is to accelerate halfway there, turn the ship around, and decelerate the rest of the way – especially if using reactionless thrusters. If the drive is a reaction drive, this uses reaction mass for the whole trip, so the drive must be able to accelerate for that long. One can save by traveling more slowly, by accelerating only part of the way, or by using a transfer orbit (see sidebar).

The distance separating two planets in a star system may be as short as the difference between their distances from their star or as long as the sum of those distances, depending on their orbital positions. For a rough average approximation, the GM can assume the distance between two worlds is equal to distance from their star to the world that is furthest from the star. For this information, see *Orbit Locations* (p. 153). A moon's distance from its primary varies considerably; ours is about 0.0026 AUs away. Some travel times for constant-acceleration trips. Distances are given in AU (1 AU = 93,000,000 miles, the distance from Earth to the sun):





Interplanetary Travel with Low-Endurance Reaction Drives

Lower-TL space games may have extremely limited reaction drives – limited enough that the type of travel described under *Speeds with Maneuver Drives* (p. 131) is inappropriate because there are more fuel-efficient routes. The *most* fuel-efficient route between two planets is called a "Hohmann transfer orbit." Hohmann transfer orbits are only available at certain times, though, with a predictable separation between them; the "frequency" row on the table below indicates how often a transfer orbit is available between Earth and some popular destinations in the near solar system (or vice versa).

For most of the time a ship is in a Hohmann transfer orbit, it is coasting (and thus not using fuel), but to complete a given orbit requires acceleration for as many hours as the "impulse" number on the table divided by the ship's sAccel in Gs. This includes the thrust required to enter or leave low orbit (except in the case of Jupiter, where the numbers reflect a trip to or from one of its major moons). The table also shows the total travel time required using such an orbit.

Destination

	Moon	Mercury	Venus
Frequency	80 min.	4 mon.	17 mon.
Impulse	0.11	0.53	0.25
Time	5 days	110 days	170 days

	Mars	Jupiter
Frequency	26 mon.	13 mon.
Impulse	0.22	0.6
Time	260 days	3.1 years

Distance (AU) Acceleration

AU	0.0001 G	0.001 G	0.01 G	0.1 G	1 G	2 G
0.1	3.1 mon	1 mon	9 days	68 hrs	22 hrs	16 hrs
0.2	4.5 mon	5.7 wks	1.8 wks	4 days	31 hrs	22 hrs
0.5	7 mon	9 wks	2.9 wks	6.3 days	2 days	34 hrs
1	10 mon	13 wks	1 mon	9 days	2.8 days	2 days
2	14 mon	4.5 mon	6 wks	13 days	4.1 days	2.8 days
5	23 mon	7 mon	9 wks	2.9 wks	6.3 days	4.5 days
10	32 mon	10 mon	13 wks	1 mon	9 days	6.3 days
50	5.5 yrs	23 mon	7 mon	9 wks	2.9 wks	2 wks
100	7.8 yrs	32 mon	10 mon	13 wks	1 mon	2.9 wks

Or use this formula: Time (in hours) = 68 × [square root of (D/A)]; D is the distance in AU, A is acceleration in Gs.

Example: Tanstaafl's hyperdrive (see *Stardrive Performance,* below) gets her to within 0.1 AU of a planet. With her maneuver drive, she can reach 1.08 G. Assuming she takes it easy with a steady 1 G, she can reach her destination in 22 hrs.

Trips with Reaction Drives

If using a reaction drive, the usual method is to boost up to a reasonably high speed, then coast the rest of the way: a short burn at the start of the trip, and a short one at the end.

The maximum speed a ship can reach using reaction drives (its delta-vee) is (*very approximately*) its sAccel (in Gs) × its Burn Endurance (in hours) × 3,600 × 21.9 mph (which simplifies to 78,840 mph × Burn Endurance per G). As the ship's crew will usually want to use half its reaction mass to slow down and come to a stop at its destination, the effective delta-vee is half that: 39,420 mph × Burn Endurance per G. To get a delta-vee in "AU per hour" divide by 93,000,000.

The total length of a full-thrust trip will be roughly Burn Endurance plus [distance (miles)/delta-vee (mph)] hours.

To convert AU distances to miles, multiply by 93,000,000.

Example: A ship with a 0.2 G sAccel and Burn Endurance of 4 hours can achieve a round-trip delta-vee of 31,536 mph. To travel 1 AU (say, a typical Earth to Venus voyage) would take 4 + (93,000,000/31,536) = 2,953 hours.

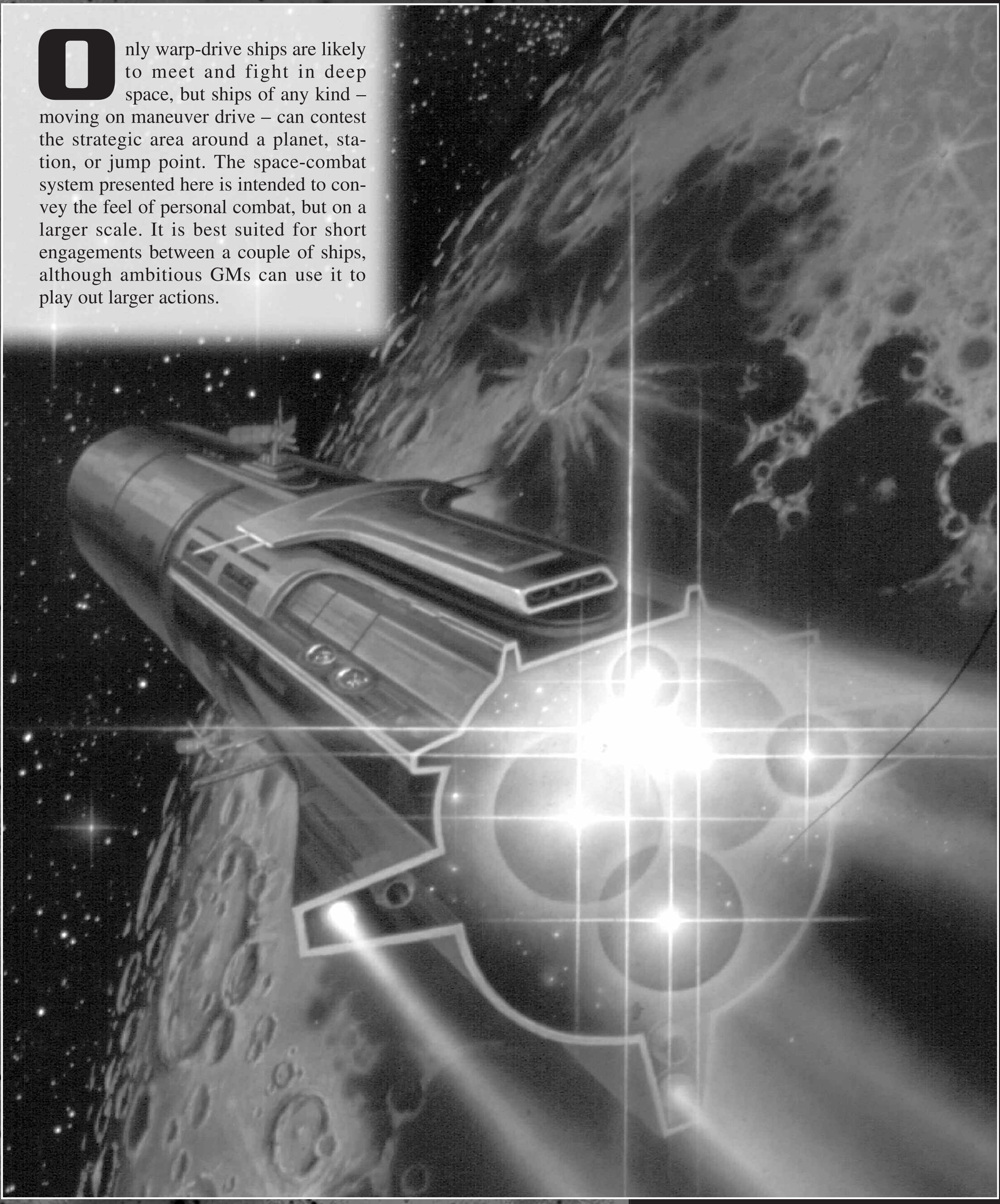
Stardrive Performance

The GM should work out the mechanics of stardrive operation using the guidelines in Chapter 2. For example, in *Tanstaafl*'s universe, travel is by hyperdrive. Drives use the standard rules for energy requirements; how often a ship can skip depends on how fast it can recharge its energy banks. Travel through hyperspace is 0.2 parsecs per day. Astrogation is "modified straight-line" (p. 34), with a -1 to Astrogation rolls for each full parsec. There are no FTL sensors; ships usually come out of hyperspace and look around every couple of parsecs to avoid getting lost. Hurried skips give a penalty to the roll: -1 for 30 minutes, -2 for 10 minutes, -3 for a minute, -4 for a skip without preparation. If an astrogator gets a critical failure, the ships may mis-skip dramatically, sometimes by many parsecs, often burning out its drive in the process. An ordinary failure may put a ship a parsec or so off course.

Hyperdrive in this setting has the following limitations: Ships can enter hyperspace anywhere as long as they are in vacuum and zero gravity (i.e., orbit); ships can't leave hyperspace within (approximately) 0.5 AU of a stellar mass or 0.1 AU of a planetary mass. Accuracy is within 100 AU per parsec, so a ship often skips into a system, takes a new sighting, then skips again to get closer. An Astrogation roll is required to get "just close enough but not too close" to a target world. For a short in-system jump, an astrogator who tries to cut it fine and fails will be bounced and appear 3d AU away from the target. If he has energy, he can skip again; otherwise, he'll have to wait for a recharge, or give up and go in on maneuver drives. In any case, maneuver drives are needed for the final 0.1 AU approach.

CHAPTER 9 SPACE COMBAT

Only warp-drive ships are likely to meet and fight in deep space, but ships of any kind – moving on maneuver drive – can contest the strategic area around a planet, station, or jump point. The space-combat system presented here is intended to convey the feel of personal combat, but on a larger scale. It is best suited for short engagements between a couple of ships, although ambitious GMs can use it to play out larger actions.



The Engagement

Before any combat involving spacecraft can occur, the opposing forces must have maneuvered, by accident or design, into the same general area of space (typically within a light second of each other – about 186,000 miles). Ships may blunder into each other by accident, may be deliberately looking for a fight, or may be attacking a defended point or patrolling a particular area. The GM should then determine whether combat can occur, based on their relative velocities and planned dispositions. He should also decide whether any celestial bodies or other interesting features exist in the combat zone to complicate the issue.

Initiative

Prior to the start of the engagement, each side's leader (the captain, if only one vessel is involved; the squadron leader or admiral in the case of multiple vessels) rolls 1d and adds the applicable modifiers from the *Initiative Table* (p. 141).

If they tie, both sides detect each other at roughly the same time and have an equal amount of time to prepare. If one side wins, it achieves *partial surprise.* If one side wins by five or more, it achieves *complete surprise.*

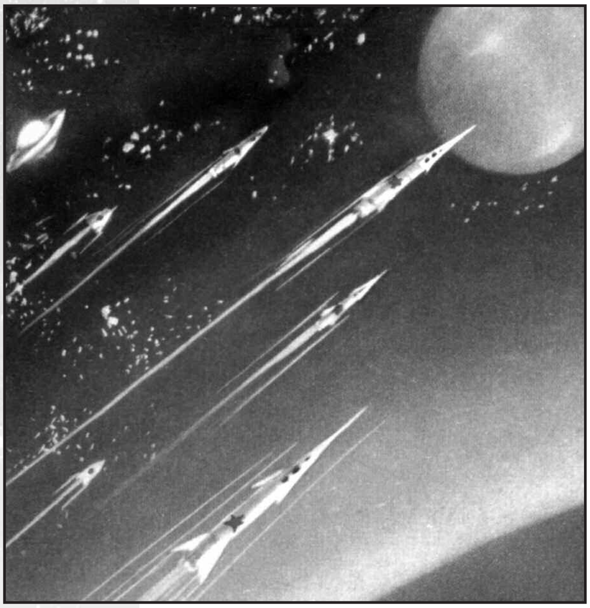
Partial Surprise

Partial surprise means that one side has detected the other a few moments before being itself detected. An engagement is unavoidable, but one side is more prepared for it. The side that was surprised may only choose Drift or Hold Course maneuvers, and suffers -4 (-2 for people with Combat Reflexes) on all attack and maneuver rolls. Partial surprise ends at the start of a surprised ship's *second* turn.

Complete Surprise

This means that one side has detected the enemy some *minutes* before being itself detected. If PCs achieve complete surprise, the GM should describe the enemy forces to them in terms of size and appearance.

If the side with surprise chooses battle, it has time to achieve a high speed and thus get among the enemy unexpectedly, or to stand off and launch missiles from a distance, or both. The enemy may take no maneuver other than Drift or Hold Course, suffers -6 (-3 for people with Combat Reflexes) on all attack and maneuver rolls, and may not fire weapons except against incoming missiles. At the start of the enemy's *second* turn, complete surprise ends, but the enemy is still off balance and suffers the effects of partial surprise, which lasts until the start of the enemy's third turn.



Alternatively, some or all of the ships on the side with surprise may break contact instead of attacking, avoiding the combat. However, if all forces retreat, it means abandoning any planet or station they were defending. In the case of a total retreat, no battle occurs, but the GM should consider the courses of both sides and decide whether or not a battle may take place hours later, elsewhere. If further action seems likely, roll initiative again; the GM may give the side that achieved complete surprise a bonus if its commanders made better plans based on their initial contact with their enemy.

Finally, a side with complete surprise may pull back but stay in fleeting sensor contact with the enemy vessels, perhaps hoping to be led to a base or the like; see *Shadowing and Detection* (sidebar).

Shadowing and Detection

A force that has completely surprised its opponents may choose to stay just on the edge of sensor range, shadowing the enemy. To do so, make another initiative roll every hour or so the shadowing takes place; the shadowing force get a +3 bonus. If they retain "complete surprise," they can continue to shadow the enemy. Of course, their opponents may eventually activate an FTL drive, arrive at a base, or even split into several groups, forcing the pursuers to split up or otherwise take action.

If "complete surprise" ever drops to "partial surprise" or worse, the shadowing force has been detected and a battle may occur.

It may or may not be possible to shadow ships moving in hyperspace or at warp speeds; an appropriate FTL drive is necessary, and FTL sensors may be required (GM's option).

Formations

A number of friendly vessels may be declared "in close formation." Designate one as the formation leader. Vessels in formation must take the same maneuver as the formation leader. If the formation leader fails at an Attack Run, Break Off, or Pursuit maneuver, they must take the same maneuver, but automatically fail also. If the formation leader succeeds at one of these maneuvers and a vessel in formation with it fails, that vessel has dropped out of formation.

As long as the ships remain in formation, they are automatically at short range to each other and to any vessel that it is at short range to any one of them.

Ships declare that they are breaking off formation at the start of the maneuvering phase of their turn. Formations may be freely designated before a battle begins. Ships may only join a formation during a battle if both they and the formation leader take the Form Up maneuver.

Space Combat Turns

Space combat is fought in *space combat turns,* each representing perhaps 10 seconds of engagement time. Space combat turns are the final dramatic moments of an engagement that may have involved several minutes or even hours of slow positional maneuvering before the ships entered weapons range and started shooting.

In space combat, each vessel takes its turn in sequence until they have all had a turn, then they start over – just like in personal combat.

The turn sequence – the order in which individual vessels take their turns – is up to the GM. The suggested method is that the side that lost the initiative roll (if both sides tied, roll a die) picks one of the *enemy's* vessels to go first and that vessel takes its turn. Then the other side picks one of its opponent's vessels to take its turn. Keep alternating back and forth until all vessels have taken turns or one side runs out of vessels. If the latter occurs, the remaining vessels take their turns in whatever order their leader wishes.

After everyone has acted, 10 seconds have passed. Begin a new turn, with surviving vessels acting in the exact same order as before. To facilitate record keeping, the GM should record the order in which individual vessels take their first turn (assign the first vessel the number 1, the second vessel the number 2, etc.).

Action Within the Turn

On a vessel's turn, the following activities take place:

1. **Maneuvering.** The captain picks a space maneuver. Any Contests of Skill that maneuver requires are resolved.
2. **Missile Attack.** Missiles the vessel launched on its *last* turn – and which were not shot down – attack their targets.
3. **Beam and Gun Fire.** The vessel's gunners may fire railguns and beam weapons.
4. **Missile Launch.** The vessel's gunners may launch missiles (which will reach their targets on the vessel's *next* turn).
5. **Other Actions.** The vessel's crew may perform other actions (repairs, moving about the ship, etc.).

After this, the active part of the vessel's turn is over and the next vessel in the sequence takes its turn. However, the maneuver the vessel chose is considered to remain in effect until the start of its next turn.

Space Maneuvers

Each captain starts a space combat turn by choosing any *one* of the following maneuvers. The maneuver a captain chooses will also affect his vessel's defenses if it is attacked before its next turn. Movement is wholly abstract: no game board is required.

Surprised vessels may only perform Drift or Hold Course maneuvers. A crippled or otherwise non-maneuverable vessel (space station, out of fuel, etc.) is limited to the Drift maneuver.

Speed Modifiers: Some maneuvers give a bonus to the "faster" ship. If both ships use maneuver drives, "faster" means "higher sAccel"; if both use warp drives, it means "higher warp speed." Where maneuvers require a Quick Contest of Piloting, the following modifier applies to the faster ship's pilot (use only the highest): +3 if faster, +6 if at least *twice* as fast, +7 if at least *five* times as fast, +10 if *ten* or more times as fast. If using warp drive and the other vessel is using only maneuver drive, a +10 modifier always applies.

Reaction Mass and Combat

A ship that uses a reaction drive must have sufficient reaction mass to maneuver in order to do anything but Drift. This is rarely a problem, as one space combat turn is 1/360 of an hour, but GMs may wish to take this into account for vessels which are low on reaction mass at the start of a fight, or which have very high consumptions (endurance under one hour).

Retaining Advantaged Status

One ship may become Advantaged over another as the result of an Attack Run maneuver, in which case it remains Advantaged until the start of its own next turn, regardless of the maneuvers taken by the enemy vessel. After that, it is no longer Advantaged until it regains that status through another successful Attack Run maneuver. A ship cannot be Advantaged against more than one opponent at a time unless those opponents are in the same formation. If a situation occurs where a ship would be Advantaged against a second opponent that isn't in the same formation, its commander must choose which ship he wishes to retain Advantage over.

Cinematic Rules

Hugging the Enemy

In some settings, small, maneuverable ships have a significant advantage over larger vessels. To simulate this, the GM may adopt the following rule:

A ship that has gained Advantage over a larger ship through an Attack Run maneuver may, *if the target has a Size Modifier eight or more greater than its own,* declare itself to be "hugging" the larger vessel – in effect, proceeding in close and using it as terrain. While doing so, it is considered at point-blank range rather than at short range; moreover, none of the bigger ship's hull weapons will be able to bear on the smaller ship (or ships, if all are in formation), and no more than two of its turrets may do so. Any shot fired at the smaller craft from a *different* vessel has a 50% chance (1-3 on 1d) of hitting the larger vessel it was hugging instead.

These effects persist only until the smaller vessel's next turn. To continue hugging its target, the smaller vessel must regain Advantaged status each turn through successful Attack Run maneuvers.

Dramatic Escape

In congested or hazardous environments, such as close to a star or black hole, within a strangely dense asteroid belt, or perhaps fighting in and around a large space station, a ship that chooses Break Off may attempt to elude pursuit by risking destruction and daring its pursuers to do the same.

The pilot of the ship attempting to Break Off describes the action, then negotiates the difficulty of the maneuver and the consequences of failure with the GM. Consequences may include damage, being caught in a gravity well . . . even instant destruction. A Piloting roll is then required to see if the maneuver succeeds – or fails, which means ship suffers the consequences.

Should the ship succeed, any opponent who wishes to pursue it (see *Pursuit,* p. 137) must not only win a Quick Contest of Piloting skills as usual, but must also dare the same maneuver, with all the same risks. Only by succeeding at *both* will the pursuing ship catch up with its fleeing target.

Attack Run

Choose a target (e.g., an enemy ship, space station, or ground installation). You attempt to close to short range (or to maintain that range, if it was already short) and place your ship in an optimum firing position. An Attack Run maneuver may not be performed on the first turn of an engagement unless your side has achieved complete surprise. You may only make attack runs against an installation on a world with an atmosphere if your ship has contragravity or streamlining.

If your target is incapable of maneuver, your Attack Run is automatically a critical success: you are at short range and are "Advantaged" against it. (An Advantaged ship has maneuvered into an especially good firing position relative to that particular target.) Otherwise, your target must decide whether to engage you or to evade. If his last maneuver was an Attack Run or Ram against *you,* he *must* engage; if it was Evasive Action or Break Off, he *must* evade.

If the target chooses to engage, the respective pilots roll a Quick Contest of Piloting skills. The pilot with the faster ship adds speed modifiers (p. 135). If either pilot is Advantaged against his opponent, he adds +4. The target's pilot subtracts any surprise penalties (if surprised). If either pilot wins the Quick Contest by four or more, or via a critical success, he is Advantaged vs. his opponent. Otherwise, win or lose, the two ships are now at short range. Exception: If you both get critical failures, you *collide!*

If the target chooses to evade, a Quick Contest of Piloting skills also takes place. The faster ship's pilot adds speed modifiers. You receive a +4 if you were at short range to the target on your previous turn, and another +4 if you were Advantaged against him. Your target receives a +4 if his last maneuver was Evasive Action. If you win, you are both at short range; if you win by four or more, or via a critical success, you are also Advantaged. If you tie or lose, your Attack Run fails and you are at long range.

See also *Hugging the Enemy* (sidebar).

Break Off

This maneuver represents an attempt to disengage from the battle. If a ship chooses a Break Off maneuver, it is assumed to have left the combat zone at the start of its *next* turn, if it has not lost maneuverability before then. However, any enemy ships that successfully perform an Attack Run or Pursuit against it before then will escape with it. This forms a second engagement that begins immediately, some distance from the first.

You may not choose Break Off if your ship's last maneuver was Attack Run or Ram.

See also *Dramatic Escape* (sidebar).

Drift

A vessel taking the Drift "maneuver" is not using its maneuver drive or warp drive, and is making no effort to avoid enemy fire. Depending on its actions on prior turns, it may still be moving or it could be stationary. This is what most orbital space facilities do *every* turn. It is also a useful option for cinematic starship captains who want to "play dead."

Evasive Action

You are maneuvering cunningly or violently, attempting to avoid enemy fire and to prevent enemy ships from closing. Evasive Action gives your pilot a +4 in any Quick Contest to evade ships that make Attack Runs against your vessel. It also gives your ship a favorable combat modifier against enemy fire.

Form Up

Your ship is maneuvering to establish a close formation with other vessels, or to incorporate another ship into an existing formation. See *Formations* (p. 134).

Hold Course

Your ship flies in a reasonably straight line, with only limited maneuvering. This is an option in a battle if you wish to keep your distance but not perform violent maneuvers. It is also a prerequisite for docking two ships, and for recovering small craft. With some kinds of FTL drive, it may be necessary to Hold Course for a given number of turns prior to engaging the drive. Finally, the GM may rule that a ship must Hold Course for a certain number of turns in order to do something; e.g., pass a blockade, land, or take off.

Docking: To dock (i.e., enter a spacedock or vehicle bay, or match courses and mate airlocks), both vessels must take the Hold Course maneuver and indicate that they are docking. The actual attempt comes at the end of the *second* ship's turn. Each pilot must make a Piloting skill roll. Failure means another turn is required; critical failure means a collision (see *Collision and Ramming Damage,* p. 140). It may be possible for a daredevil pilot to dock with a ship doing something other than a Hold Course maneuver, but the GM should apply a -4 or worse penalty.

Pursuit

You are attempting to follow a particular ship that is trying to flee the combat zone. Choose a target ship whose current maneuver is Break Off. You cannot pursue a ship that is faster than your own! If your ship is equal in speed or faster, your pursuit is successful if your pilot wins a Quick Contest of Piloting skills with the other ship's pilot. Add speed modifiers (p. 135); add an extra +4 if you were at short range to the target on your last turn, or +6 if you were Advantaged against it.

If you lose, your opponent will escape when he breaks off. If you win, your opponent breaks off from the main engagement, but you (and any other ships that have successfully pursued) follow him, starting a new engagement.

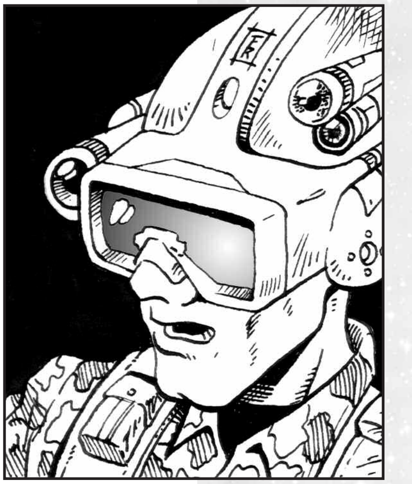
Ram

You attempt to ram a vessel or other target. To attempt this maneuver, you must select a specific target that you were at short range to on your previous turn. You may not attempt to ram a target that is Advantaged against you.

Your ramming attempt is *automatically successful* if your target is taking the Drift maneuver. Otherwise, your opponent must decide whether to accept the collision or to attempt to evade it. If he wishes to accept the collision, you ram each other automatically.

If your target wishes to evade, your pilot rolls a Quick Contest of Piloting skills against your target's pilot. The faster ship adds any speed modifier. You are at -4 *unless* you are presently Advantaged against this target. Your opponent gets +4 if his last maneuver was Break Off or Evasive Action. If you win the Quick Contest, your ram is successful. If you fail by 1-4, your ram just missed but is treated as a successful Attack Run (you are at short range to your opponent). If you fail by 5 or more, you did not even get near the target, and will be at long range.

If a ram succeeds, you smash into the enemy ship, doing collision damage in the missile attack phase of your *current* turn.



Selective Targeting

A gunner can choose to selectively target individual turrets or systems. When doing so, use the cSM of the turret or system rather than the cSM of the ship itself.

Turrets

Small Turrets: cSM -6 if single or double, cSM -5 if triple or quad.

Medium Turrets: cSM -4 if single or double, cSM -3 if triple.

Large Turrets: cSM -2.

Turrets have 15 cHP (small turret), 60 cHP (medium turret), or 150 cHP (large turret).

Ship Systems

Gunners may be able to aim at individual systems within a hull, provided the system is externally visible (e.g., a weapon, maneuver drive, or space dock) or shows up well on sensors (e.g., a power plant), or the gunner has knowledge of the target's internal layout. GMs may allow other systems to be targeted if they occupy 25% or more of the vessel (e.g., tanks, if a ship is mostly reaction mass tankage). Substitute the system's cSM for the vessel's. The cSM of a system depends on its size in spaces:

Spaces	cSM
0.5	-7
1-2	-6
3-6	-5
7-20	-4
21-60	-3
61-200	-2
201-600	-1
601-2,000	0
Etc.	Etc.

An attack on a system damages both the ship's hull cHP *and* the cHP of the system.

Assume that one space of system is destroyed per full [(hull cHP/hull volume) × 500] points of cDAM inflicted. Systems may degrade as they are damaged, or the GM may rule that the entire system must be knocked out to have effect, depending on the desired complexity level.

Alternatively, calculate individual component hit points using ***GURPS Vehicles*** and divide by 100 to get cHP.

If shooting at light sails, see *Light Sail Operations* (p. 127).

Asteroids!

In some scenarios, especially cinematic ones, the heroes may need to destroy asteroids. As a rule of thumb, a stony asteroid D yards across has a mass of (D cubed) tons, and has (D squared) cHP and a cDR of (D/10). Double all figures for a nickel-iron asteroid; reduce them by 50% or more for a snowball or cometary nucleus. See pp. 160-162 for more on asteroids.

Groundfire

If the battle is taking place close to a planet, moon, or asteroid, vessels in orbit may direct fire down onto it, or vice versa.

If the body has more that a trace atmosphere, beam weapons firing in either direction may have trouble penetrating the atmosphere. "Realistic" X-ray lasers, antiparticle beams, and neutral particle beams cannot fire through an atmosphere. This means that missile bays, lasers, railguns, and disintegrators are best suited for orbital bombardment.

Firing to or from space, light and medium lasers and disintegrators can only hit targets at short range. Heavy or larger weapons can engage targets at long range. Missiles and railguns can fire from long range if attacking from space to ground, but only from short range if firing from ground to space.

GMs may decide that clouds block fire on a particular target. This depends on climate and weather, but may occur occasionally on planets with standard atmospheres, often for dense atmospheres, and perpetually for very dense or superdense atmospheres. Radar can see through clouds, but passive and ladar sensors cannot, making precise identification of targets problematic without someone on the ground (requires Forward Observer skill, p. B234; the GM may assess penalties for observers unfamiliar with orbital bombardment). Clouds provide a cDR vs. laser fire of twice the planet's atmospheric pressure measured in atmospheres; e.g., cDR 2 on Earth.

Range

Range is an abstract measure of how far apart two ships (or formations) are. It may be *point-blank, short,* or *long.*

Your vessel is at ***point-blank*** *range to an object if:*

- It is a missile (except an X-ray laser type) that is targeted on your vessel.
- It is docking with you.
- It, or its opponent, is "hugging the enemy" (p. 136).

Your vessel is at ***short range*** *to an object if:*

- You just successfully performed an Attack Run against that object, or a vessel that it is in formation with. You remain at short range until your next turn.
- It just successfully performed an attack run (or barely failed a ram) against you (or a vessel you are in formation with). You remain at short range until its next turn.
- It is a missile (except one with an X-ray laser warhead) targeted on a vessel you are in formation with.
- It is a missile with an X-ray laser warhead targeted on your vessel.

Your vessel is at ***long*** *range to an object if:*

- None of the above apply.

Missile Attack

If the ship fired any missiles during its *previous* turn, and they were not intercepted, we now see if they hit. In the case of a nuclear missile, the firer must decide whether to try for proximity or impact detonation before rolling to hit. Any attempt to aim at specific locations must also be indicated (see *Selective Targeting,* p. 137).

Automatic Hit: If the target is drifting (crippled or incapable of maneuver), the missile always gets a critical hit.

Automatic Miss: If the target's current maneuver is Break Off or Evasive Action, it may be impossible for a slow missile to catch it! Compare the missile's performance (see *Missile Table,* p. 143) to the target's. The missile misses if the target is equally fast, or faster, in terms of sAccel. If the firing ship took an Attack Run or Hold Course maneuver on the turn it launched, adds it sAccel to that of the missile for this purpose.

Otherwise, the missile's firer (or the GM) makes an attack roll: 3d against the missile's Skill value (see *Missile Table* on p. 143), with modifiers from the *Missile Attack Table* (p. 144).

A successful roll means that the missile hit the target (or exploded nearby, if a proximity blast) – see *Damage* (p. 140). A failed roll means the missile overshot (or malfunctioned). It can be assumed to have run out of fuel or self-destructed. A critical failure may have no further effect, or it may mean that the missile accidentally locked onto a friendly vessel, if that seems remotely plausible to the GM (if so, resolve it next turn).

Rams

Ram damage is also resolved in this phase – see *Damage* (p. 140). No attack roll is necessary, as the maneuvering determined whether or not the rammer was on target.

Beam and Gun Fire

After a captain has chosen his vessel's maneuver and resolved any Quick Contests or missile attacks, some or all of his beam and gun weapons may be fired.

Resolve the vessel's fire one gunner at time, with the gunner's character using his skill to determine the results. (On ships with NPC gunners and PC officers, the GM may have the PCs make tactical decisions and let the players roll for the NPCs.)

A single gunner can control all the weapons in one turret, or fire any number of *identical* hull-mounted weapons. However, he must fire all weapons at the same target (or at the same salvo of missiles). Each Gunner program running can replace one gunner.

The target must be specified before rolling to hit, along with any selective targeting (see p. 137). Most guns and beams can fire at targets at any range (for some exceptions, see *Groundfire,* p. 138), but firing at targets that are at point-blank or short range is easier. Guns or beams installed in the hull cannot shoot at an enemy ship that is presently Advantaged over the firing vessel. And if an enemy has left the battle through Break Off or Pursuit, it cannot be fired at by vessels still in the original battle, and vice versa.

Each gunner may make one attack roll per turn. When one gunner fires multiple identical weapons, only one roll to hit and one damage roll are made, but if the attack hits, damage that penetrates cDR is multiplied by the number of weapons fired. Thus, four lasers in a quad mount do four times damage after cDR; a battery of 100 particle beams does 100 times damage after cDR. If 2+ weapons are fired like this, a miss by 1 or 2 means that *half* the weapons firing still hit; if 10+ weapons fire, a miss by 3 or 4 means *1 in 10* hit (round down). E.g., if an attack with 26 lasers misses by 3, two lasers hit and the damage (after cDR) would be multiplied by 2, not by 26.

Battery Anti-missile Fire: Battery fire can be used when firing at clouds of identical incoming missiles. Don't roll damage; if the battery hits, it kills as many missiles as there are guns in the battery (up to the number fired at).

Note on Shots: Beams and guns are usually limited in the number of shots they can fire before draining a ship's energy banks or running out of ammunition, as described in Chapter 8. Many ships are built with enough energy for dozens or even hundreds of shots – if so, there is no real need to keep track during a battle. For ships whose number of shots is significantly limited, GMs can track expenditure; assume that one well-aimed shot is being fired per weapon per turn.

Rolling to Hit

To hit, the gunner rolls 3d against his effective Gunner skill; see the *Beam and Gun Modifiers Table* (p. 143) for applicable modifiers.

Success means that the target is hit – see *Damage* (p. 140). Critical success does *double damage.* Critical failure means the weapon malfunctions, except for very reliable weapons (roll 3d again: only on a second critical failure does it malfunction).

Missile Launch

A vessel may launch one missile per missile bay on its turn, subject to ammunition limitations (you can't fire missiles from an empty bay), and provided it is not suffering complete surprise.

The type of missile and its target must be specified at launch ("We are firing six heavy X-ray laser missiles at the *Argument of Kings.*"). Decisions are made by the bay's gunners. The target may be any ship in the same engagement, but missile bays installed in the hull cannot launch missiles against an enemy ship that is presently Advantaged over the launching vessel. Different missile bays can engage different targets. If necessary, make a note of which missiles are targeted at which target.

Missiles launched *this* turn will not impact their targets until the missile attack phase of the firing ship's *next* turn. This gives the target (and perhaps other vessels in its formation) time to shoot at them. Exception: Missiles fired at targets at point-blank range impact their targets *immediately after being fired.* Use the same rules as for longer-ranged fire, but resolve the attacks immediately.

Kinetic-kill missiles launched on the first turn of battle by ships (not stations) that have achieved surprise against an opponent will do extra damage; it is assumed that ships (and missiles) have time to accelerate to higher speeds. This bonus increases if the missiles possess reactionless or grav drives, as such missiles have no fuel limitations and can accelerate for longer.

Ammunition: Unlike beam or gun weapons, missile bays typically carry only a limited number of shots, and may contain even fewer shots of a specific missile type; moreover, individual missiles cost many thousands of credits each. GMs should track missile expenditure carefully.

Other Space Combat Systems

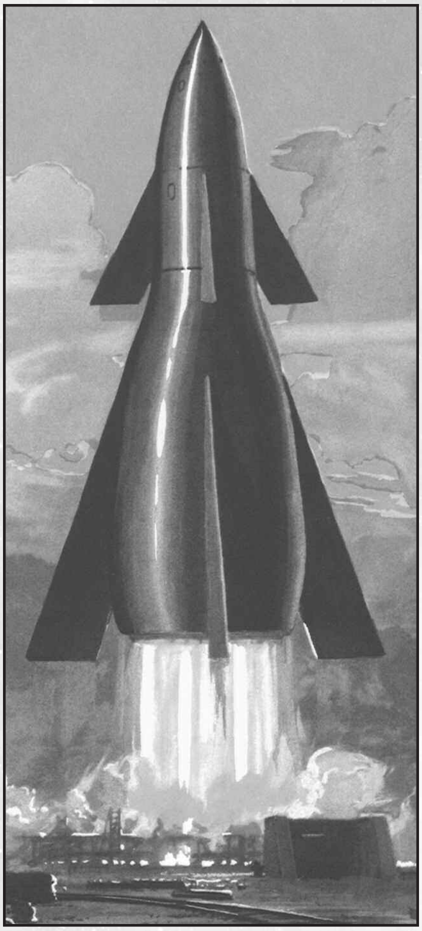
Alternative methods of resolving space combat can be found in several ***GURPS*** books:

Abstract Space Combat System (pp. CII100-106). A simpler system. To use it with ***Space,*** *Third Edition* ships, convert ship size in cubic feet to cubic yards (divide by 27) and derive DF and FP values as described on pp. CII100-101.

Space Opera Combat System (pp. CII106-111). A cinematic system relying heavily on GM fiat. Attempts to convey the heroic flavor of space-opera battles.

GURPS Vehicles, *Second Edition* (pp. VE164-165, 187) includes an outline for a complex system for resolving battles on a hex grid.

GURPS Traveller (pp. GT163-174). Another hex grid-based system, optimized for the ***Traveller*** setting. GMs who wish to use ***Traveller*** ships with this system should derive appropriate cSM, ASig, and PSig values using the rules in Chapter 8, and convert ***Traveller*** weaponry to cDAM and sAcc values using the guidelines in these sidebars. Change the time scale from 10 seconds to one minute and double the damage of ramming and kinetic-kill weapons (with a longer time scale, there is more time to build up higher speeds).



Damage

If a beam, gun, or missile attack succeeds, then the target has been hit and the firer should make a damage roll. (Exception: no damage roll is made when shooting at missiles. *Any* hit from a standard weapon will destroy a missile.) Damage dice are determined by the weapon's cDAM; see the *Beam and Gun Weapons Table* (p. 142) or *Missile Table* (p. 143), as appropriate. Note that some weapons suffer from reduced damage at long range.

Subtract the target's combined armor and force screen cDR (modified by the weapon's armor divisor, if any). If damage penetrates armor and screens, the excess hits are taken as damage. Apply damage against the target's hit points – normally the hull's hit points, unless the attack was specifically aimed at a turret.

Force screens may be overloaded by damage. If damage fails to penetrate a force screen but exceeds half the screen's cDR, the screen gains one energy level. If damage penetrates, the screen gains two energy levels. After a screen has gained eight energy levels, it collapses and cannot be raised again during the battle. (Screens may work differently in some settings.)

Force screens may be turned off in order to shed energy levels; this must be done on the ship's own turn. If so, every turn the screen is deactivated removes one energy level. GMs may allow engineers to make a heroic effort (see p. 49) to shed more energy: a successful Electronics Operation (Force Shields) roll will shed twice as much energy, but any failure will disable the screen.

Collision and Ramming Damage: If a ship collides with its target accidentally (due to a critical failure during a docking attempt or Attack Run), it inflicts cDAM equal to 1d(5) times *smaller* ship's cHP. If the collision is due to a deliberate attempt to a ram, multiply this damage by the amount by which the ramming ship won the Quick Contest of Skills (maximum 10). If both ships agreed to ram, or if the ram succeeded due to a critical success, multiply damage by 10. Note that *both* ships take ramming damage!

Damage Effects

All damage effects described below occur immediately after the damage occurs.

Major Damage: Each time cumulative damage to a ship's hull reaches a full multiple of 10% of its original cHP, roll 3d on the *Major Damage Table* (p. 144) and apply the result. This results in specific damage effects, like disabled drives.

A hull or turret reduced to 0 or fewer cHP is *disabled.* One reduced to -5 × its original cHP is *destroyed.* This has additional effects, as follows:

Hull Disabled: The spacecraft is crippled, out of power, and leaking air. A crippled vessel cannot take any maneuver but Drift, and can use neither FTL drives nor shipboard systems like sensors, computers, communicators, or weapons. However, piloted spacecraft (such as lifeboats or fighters) can still be launched.

Hull Destroyed: The spacecraft loses structural integrity. At the GM's discretion, it may break up or even explode, and the crew may be killed or be trapped in wreckage.

Turret Disabled: Weapons and other systems built into that turret no longer function.

Turret Destroyed: As above, but the systems cannot be repaired – they must be replaced at full cost. Any crew in the turret take 5d damage (personal DR does not protect against this).

Ending the Battle

In an abstract system, ending an engagement must be at the discretion of the GM. Assuming neither side agrees to stop fighting, the battle ends when one side is crippled or when its ships have broken off. GMs should be sympathetic to clever PC ploys to escape a hopeless battle! The GM may also rule that after breaking off, a new battle will begin a few minutes, hours, or days later, after the forces have had time to regroup, repair, and make new plans. This might also be the case if, for instance, the forces met at high speed and passed through each other while firing!

GURPS Weapon Statistics

Here are ordinary ***GURPS*** statistics for the guns and beam weapons used in ***Space.***

SS: 30.

Damage: Multiply cDAM by 100 to get ordinary damage. If using the table on p. VE125 to calculate damage for extremely powerful beam weapons (output over 1,000,000 kJ), substitute [10 × (cube root of O)] for (square root of O).

1/2D Range and **Acc:** 1/2D range in yards (*Max* range for disintegrators) in atmosphere is given below. Acc follows in parentheses.

Railguns: Lt.: 12,000 (19). Md.: 36,000 (19). Hv.: 120,000 (19).

Lasers (UV): Lt.: 110,000 (29). Md.: 340,000 (32). Hv.: 1,100,000 (35). EHv.: 3,400,000 (38). SHv.: 11,000,000 (41). UHv.: 33,000,000 (44).

Particle Beams: Lt.: 46,000 (27). Md.: 140,000 (29). Hv.: 460,000 (33). EHv.: 1,400,000 (35). SHv.: 4,600,000 (39). UHv.: 14,000,000 (41).

X-ray Lasers: Lt.: 230,000 (31). Md.: 730,000 (34). Hv.: 2,300,000 (37). EHv.: 7,300,000 (40). SHv.: 23,000,000 (43). UHv.: 73,000,000 (46).

Antiparticle Beams: Lt.: 90,000 (28). Md.: 280,000 (31). Hv.: 900,000 (34). EHv.: 2,800,000 (37). SHv.: 9,000,000 (40). UHv.: 28,000,000 (43).

Disintegrators: Lt.: 250,000 (31). Md.: 790,000 (34). Hv.: 2,500,000 (37). EHv.: 7,900,000 (40). SHv.: 25,000,000 (43). UHv.: 79,000,000 (46).

Max Range: For beam weapons other than disintegrators, this is three times ½D range. For railguns, it is twice ½D range.

Deriving sAcc

sAcc is a number that combines the weapon's Accuracy bonus, a range modifier, and modifiers for aiming and computer programs into one, easy-to-use value. GMs who wish to convert other ***GURPS Vehicles***-built weapons to this system can determine sAcc as follows:

sAcc = (Acc/2) - 17.

Acc/2 is half the weapon's Accuracy (using the *Reduced Hit Probability* rule, pp. VE182-183).

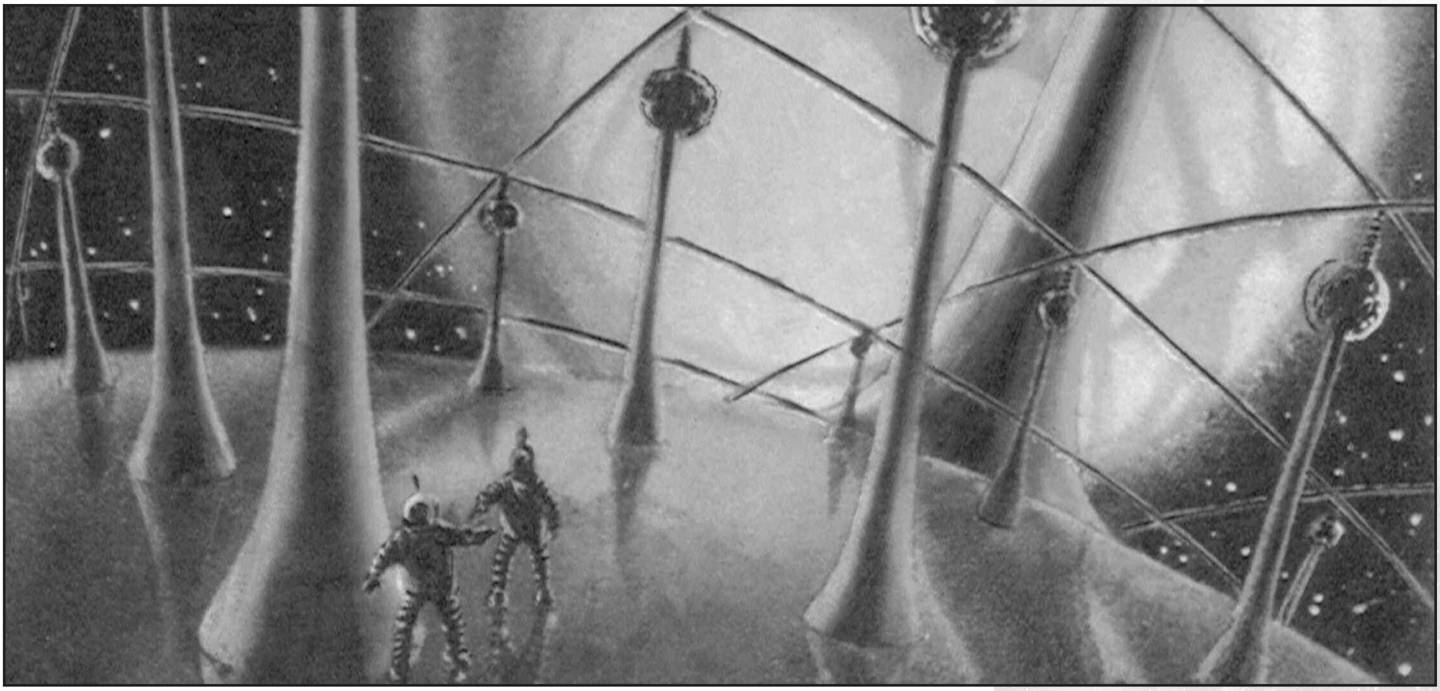
The -17 derives from the sum of these modifiers:

+3 for aiming for 3 seconds.

+5 for a Targeting program with Complexity 4.

+10 to account for the difference between cSM and Size Modifier.

-35, the Speed/Range modifier for 1,000 miles.



Tables

Initiative Table

Each side's captain (or squadron leader, if several ships) rolls 1d and adds:

+1 if he has a higher Tactics skill than the opposing commander, or +2 if skill is five or more higher. (Substitute Strategy skill if commanding 10 or more vessels.)

+1 if he has a higher IQ than his opponent.

+1 if his side has a ship whose sensors have a Scan bonus *higher* than any Scan bonus possessed by the enemy, or +2 if that bonus is five or more higher.*

+1 if his side has a sensor operator on duty who has a higher Electronics Operation (Sensors) skill than any sensor op on duty on the other side, or +2 if skill is five or more higher.

+1 if all vessels on his side have lower ASigs than the lowest ASig possessed by any of the enemy vessels.

+1 if all vessels on his side have lower PSigs than the lowest PSig possessed by any of the enemy vessels.

+1 if his side's slowest vessel is still faster than the enemy's slowest vessel, or +2 if it is also faster than the enemy's *fastest* vessel. For most ships, "fastest" means highest sAccel.

+1 or +2 if fighting in a busy region of space that is more familiar to his side than it is to the enemy. This includes dense asteroid belts, the space around a gas giant, the space junk- and satellite-filled orbits around a high-tech planet, etc.

+2 if the other side is broadcasting its position on open traffic-control frequencies. Civilian ships may be required by law to do this, which gives raiders a big advantage . . .

+1 to +3 if he possesses accurate intelligence on the enemy's intentions or predicted course and uses it to set an ambush (for example, laying in wait concealed behind asteroids), or if the GM decides that his side has a particularly clever plan.

* When comparing Scan bonuses for initiative, the PESA (passive) Scan number is normally used. Either side may indicate that it has turned on AESA (active sensors) *before* the engagement, however. If so, use the higher AESA Scan rating. Active sensors make it harder to be surprised, but they also make it nearly impossible to achieve surprise: If the side using AESA would have gained partial surprise, it is instead treated as a tied result; complete surprise is reduced to partial surprise.

Missile Performance

sAccel is based on the missile's sustained thrust. In order to produce the listed performance figures, reaction-drive missiles were assumed to need 30+ seconds' thrust; reactionless- and grav-drive missiles were assumed to require 20+ minutes' thrust (hence their ability to build up high speeds in the opening portion of the battle, if one side has the advantage of surprise). If converting ***GURPS Space,*** *Third Edition* missiles to the ***Traveller*** hex-grid system, only reactionless- or grav-drive missiles have the endurance to maneuver on the scale of that system. Light missiles have three turns' endurance, heavy missiles have four turns' endurance.

cSM is the missile's Size Modifier-10.

Skill was determined using the appropriate missile guidance system from ***GURPS Vehicles,*** with a -10 modifier (the difference between cSM and Size Modifier). Some missile designs may be operator-guided (for example, the missiles in ***GURPS Traveller***); in that case, Skill is 0 and the attack roll is against the gunner's Gunner (Guided Missile) skill.

Kinetic missile damage is an abstraction, since relative velocities will vary constantly through an engagement. It is based on the speed the missile could achieve in 10 seconds and assumes an armor-piercing depleted-uranium warhead.

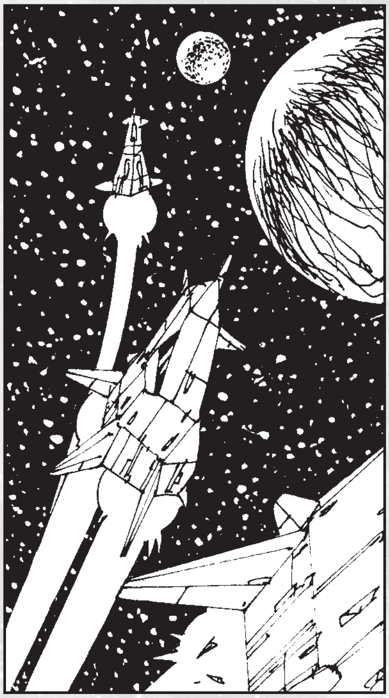
X-ray laser missile damage assumes a sub-kiloton yield nuclear bomb used to pump a 1 gigajoule energy beam.

Missiles were generally designed with DR 50 (cDR 0).

Covert Operations

Spies, smugglers, and special operators may wish to land covertly on an inhabited planet. A ship coming in for a landing will be at least as visible and audible as a large meteor due to the flare of reentry and the sonic booms as it decelerates from orbital speed. Of course, a vessel that possesses contragravity may be more stealthy!

If the planet is TL5-, the best solution is to come down in a secluded area (such as over the ocean or wilderness) a few hundred miles from any known habitation. With luck, no one will be there to see the ship. Making a landing during bad weather can further reduce this chance.



On TL6+ planets, the situation is made more difficult by the all-weather active and passive ground- and space-based sensor arrays routinely used for traffic control and planetary defense. Eluding them requires a combination of careful navigation (to avoid areas of extensive sensor coverage), good planning, and sensor-masking technology. Even so, the sensor arrays of major ultra-tech worlds may be all but impenetrable – at TL8+, a smuggler may only have a chance on frontier worlds.

Continued on next page . . .

Beam and Gun Weapons Table

Weapon	TL	Malf	sAcc	cDAM*
Railguns				
Light	8	ver.	-8	4d+1(3)†
Medium	8	ver.	-8	6d+2(3)†
Heavy	8	ver.	-8	9d×3(3)†
Lasers				
Light	8	ver.	-3	1d
Medium	8	ver.	-1	4d-1
Heavy	8	ver.	0	4d×2
Extra Heavy	8	ver.	+2	6d×3
Super Heavy	8	ver.	+3	8d×5
Ultra Heavy	8	ver.	+5	6d×15
Particle Beams				
Light	8	crit.	-4	6d
Medium	8	crit.	-3	6d×3
Heavy	8	crit.	-1	6d×6
Extra Heavy	8	crit.	0	6d×15
Super Heavy	8	crit.	+2	6d×30
Ultra Heavy	8	crit.	+3	6d×80
Tight-beam Particle Beams				
Light	8	crit.	-4	2d(4)
Medium	8	crit.	-3	6d(4)
Heavy	8	crit.	-1	6d×2(4)
Extra Heavy	8	crit.	0	6d×5(4)
Super Heavy	8	crit.	+2	6d×10(4)
Ultra Heavy	8	crit.	+3	8d×20(4)
X-ray Lasers				
Light	10	ver.	-2	2d(2)
Medium	10	ver.	0	6d-1(2)
Heavy	10	ver.	+1	6d×2(2)
Extra Heavy	10	ver.	+3	5d×5(2)
Super Heavy	10	ver.	+4	6d×9(2)
Ultra Heavy	10	ver.	+6	6d×20(2)
Antiparticle Beams (APAWs)				
Light	12	ver.	-3	3d×5(2)
Medium	12	ver.	-2	7d×5(2)
Heavy	12	ver.	0	5d×15(2)
Extra Heavy	12	ver.	+1	8d×20(2)
Super Heavy	12	ver.	+3	6d×60(2)
Ultra Heavy	12	ver.	+4	8d×100(2)
Disintegrators				
Light	15	crit.	-2	2d+1(100)
Medium	15	crit.	0	6d-1(100)
Heavy	15	crit.	+1	6d×2(100)
Extra Heavy	15	crit.	+3	5d×5(100)
Super Heavy	15	crit.	+4	6d×9(100)
Ultra Heavy	15	crit.	+6	6d×20(100)

TL: The tech level at which the weapon is introduced.

Malf: The likelihood of a malfunction on a critical failure. "Crit." means a malfunction occurs on any critical failure; "ver." means that it must be verified by a second roll, and only on another critical failure does it occur. Particle-beam Malf. goes from crit. to ver. at TL10+. If a malfunction occurs, an Armoury roll is needed to fix it (one crewman may attempt this each turn).

sAcc: The space-combat Accuracy value.

cDAM: Damage dice. A parenthetical number after damage is an armor divisor; e.g., 2d(2) means cDR is divided by two against that attack. Multiply cDAM by 100 to convert it to ordinary damage.

* If a weapon is designed at a TL higher than the one at which it was introduced, add +1 per die per TL for the first three TLs after it appears. E.g., a TL9 light particle beam would inflict 6d+6, while a TL11+ heavy railgun would dish out (9d+27)×3(3)!

† TL11+ railguns fire *hyperdense* ammunition. Change armor divisor from (3) to (5).

Beam and Gun Modifiers Table

Roll 3d against Gunner skill, with these modifiers:

Weapon: sAcc modifier (see *Beam and Gun Weapons Table,* above).

Target Size: Add the target's cSM. For objects for which cSM has not been calculated, cSM equals Size Modifier-10.

Range: +4 if target is at short range, or +10 if target is at point-blank range.

Target took Evasive Action maneuver: -2.

Target took Drift maneuver: +4 (+8 if firing railgun).

Firer Partially Surprised: -4 (-2 if gunner has Combat Reflexes).

Firer Completely Surprised: May only fire at missiles targeted on his ship, and does so at -6 (-3 if Combat Reflexes).

Targeting Program: A +5 Targeting program is built into a dedicated computer incorporated into each weapon system. If a better Targeting program is being run on the ship's computer, add its (bonus-5).

Missile Table

Missile	sAccel	cSM	Skill	Kinetic	Nuclear	X-ray
Reaction Drive						
Lt./8	6	-10	14	7d(3)	spcl.	–
Hv./8	9	-9	17	6d×3(3)	spcl.	–
Lt./9	9	-10	15	8d(3)	spcl.	–
Hv./9	12	-9	18/11	7d×3(3)	spcl.	5d×2(2)
Lt./10	12	-10	16	5d×2(3)	spcl.	–
Hv./10	20	-9	18/12	6d×9(3)	spcl.	(5d+5)×2(2)
Lt./11	14	-10	17	6d×2(5)	spcl.	–
Hv./11	25	-9	19/13	7d×8(5)	spcl.	(5d+10)×2(2)
Reactionless Drive						
Lt./9	0.5	-10	15	2d(3)	spcl.	–
Hv./9	0.5	-9	18/11	5d(3)	spcl.	5d×2(2)
Lt./10	2	-10	16	4d(3)	spcl.	–
Hv./10	2	-9	18/12	4d×4(3)	spcl.	(5d+5)×2(2)
Lt./11	17	-10	17	6d×2(5)	spcl.	–
Hv./11	25	-9	19/13	5d×10(5)	spcl.	(5d+10)×2(2)
Grav Drive						
Lt./12	350	-10	17	6d×10(5)	spcl.	–
Hv./12	500	-9	19/13	6d×40(5)	spcl.	(5d+10)×2(2)
Lt./13	700	-10	17	4d×20(5)	spcl.	–
Hv./13	1,000	-9	19/13	6d×60(5)	spcl.	(5d+10)×2(2)

sAccel: Missile's acceleration in Gs. Used to determine whether a missile can catch a target that is taking evasive action or breaking off.

cSM: Space-combat Size Modifier. Used when the missile is being shot at.

Skill: Abstract measure of missile's guidance system quality. Roll against this number to determine if the missile hits its target. Number after / applies if using an X-ray laser warhead.

Kinetic: cDAM with a kinetic-kill warhead. Damage is *halved* if fired at a target at point-blank range, *doubled* if fired at long range. If fired by a ship (not a station or other immobile vessel) with the advantage of surprise, damage is increased: if partial surprise, ×2 for reaction-drive missiles and ×5 for reactionless- or grav-drive missiles; if complete surprise, ×3 for reaction-drive missiles and ×10 for reactionless- or grav-drive missiles.

Covert Operations
(Continued)

Full details of planetary defenses are beyond the scope of this book, but for a quick and dirty rule for penetrating them, use the following:

1. If there are vessels in space near the world, the intruder must first achieve *complete surprise* against them, per p. 134. If it does this, it can slip past. If it fails, those vessels can intercept the intruder and can alert the planet's defenses, if any. If this happens, the intruder must either give up and try to break off, or abandon stealth and fight its way through. (If the planet's navy is alerted and has established patrols through the system, the GM may require two rolls to penetrate!)

2. If the intruder successfully eludes the planet's space patrol, it can attempt to evade orbital and ground sensors or watchers. For *each ship* trying to land undetected, roll against the captain's Tactics skill, with the modifiers below. Critical success means the ship can come down wherever it pleases without detection, and can fly about at will (the GM may require a further roll each hour). Success means the ship successfully avoids detection while in the upper atmosphere, but will be detected unless it chooses to land somewhere far from any habitation. Failure by 1 or 2 is treated as a success, except that the ship's trajectory was briefly tracked (visually or on sensors) and someone has a rough idea of where it is to within a few hundred miles. Failure by 3+ means the ship was detected while still in the air or in orbit. Depending on the planet's defenses and attitude, the ship may be ignored, or traffic control or a naval base may verbally challenge it, launch ships or aircraft to intercept it, or open fire with planetary or orbital weapons.

Modifiers to the captain's Tactics roll:

Alertness: +4 if the authorities are not very alert (typical of a sleepy frontier planet or complacent inner world); +2 if the planet is somewhat alert (usually the case if there is a navy or Patrol base present); no modifier if the planet is on high alert to the danger of intruders (e.g., a navy or Patrol base on a war footing or making a special effort to deal with smugglers or spies).

Piloting Skill: +1 if the ship's pilot has skill 15+, or +2 if he has skill 20+.

Continued on next page . . .

Covert Operations
(Continued)

Ship's ASig or PSig: Use the *higher* of the two values. If this is negative, add it to the captain's skill. If positive, subtract it from skill. E.g., a ship with ASig -6 would give +6 to Tactics; one with ASig +2 would give -2.

Starport Type: Subtract the starport class (p. 171) from skill.

Sensor TL: Subtract 2 × (TL-6) of the starport or planetary-defense sensors. If planet is TL5-, *add* +2.

Population: Add the (10 - Population Rating) (p. 166). E.g., a world with PR 7 would give a +3 bonus.

Contragravity: Ships with contragravity get +4 unless sensors can detect CG emanations (likely at TL11+).

Knowledge: If the captain has details of the planet's sensor systems and any weaknesses, blind spots, or pass codes, or even holidays when the defenders may be less alert, etc., the GM may assign a +1 to +5 bonus. Having bridge crew aboard who have previously made a run through this planet's defenses without being detected should give +2 or +3. But if planetary defenses have been warned to expect intruders at a particular time or place, the GM can apply a -1 to -5 penalty!

Good Planning: The basic Tactics roll simulates good planning, knowledge of sensors, and the use of night, weather, and terrain to mask approaches. The GM can give bonuses for good ideas (or penalties for bad ones). For example, a smuggling run might be timed to coincide with a heavy meteor shower. The ship glides in, its entry path mimicking a meteor's trajectory, using engines to level out only at the last moment, when it is below the clouds and hopefully masked by terrain from any ground-based sensor systems. This might give a +5 or better bonus . . . if meteor showers are common in that system at that time of year, and if the locals have no reason to suspect such a trick. This is most effective if the ship is relatively small (PSig and ASig total 0 or less). A "large meteor" might well be blasted out of space without any warning at all by planetary defense systems designed to protect against asteroids!

3. Taking Off. For ships attempting to take off without being detected, the GM can reverse the above procedure. Obviously, some tricks will not work (e.g., pretending to be a meteor).

Nuclear: cDAM with a nuclear warhead is 6d×200,000 with a light missile or 6d×20,000,000 with a heavy missile. If nuclear attack is a proximity explosion, divide damage by 10,000. cDR protects at a higher value than normal against explosions (impact or proximity): square it and multiply by 100 to get effective cDR (e.g., cDR 5 would protect as cDR 2,500 vs. explosions).

X-ray: cDAM with an X-ray laser warhead.

Missile Attack Table

Roll 3d vs. the missile's Skill, with these modifiers:

Target's Sensor Signature: Add the *higher* of target's ASig and PSig.

Relative Speed: -4 if the missile is no faster than the target, or slower; -2 if the missile is faster than the target, but less than twice as fast.

Target took Evasive Action maneuver: -2.

Proximity Blast (nuclear missiles only): +6.

Major Damage Table

3 – Energy bank damaged: lose 50% of stored energy. If target has no energy bank, treat as #12.

4 – Force screen damaged: halve its DR. If target has no force screen, treat as #13.

5 – FTL drive knocked out (if warp drive, halve its speed instead).* If target has no FTL drive, treat as #14.

6 – Cargo damage: 25% of cargo is lost.

7 – Roll 1d: on 1-3, one sensor is knocked out; on 4-6, one computer is knocked out.

8 – One accessory or gravity system (e.g., automeds, lab, freeze tubes, tractor beam, teleport projector, artificial/spin gravity, or contragravity) is knocked out. Roll randomly, or GM assigns.*

9 – Power loss: -50% power output from highest-output plant.

10 – Weapon damaged: largest turret or other weapon disabled (GM's option).* If target has no weapons, treat as #6.

11 – No special effect.

12 – Tankage shattered: 25% of fuel or reaction mass lost. If target has no tanks, treat as #14.

13 – 1d passengers injured: 5d damage each, ignore DR.*

14 – Maneuver drive damaged: halve sAccel.* If target has no maneuver drive, treat as #9.

15 – Spacedock or vehicle bay damaged: door cannot be opened/shut.* If target has no docks or bays, treat as #6.

16 – Bridge or cockpit knocked out. Ship is crippled unless it has an extra bridge.*

17 – Life support damaged: loses 10% of original capacity.*

18 – Power plant knocked out: lose highest-output plant.* If power plant is antimatter, roll 3d: on a 16 or less, the ship blows up and everything nearby takes damage as per a proximity nuclear blast from a light missile.

* One-third of the crew in that area (engineers if drive or power plant, gunners if turret, medics if surgery, stewards if passenger compartment, etc.) are badly injured and out of action, minimum one character. If PCs or major NPCs are present, roll 1d: on a 5-6, 5d damage is suffered (ignore DR).

Any time the damage result could describe more than one system (e.g., "drive" when the ship has two different drives), roll randomly to see which one is affected. With some FTL drives, it will be impossible to enter FTL until the drive is fully operational. With other drives, the ship is simply slowed.

Loss of power may force systems to shut down – see Chapter 8 for system power requirements. Loss of computers prevents the use of software (p. 66). Loss of *all* sensors means that no weapons except missiles can be used.

If crew or passenger injuries result from a particle beam, antiparticle beam, or nuclear missile, 10 rads × damage rolled may also be suffered (GM's option).

CHAPTER 10

STARS AND WORLDS

When the GM knows what type of campaign he wants to run and what his interstellar civilization is like in general, it's time to draw a star map and start creating worlds.

This chapter describes a step-by-step method for the GM to follow in building stars and worlds logically. Also included, mostly in the sidebars, are probability tables for the GM who wants to create many worlds quickly (or perhaps write a computer program to do the job).

Fill in a Planetary Record sheet (example on p. 164, blank form on p. 176) as you develop each system and its worlds.

Star Mapping

The type of map to draw depends on the scope of your campaign and especially on the type of FTL travel used in your universe.

If starships move by "jumplines" or a similar system, space can be mapped just by drawing the jumplines. A star (or anything else) that isn't on a jumpline may be ignored; it can't be reached except by a generation ship! If travel is instantaneous, only the connections are important. If travel along jumplines takes time, the length of each line must also be shown.

If ships move through hyperspace, the distance between stars is important, but intervening features may be ignored.

If FTL ships use a warp drive to move through normal space, possible hazards like nebulae should be mapped. In general, any area that could harbor foes or slow travel should be shown on a map.

Map Scale

Map scale will depend entirely on the frequency of important worlds (not just habitable ones). If useful worlds average 3-5 parsecs apart, for instance, a ¼″ square grid, with each square representing a parsec, will be convenient. If worlds are closer together, as in a cluster, use a smaller scale.

The Third Dimension

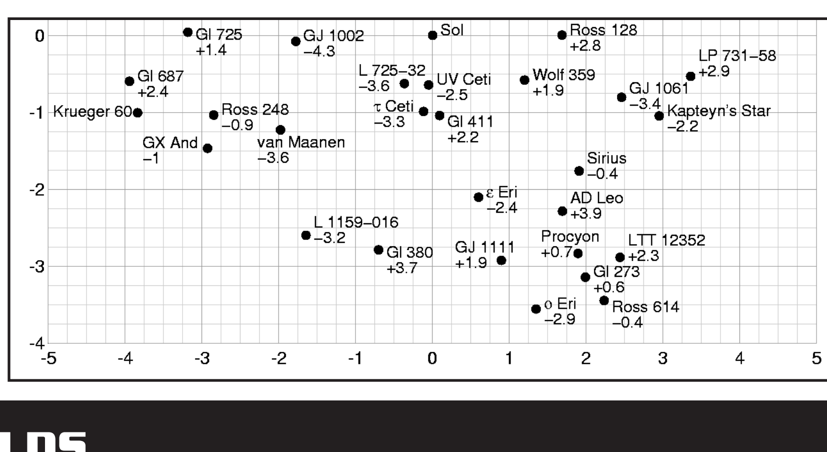
Maps (at least the convenient kind) are flat, but space is not. You may simply ignore this and place all your star systems in the same plane. But it is more realistic to use a three-dimensional grid system. The map surface itself represents a "height" of 0. If you are mapping a whole galaxy, zero height indicates the "galactic plane."

A star above the galactic plane should be mapped with a "+" sign, followed by its distance above the plane in parsecs. If it lies below the plane, note it with a "-" sign and the distance. Stars on the galactic plane need no designation. Thus, if Lestrade's Star lies 4 pc below the galactic plane, this should be noted on your map with (-4).

To find distances between stars when using 3D coordinates, use the formula $x^2 + y^2 + z^2 = d^2$. That is: square the distance, on each of the three axes, between the two stars. Sum the squares. The square root of the sum is the straight-line distance between the stars.

3D Terminology

A spacer uses standard directions to describe star locations. When he says "north," he means *galactic* north, unless he is groundside. Galactic north is perpendicular to the plane of the galactic disc; looking "down" from the galactic north pole, the galaxy rotates counterclockwise around the observer. Galactic east is the direction of galactic rotation. The remaining dimension is described as "in" toward or "out" away from the galactic core.



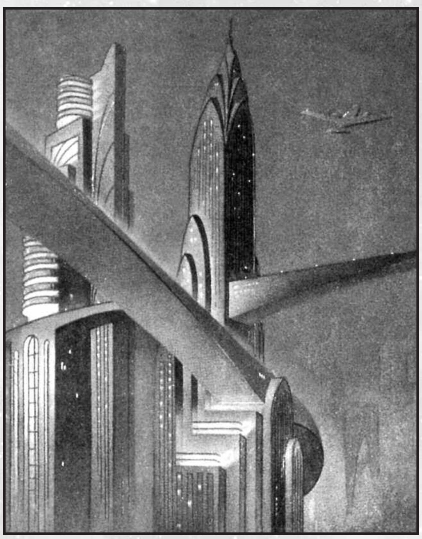
Astronomical Measurement

Three measures of distance are used on the stellar and interstellar scale:

The *astronomical unit* (AU) is approximately 93 million miles. This is the distance from Earth to the sun. Orbital distances from a star are expressed in AU in this book. In our own solar system, Earth lies 1 AU from the sun, Mercury is 0.4 AU from the sun, and Uranus lies 19.2 AU out.

The *light year* (ly) is some 5.9×10^{12} miles – the distance light travels in one year. This is a common measure of distance in science and science fiction. One ly equals 63,271 AU.

The *parsec* (pc) – a *par*allax of one *sec*ond, or 206,265 AU – is approximately 3.26 ly. This is roughly the distance from Sol to the nearest star, Alpha Centauri. The parsec is the standard unit of interstellar measurement in this book.



Random Star Location

Assuming three-dimensional grid points one parsec apart, and a general separation between stars of about 4 parsecs, the GM may roll 2d to determine what lies at each grid point. Add 1 to the roll in a cluster or core area.

2-9 – Empty space.

10 – Possible unusual item; roll one die. If the result is a 6, go to the *Unusual Stellar Objects* table (p. 149). Otherwise, there is nothing here.

11+ – Star system.

Note that this is a very time-consuming method of building a star map, unless you program a computer to do it for you. See p. 148 for an alternate method of placing worlds.

Astrographic Features

Map features (depending on the scale chosen) may include:

Galactic clusters. Galaxies congregate into structures known as *clusters:* groups of 10-100 galaxies within 1.5 million parsecs of one another. Clusters are distributed through the universe as though space contained invisible bubbles, with clusters on the surface of the bubbles. There are great voids, surrounded by expanding fringes of galactic clusters. The "bubbles" seem to be distributed evenly; scientists differ over whether the universe has or *can have* a center.

Galaxies. Our galaxy is 30,000 parsecs across, with most of its matter close to the galactic plane, in the "disk." The "core" is a flattened bulge, about 1,800 parsecs thick. Our galaxy may be a "barred" spiral with an elongated core about 1,800 parsecs wide and 4,500 parsecs long.

"Elliptical" galaxies also exist, and differ from our own in that they are not disk-shaped and tend to be made up of Population II stars (see p. 150). There are also "irregular" and "dwarf" galaxies. Dwarf galaxies may be tens or hundreds of times less massive than our own galaxy, and are far more numerous than disk galaxies.

Galactic arms. Our galaxy, like many, has spiral "arms." The arms contain more gas and hot, young stars; this is what makes them visible. Stars are born in the arms, but as they age their orbits take them elsewhere in the disk. The spiral pattern will continue, with new stars born as others age and wander. Galactic arms are often broken or irregular. An average arm is 1,800 parsecs wide and 600 parsecs thick. Elliptical galaxies lack this kind of internal structure.

Globular clusters, 6-60 parsecs in diameter, form when a galaxy is young. They contain some 100,000 tightly packed stars. In our galaxy, these clusters and their stars are very old. Many of the stars are red giants, and a large black hole may reside at a cluster's core. Star systems may be mere light-weeks apart in the center; thus, few worlds have stable orbits or life. Clusters do not concentrate in the galactic disk, but orbit the core, crashing through the disk twice per orbit.

Molecular clouds or *dark nebulae* are gas clouds 1-60 parsecs across. They may contain stars in the process of formation. A "dark" nebula may glow if it is excited by radiation from a nearby star or its own protostars. Nebulae can be important in a campaign if they conceal stars or block or slow interstellar travel.

Open clusters. When a nebula is disturbed by an outside influence, concentrations of gas occur, which then suck in more gas . . . and stars are formed. Originally, the stars are close together, but outside influences gradually scatter them – especially in smaller clusters. Binary (two-star) systems are common in open clusters; trinary (three-star) and larger systems are possible. Stars, and therefore worlds, are close together in clusters, making them strategic locations and logical centers of trade.

Young open clusters are tight-packed groupings of stars, 3-15 pc across; many are hot and bright. Their radiation may ionize any remaining interstellar gas in the cluster, making it glow. Or a dense cloud may shield the stars within from outside view; on the inside, the cloud will be lit by the stars' light.

Middle-aged open clusters are less tightly packed: 6-25 pc across. The hot, bright stars have destroyed themselves in supernovae. Any remaining gas in the cluster is dark. These clusters are most likely to have life-bearing worlds.

Old clusters are rare, since a cluster is usually scattered before it reaches this age. They include many red giants and dwarf stars.

Active galactic nuclei. At the center of some galaxies lurk huge black holes, up to billions of times as massive as our sun. If there is interstellar gas accreting onto the black hole, the energy released may cause the central regions of the galaxy to become an *active galactic nucleus* (AGN). This can occur in any kind of galaxy. A *quasar* is a particularly bright type of AGN. The central regions of a galaxy with an AGN will be flooded with high-energy radiation out to hundreds, even thousands of parsecs. An AGN would make traveling near the galactic core very dangerous (thousands or millions of rads of gamma radiation per second!). Only a TL16 civilization could even venture into the same galaxy as a quasar.

Generating Star Systems

Single or Multiple?

As many as one in three star systems may be a multiple star. Roll 2d to determine how many stars there are in the system, adding 2 to the roll if the area is in a cluster or galactic core:

2-9 – Single star.
10 – Double star.
11 – Triple star.
12+ – Four or more stars – a double rotating around a double or triple, for instance – GM's decision!

Star Class (Size)

Stars fall into four size classes: *main-sequence* stars (average-sized stars like our own sun, and the most common), smaller *dwarfs* and *subdwarfs,* larger *giants,* and huge *supergiants.* Roll 3d:

3-5 – White dwarf (Class D).
6 – Subdwarf star (Class VI).
7-17 – Main-sequence star (Class V).
18 – Giant star; roll 3d again:
3 – Class I supergiant. 1 in 3 chance of Class Ia (the largest); 2 in 3 chance of Class Ib.
4 – Class II large giant.
5-12 – Class III giant.
13-18 – Class IV subgiant.

Main-Sequence Star Types

To determine type of a main-sequence star (Class V), roll 3d:

3 – O (Blue).
4 – B (Blue-white).
5 – A (White).
6 – F (Yellow-white).
7 – G (Yellow).
8 – K (Orange).
9-18 – M (Red).

Clearly, the small, M-type red stars are by far the most common.

Giant Star Types

To determine the type of a giant, subgiant, or supergiant star, roll 2d:

2 – O (Blue).
3 – M (Red).
4, 5 – B (Blue-white).
6-9 – K (Orange).
10-12 – A (White).

Certain giant stars do not seem to exist. Ignore and re-roll the following results: O-II, O-III, O-IV and M-IV.

Also ignore any Blue or Blue-white result if you are mapping an area of space other than a spiral arm or young cluster.

Giant stars of types F and G are very unusual – they exist, but they are much too rare to show on a random table.

Subdwarf Star Types

Roll 1d for a subdwarf's color:

1 – G (Yellow).
2 – K (Orange).
3-6 – M (Red).

Placing Worlds

There are some 4×10^{11} stars in our galaxy; 1.3×10^{11} (one third) are thought to have planets. How many of these are suitable for life? *Insufficient data. It's anyone's guess.* Any number of scholarly calculations can be made, and they're all based on assumptions.

This means that the GM is free to make habitable worlds as common as he likes. It is possible that earthlike worlds are a natural feature of G-type stars. It's also possible that the right combination of temperature, gravity, and composition is so rare that explorers will have to search thousands of stars to find one marginally habitable world.

Unless habitable worlds are incredibly rare, we will find many planets that just aren't worth bothering with. These will include some we might not care to colonize (though there will usually be at least two life-candidates per system): hot or cold, thick or thin atmospheres, or tide-locked worlds on which one side permanently faces the sun. There will be worlds with nothing more than amoebas in an organic soup, or lichen on eroding rock. There will be worlds with intelligent life that has not developed star travel, or that has destroyed itself or been destroyed. There will also be high-TL races which have no star travel due to lack of metals, odd technological development, or unsuitable physiology or temperament (aerial or aquatic creatures, perhaps).

The point is this: If the campaign covers more than a few cubic parsecs, the GM should not try to map every star, or even every habitable system, and probably not even every world with intelligent life. There are just too many. The GM can concentrate on locating the major star systems in his campaign, just as the publisher of a road atlas selects the most important cities for a national map.

There are two ways to locate worlds. The easiest is to close your eyes and mark the map twenty or so times – each mark will be an important world.

The harder method is to study the map and add systems at selected spots for economic, military, and campaign reasons. For instance, clusters will logically contain more stars, and more chances for a useful world.

For realism, GMs should combine both methods. Systems in vital locations will be colonized, even if they aren't ideal. And some of the best worlds for settlement may be remote. Random location reflects this.

Unusual Stellar Objects

Many of the following interstellar objects are rare, once-in-a-campaign encounters. They may be posted "prohibited" or "hazardous" by interstellar authorities, *if they are known.* Even in known space, however, many of the smaller or dimmer objects may be uncharted.

Protostars. A star is created by the collapse, due to gravity, of a cloud of dust and gas. A small cloud – a "globule" – can give birth to 1-3 stars; larger nebulae create a cluster of stars of many different types. The condensing cloud spins and begins to glow as it collapses. These objects are also called *T Tauri variables.*

Lost planets. Worlds can become separated from their parent star when another star passes, becoming frozen wanderers of interstellar space. Such planets may be fairly common, but they are extremely unlikely to be discovered due to their size and darkness in the vastness of space. However, they might contain relics of former life, or even surviving life that has somehow adapted. Wandering gas giants, or even "brown dwarfs" (see p. 154), are also possible.

Planetary nebulae. In the last stages of a red giant's life, it throws out much of its mass to form a spherical shell, 0.1-0.5 pc across, called a *planetary nebula.* The star's ultraviolet light makes the nebula glow brightly. A giant may throw off several nebulae, one after the other.

White dwarfs. After a red giant throws off its last planetary nebula, the core that remains is a white dwarf star: a ball of degenerate matter at a uniform temperature. This is small but extremely dense, rarely larger than a medium-sized planet. If any worlds survive, they are usually long-dead, outer-orbit cinders (the inner worlds were destroyed when the star became a red giant).

Multiple-Star Systems

Most multiple-star systems are made up of stars which evolved together. The companions may be of very different types, but they will have the same age. But since stars evolve at different rates, a pairing like red giant/blue giant is possible. Another likely combination is a red giant and a white dwarf; if they are close binaries, they may form a nova system (see p. 149). If close companions are very different in energy output, their worlds will experience "seasons" depending upon which star is closest to them. These seasons may be as short as days or as long as months.

The dynamics of multiple-star systems make planets rarer than in single-star systems: Under *Generating Worlds* (p. 154), modify each die roll by +/-2 toward "Empty orbit" when checking for planets in multiple-star systems; e.g., a roll of 6 for "Orbits Outside the Biozone" would become a 4; a roll of 1 would become a 3.

Binary Systems

These contain two stars, revolving around one another. Binary systems are common, especially within open clusters (p. 147). Binary systems with planets fall into one of two types:

Close Companions: The two stars are very close, revolving rapidly around one another. Worlds orbit around the center of mass of the stars. The minimum orbital distance equals three times the separation between the two stars. Habitable close binaries are rare – it is difficult to have worlds close enough to be habitable, unless the stars are so close that they will soon destroy one another. In a *contact binary,* the stars' gaseous envelopes are in contact.

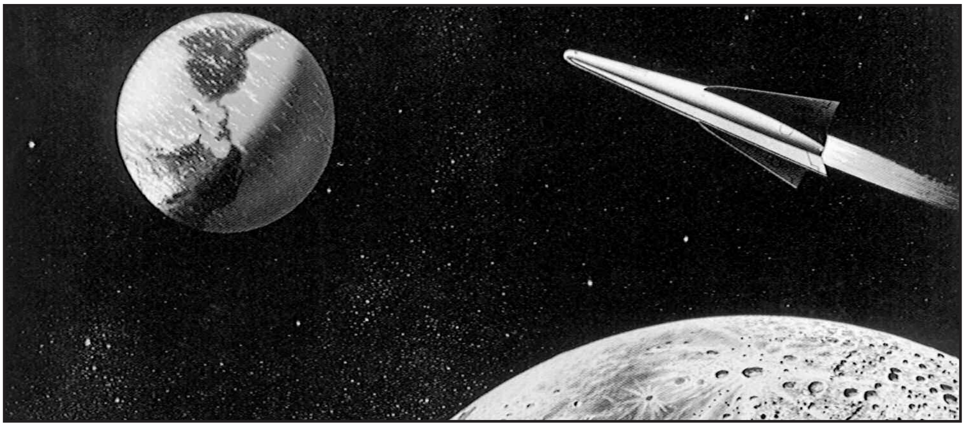
Distant Companions: The two stars are distant, so each star can have its own set of worlds. Neither star has much effect on the other's planetary system. Distant binaries are less common than close binaries. When determining worlds for a system with a distant companion, use the normal rules for each of the two stars. The maximum orbit for any world is 1/3 the distance between the stars.

Trinary Systems

These systems have three stars in close association. Commonly, two form a close binary pair; the third star is a distant companion of the close binary.

Quaternary Systems

These four-star systems typically consist of two binary pairs, each pair being a distant companion of the other. Larger systems are possible, but rare; they are usually found in open clusters.



Black dwarfs. White dwarfs eventually cool and become dark and dead. Any remaining worlds are perpetually frozen. Formerly inhabited worlds of such suns will be eerie museums, full of relics of their vanished peoples.

Novae. When two stars of unequal mass form a close binary pair, the larger star will use its fuel faster – going to red giant and then white dwarf stage before its companion. When a red giant is a close companion with a white dwarf star, the white dwarf will collect hydrogen from the red giant's stellar atmosphere. The hydrogen compresses under the dwarf's gravity until it flares in a brief thermonuclear reaction – a *nova.* Such a binary pair may "go nova" several times in its lifetime. Each time, ejected material forms a spherical shell of gas (a "nova shell") around the system, up to 12 pc across. It is probable that there are other mechanisms – for instance, collision with a large planet or even a dense nebula – that could create a nova or nova-like effect.

Supernovae. A *supernova* is the explosive death of a star, which for a few weeks may be as bright as an entire galaxy. There are two primary sorts of supernovae. One is similar to a nova (above), but completely destroys the white dwarf. The other is the collapse of a huge star (at least 8 times the mass of our sun) which has exhausted all of the nuclear fusion fuel at its core.

A supernova creates a shockwave which may help form gas clouds and trigger the formation of new stars. A star goes supernova only once, leaving behind a vast, glowing gas shell (called a *supernova remnant*) up to 60 pc across possibly with a pulsar (below) or black hole (p. 150) at its center. Remnants eventually become dark nebulae (p. 147) when the radiation levels fall off (about 100,000 years). Supernovae are believed to occur approximately once per century in our galaxy.

Variable stars increase and decrease their output of energy at regular or irregular periods. These include pulsational variables, such as the F and G supergiant *Cepheid variables* and type-A blue giant *RR Lyrae* stars (limited to the galactic core and globular clusters), that have regular intervals between their pulses of energy; *explosive* or *catastrophic variables,* such as the binary *SS Cygni,* that exhibit nova-like bursts, but of smaller amplitudes, every few months to a year apart; and other variables, such as red *UV Ceti* flare stars, which display intense solar flares on irregular occasions.

Neutron stars and *pulsars.* The central remnant of a supernova (above) which destroys a star up to 20 times as massive as our sun will collapse under gravity until the pressure of its neutrons can support it – creating a *neutron star.* A neutron star is a hot, dim object about 20 miles across, with intense gravitational and magnetic fields. There is evidence that neutron stars may retain planets, although these will be sterile rockballs charred by the supernova blast. The matter of a neutron star (sometimes called "neutronium") is dense – a teaspoonful weighs billions of tons.

Neutron stars generally rotate very rapidly (once per second or so). High-energy radiation is emitted from the star's magnetic poles, forming "lighthouse" beams which can be detected at interstellar distances. To someone in the right position to view these, the star appears to pulse at regular intervals, forming a *pulsar.* The pulse is extremely hazardous to ships in the vicinity – but from a distance, a pulsar is an excellent landmark for a lost ship trying to orient itself.

Unusual Stellar Objects

To generate a random "unusual object" in interstellar space, roll 3d. Supernovae, huge black holes, zones of improbability (p. 164), and white holes are too uncommon to appear randomly on a three-die table; the GM must place these unique objects intentionally if he wants them to exist.

3 – Neutron star.
4 – Black dwarf (no planets).
5 – X-ray star.
6, 7 – Brown dwarf, with planet-size moon(s).
8, 9 – Lost planet (gas giant).
10-13 – Lost planet (terrestrial).
14 – Flare star (red M-type).
15 – SS Cygni catastrophic variable; roll 2d for number of months between bursts.
16 – Center of nova shell.
17 – Center of small dark nebula; roll 1d for diameter in parsecs.
18 – Roll on *Very Unusual Stellar Objects* table (below).

Very Unusual Stellar Objects

3 – Antimatter system.
4 – Planetary nebula; diameter 1d × 0.1 pc.
5 – Pulsar.
6 – Center of dark nebula with T Tauri protostars condensing; roll 1d for diameter of nebula in parsecs, 1d for number of protostars.
7 – Black dwarf, with planets.
8 – Center of large dark nebula; roll 3d for diameter in parsecs.
9, 10 – Black hole of average stellar mass.
11 – Nova.
12 – Black hole of 10 times average stellar mass.
13 – X-ray burster.
14,15 – Natural wormhole to *somewhere.*
16 – Star enclosed by Dyson sphere (p. 162). Star will be type F through M.
17 – Center of huge dark nebula; roll 6d for diameter in parsecs.
18 – Neutron star/pulsar surrounded by supernova remnant.

Stellar Populations

Astronomers sometimes divide stars into two distinct types according to their age: Population I and Population II. The two types are not absolutely distinct, and astronomers recognize a wide range of intermediate types.

Population II stars tend to be older, relics of the galaxy's early history. Extreme Population II stars may be left over from the original formation of the galaxy. Such ancient stars contain almost nothing except hydrogen and helium. They are unlikely to have any planets except for hydrogen-helium gas giants and the rare captured world.

Younger Population II stars, and all Population I stars, are from the second (or later) generation. They formed from interstellar material enriched in heavy elements by earlier stars. Since planets are formed from the same material that makes up their star, Population I stars can have planets with heavy elements. The younger the star, the more likely it is to have high-density planets.

Population I stars are found only in the galactic arms. Population II stars are more likely to be found in the galactic core and the "halo" around the galaxy. The closer one gets to the galactic disk, the younger the stars are likely to be.

It is easy to estimate the age of a star at a great distance. If a star can be seen, its spectrum can be studied and the presence of heavy elements determined. If the age of stars is going to be used in a campaign, the *Stellar Ages and Planetary Density* rule (sidebar, p. 156) should be applied. Stars older than about 10 billion years are likely to be very deficient in heavy elements. Such stars will only have hydrogen-helium gas giants, and will have no asteroid belt, comets, or Oort Cloud.

Black holes. When the largest giant stars (more than c. 20 times the mass of our sun) go supernova (p. 149), the object at the core of the supernova remnant is too massive to be supported against gravity by neutron pressure. As the core collapses to only a few miles across, its gravity increases beyond 10^{10} Gs. This makes the escape velocity greater than the speed of light – the star *vanishes from sight,* becoming a black hole. The sphere from within which light cannot escape is known as the *Schwarzschild region,* the boundary of which is called the *event horizon.*

Black holes passing through a cloud or accompanying another star may be surrounded by an *accretion disk,* a disk-shaped collection of dust and molecules orbiting just outside the event horizon and spiraling inward. At the cores of galaxies or globular clusters, extremely massive black holes can be formed by accretion. A black hole with the mass of our galaxy would have an event horizon radius of 0.01 pc. Accretion onto such a black hole would power an AGN (p. 147).

Black holes slowly "evaporate" by a process known as Hawking radiation, and will eventually vanish. A black hole of stellar mass radiates slowly and may outlast the universe; smaller holes evaporate faster. A 2,000-ton black hole would last only a second before exploding in an intense burst of gamma rays. Therefore, conveniently small black holes have inconveniently short life spans.

Gravity waves are produced as objects fall into a black hole; ships near the event horizon can be torn apart by them. Within about 1000 miles, the normal gravitational "tide" of a stellar-mass black hole is dangerous as well – it will stretch ships until their structures fail. Even approaches to within 100,000 miles or so of such a black hole are hazardous: the gravitational field produces a relativistic effect which will effectively send an intruding starship on a one-way trip to the future. Physics and Astrogation rolls, both at -5, would be required to predict this effect enough to use it constructively. Otherwise, the ship might find it has "lost" anything from a few minutes to billions of years.

The laws of physics, as currently understood, suggest that nothing can stop the eventual collapse of all matter within a black hole's event horizon into an infinitely dense point with no size: a *singularity.* At, or within observation range of, a singularity, the known laws of physics may break down in unpredictable ways: time might reverse, cause-and-effect might disappear – anything could happen. For this reason, physicists are grateful that singularities are invisible within their event horizons . . . but what happens to someone who penetrates the event horizon and sees a singularity is unknown, except that the enormous gravity should rip his molecules into disassociated atoms first. A suitably protected starship at FTL speeds could theoretically escape from within the event horizon, but would exit into a universe eons older than when it entered, or perhaps into a different universe . . .

X-ray stars. These are binaries where one component is a normal star and the other is either a black hole or a neutron star. Matter from the normal star flows to its companion, producing radiation. If a black hole is involved, this is continuous, full-spectrum radiation that includes visible light and gamma rays. If the companion is a neutron star, the effect is more nova-like and very energetic, producing frequent bursts of hard X-rays. These objects are called *X-ray bursters.* Starships within 100 AU will take 1d cDAM (see Chapter 9) and 10+ rads per hour; those within 10 AU will take 3d cDAM damage and 1,000+ rads per hour.

White holes. It was once speculated that an object sucked into a black hole would reenter normal space at a point called a "white hole." There is currently no evidence to support this. If white holes exist, they are probably rare and would be of value for research – wars might even be fought over them.

Antimatter systems. Theoretically possible, though none are known. Such a system would appear quite normal, but since it would have to originate outside the galaxy, its orbit might be unusual. It would also generate a high level of gamma radiation through interaction with cosmic gas and dust. Generate such a system normally (planets and all), but all objects in the system will be antimatter. Contact with any of them will be explosive!

An antimatter system, if already charted, will definitely be off limits. If uncharted, explorers will have a chance to realize its nature: antiparticle radiation from the star will cause random instrument errors, and then actual failures, as the star is approached. Contact with even the fringes of a planet's atmosphere will produce explosions as the antiparticles annihilate the particles of the ship, boat, or probe. On the other hand, superscience technologies may allow such systems to be "mined" for antimatter fuel in some universes.

Wormholes. A ship making a proper approach to such a "natural stargate" may come out . . . somewhere else. Even if a return trip is possible, an Astrogation roll is necessary to do it right. A failed roll can mean the ship is lost forever, and crew and passengers have suddenly become colonists.

Creating the Star System

When the stars have been mapped, the GM can detail the systems in which the campaign will take place. The most important systems will have at least one habitable world. A world is "habitable" if an intelligent race can establish a viable colony there. Uninhabitable worlds can still hold docking facilities, mines, or research stations.

Star Types

To design a world in detail, start by choosing the type of star the world orbits. Stars are classified by spectral type. From brightest (and hottest) to dimmest, the "main-sequence" star types are O (blue), B (blue-white), A (white), F (yellow-white), G (yellow), K (orange), and M (red). Astronomers remember spectral types and their order with a mnemonic: "**O**h, **B**e **A** **F**ine **G**irl, **K**iss **M**e." Each type is further divided into subclasses 0-9, 0 being brighter than 9. A Roman-numeral suffix indicates the star's size; supergiants are Ia and Ib, giants are II and III, subgiants IV, main-sequence stars V, dwarfs VI. Our sun is classified G2 V, a fairly bright, yellow, main-sequence star.

Outside the regular classification system are white dwarfs (type D), the last stage in the life of a main-sequence star. They are unlikely to have usable worlds.

The brightest stars are the blue, blue-white, and white ones: O, B, and A types. These stars are massive, but they also burn their hydrogen quickly, which means they are short-lived. Observation of the rotation rate of these stars argues that they are unlikely to have planets – and if one did, the system would be so young that life would have had little time to evolve.

F (yellow-white) stars are brighter than our sun, so earthlike planets will orbit at a greater distance. These stars also emit more harmful radiation, which can be counteracted if a world has a high magnetic field (due to a high density) or a thick atmosphere.

K (orange) stars are dimmer than our sun; M (red) stars are smaller and dimmer still. K and M stars produce much less radiation than G stars, so habitable worlds require little radiation protection. The dimmer the star, the longer-lived it will be, and the more highly developed its life might be.

On the whole, the GM may choose any star type from F to M for a habitable world. O, B, and A stars will have habitable planets only rarely. White dwarf stars will often have planets, but they will have been badly scorched during the star's red-giant phase.

Rarer Star Types

Some dim stars similar to M stars are classified on the basis of the molecules found in their outer layers. "Carbon stars" (R and N stars) feature certain carbon-containing molecules, while S stars contain particular heavy metal oxides. At the other end of the scale are rare "Wolf-Rayet stars": massive, O-like stars which have lost most of their outer material to a companion, leaving an extremely hot, exposed stellar core.

System Names

Stars and worlds are traditionally named by the discoverer, though they may be renamed by colonists or conquerors. Military and scientific personnel often refer to planets by their star name and orbit number (Cephallo III would be the third planet of the star Cephallo).

There is usually a connection among the names of the worlds in a system, though the connection may be obvious only to the namer.

Types of names include:

Native names. Likely to be unpronounceable by humans. Example: Brqqsh.

Astronomical names. The classic method of naming stars is by their visibility within a constellation; thus Alpha Draconis is the brightest star in the constellation Draco. This will continue, and stars will be named after the constellations of new skies.

Researchers' names. Many worlds and stars are named by scientists or other researchers. These tend to be poetic, often based on archaic languages, legends, or names of deities. Examples: Siva, Cantrip, Acheron, Nubia. Or they may honor scientific or literary greats of the past (Einstein's Star, Asimov, Tesla, etc.).

Descriptive names. Classical or plain-language references to the world's most obvious feature. Examples: Oceania, Verdant, Sunrise.

Derogatory names. A description may be offered by an irreverent scout or disgruntled colonist – and stick. This is likeliest on a marginal world. Examples: Dustball, Hell's Kitchen, No Hope.

Random names. Scouts may name a star *anything,* especially if they've been out for a while and are getting bored. It isn't uncommon to find stars and planets named after a scout's pet cat, his favorite holovid star, or even his lunch. Examples: Sombrero, Kudzu, Charlie Brown.

Nostalgic names. Many worlds are named after someone's mate, home town, or friends. Examples: Cynthia, Wolverton, New Sweden, New New England.

Societal names. Worlds often receive new names when colonized or conquered by a new society. These names reflect the principles or personalities of the conquerors. Example: Prosperia, King Willem's World, New Beginnings.

Real star names. Unless the campaign involves only very local stars, GMs should not worry about using "real" star names. Many stars were named because they were bright enough to be seen by the naked eye – and such stars seldom have habitable worlds. Other "named" stars have cryptic or coded names (L115-21, for instance). Meanwhile, many stars with habitable worlds have never been seen by astronomers because they are too dim.

Creating Star Systems

If systems are being randomly generated, it is easiest to start by creating the star, as described on pp. 151-153. Roll to see if the star has planets (see p. 153); if it does, generate them as described on pp. 153-160. If a possibly habitable world appears, the details can then be determined.

Number of Orbits

Roll for the number of orbits in the system, as per the table on p. 152; big stars have more orbits. Most of these orbits will have planets, but some may turn out to be empty. The next step is to determine where those orbits lie. This is done according to Bode's Law.

Bode's Law

Bode's Law – more formally, the Titius-Bode Formula – is an empirical method of describing the orbital locations in our solar system. "Law" is used loosely here; it is *not* a law of nature. It works well for the planets up to Uranus, if you count the asteroid belt as a planet. It fails totally for Neptune and Pluto, but works for Pluto if you pretend that Neptune isn't there. (Some astronomers have suggested that Neptune occupied Pluto's orbit, with Pluto as a moon, until a wandering planet threw Neptune into a closer orbit. This would make the observed facts fit the theory exactly, and also explain Pluto's eccentric orbit.)

To find an orbital placement according to Bode's Law, start by taking the series 0, 3, 6, 12, 24 . . . After 0 and 3, each of these is twice the preceding number. Now add 4 to each number, and divide the result by 10. This yields a value, in AU, for orbital radius.

In the following table, the first column gives the orbital radius predicted by Bode's Law; the second column gives the actual orbit.

Mercury	0.4	0.39
Venus	0.7	0.72
Earth	1.0	1.00
Mars	1.6	1.52
Asteroids	2.8	2.77 (Ceres)
Jupiter	5.2	5.20
Saturn	10.0	9.54
Uranus	19.6	19.18
Neptune	–	30.60
Pluto	38.8	39.44
Next planet	77.2	???

Since we have only one solar system to observe, we cannot know whether Bode's Law is pure coincidence, universal law, or something in between. It does not seem to hold, in any form, for the moons of Jupiter or Saturn.

Orbit Locations (p. 153) describes how to use Bode's Law to generate the orbits for your solar system.

The Habitable Zone

Each star has a "habitable zone," or *biozone,* defined as the distance from the star at which water can exist in liquid form on a planet's surface. Human-habitable worlds must lie within this zone. The larger and hotter the star, the larger the biozone and the farther from the star it is, as shown by the chart below. The chart assumes all planets have earthlike albedo and "greenhouse effect," which is not always the case; see p. 157.

Star Types and Planetary System Data (distances in AU)

Type	Size	Stellar Mass	Biozone	Inner Limit	Stellar Radius	Planets On	Number of Orbits	Life Roll Modifier
O	Ia	70	790-1190	16	0.2	–	–	-12
	Ib	60	630-950	13	0.1	–	–	-12
	V	50	500-750	10	0.0	–	–	-9
B	Ia	50	500-750	10	0.2	–	–	-10
	Ib	40	320-480	6.3	0.1	–	–	-10
	II	35	250-375	5.0	0.1	3	3d+1	-10
	III	30	200-300	4.0	0.0	3	3d+1	-10
	IV	20	180-270	3.8	0.0	3	3d+1	-10
	V	10	30-45	0.6	0.0	4-	3d	-9
A	Ia	30	200-300	4.0	0.6	3	3d+3	-10
	Ib	16	50-75	1.0	0.2	3	3d+2	-10
	II	10	20-30	0.4	0.0	3	3d+2	-10
	III	6.0	5.0-7.5	0.0	0.0	3	3d+1	-10
	IV	4.0	4.0-6.0	0.0	0.0	4-	3d	-10
	V	3.0	3.1-4.7	0.0	0.0	5-	3d-1	-9
F	Ia	15	200-300	4.0	0.8	4-	3d+3	-10
	Ib	13	50-75	1.0	0.2	4-	3d+2	-10
	II	8.0	13-19	0.3	0.0	4-	3d+1	-9
	III	2.5	2.5-3.7	0.1	0.0	4-	3d	-9
	IV	2.2	2.0-3.0	0.0	0.0	6-	3d	-9
	V	1.9	1.6-2.4	0.0	0.0	13-	3d-1	-8
G	Ia	12	160-240	3.1	1.4	6-	3d+3	-10
	Ib	10	50-75	1.0	0.4	6-	3d+2	-10
	II	6.0	13-19	0.3	0.1	6-	3d+1	-9
	III	2.7	3.1-4.7	0.1	0.0	6-	3d	-8
	IV	1.8	1.0-1.5	0.0	0.0	7-	3d-1	-6
	V	1.1	0.8-1.2	0.0	0.0	16-	3d-2	0
	VI	0.8	0.5-0.8	0.0	0.0	16-	2d+1	+1
K	Ia	15	125-190	2.5	3.0	10-	3d+2	-10
	Ib	12	50-75	1.0	1.0	16-	3d+2	-10
	II	6.0	13-19	0.3	0.2	16-	3d+1	-9
	III	3.0	4.0-5.9	0.1	0.0	16-	3d	-7
	IV	2.3	1.0-1.5	0.0	0.0	16-	3d-1	-5
	V	0.9	0.5-0.6	0.0	0.0	16-	3d-2	0
	VI	0.5	0.2-0.3	0.0	0.0	16-	2d+1	+1
M	Ia	20	100-150	2.0	7.0	16-	3d	-10
	Ib	16	50-76	1.0	4.2	16-	3d	-10
	II	8.0	16-24	0.3	1.1	16-	3d	-9
	III	4.0	5.0-7.5	0.1	0.3	16-	3d	-6
	V	0.3	0.1-0.2	0.0	0.0	16-	3d-2	+1
	VI	0.2	0.1-0.1	0.0	0.0	16-	2d+2	+2
D		0.8	0.03-0.03	0.0	0.0	*	*	-10

* Type D (white dwarf) stars have been through a great deal. When a main-sequence star burns all of its hydrogen, it expands into a red giant, scorching its inner planets in the process. Then it collapses into a white dwarf; see p. 148. To generate a

white dwarf's planetary system, start by creating a system for a normal main-sequence star of any color. Change any gas giant inside 80 AU to a terrestrial planet (this is the core of the former gas giant). Turn any planet inside 40 AU into a rockball, with no atmosphere or trace atmosphere. Remove all planets within 1 AU; they evaporated while the star was a red giant.

Type refers to a star's color and temperature, and *Size* to its classification (giant through dwarf), as described on p. 151. A few types (e.g., M-IV) are omitted from the table because such stars don't seem to exist!

Stellar Mass is the mass of an average star of the type, relative to our sun. Thus, a K-V star with a stellar mass of 0.82 is about 4/5 as massive as the sun.

Biozone is the range of distances (in AU) at which a planet of the star can have liquid water.

Inner Limit is the distance from the star (in AU) at which rock vaporizes; any orbit at or within this limit will be empty.

Stellar Radius is the star's own size (in AU). This is effectively zero for all but giant and subgiant stars. Note that an inner planet of a type-M giant can be *within* the star's glowing envelope of gas without melting!

Planets On indicates the roll, on 3d, on which the star has planets. For instance, if this entry reads 12-, then the star has planets on a roll of 12 or less.

Number of Orbits indicates how many dice are rolled to determine the number of planets the star has, if it has planets at all.

Life Roll Modifier is used when randomly determining the highest life form on the star's planets (p. 160). Very young stars are unlikely to have life, and if they do, it will be primitive. Older stars are much likelier to have life, and it may be advanced.

World Types

Now generate the system's worlds. There are two basic types of worlds, each with subdivisions, described below. For some campaigns, it will be enough to describe a world as a "small gas giant" or a "cold desert world" and leave it at that. Other campaigns will need the detailed rules in the rest of this chapter.

Terrestrial Worlds

Terrestrial worlds are usually small to medium-sized planets, of silicate, iron-silicate, or occasionally metallic composition (see p. 155). If located within a star's biozone, they may eventually develop breathable atmospheres and life as we know it. Terrestrial worlds come in five main types:

Earthlike: A terrestrial world rated as earthlike will be very much like our own planet – or at least like parts of it, depending on its overall climate, the amount of water it has, and its atmosphere. The climate may be temperate, tropical, or arctic, but is livable by definition. Of course, there may still be obvious flaws or hidden death-traps, making the world useless.

Greenhouse: These planets have thick, dense atmospheres that magnify the greenhouse effect, producing worlds that are too hot for life to develop. Atmospheres have high concentrations of carbon dioxide, sulfur compounds, and sometimes water vapor. Venus is an extreme example of a greenhouse world.

Desert: Desert worlds are usually smaller worlds with thin atmospheres and little free water, if any. Their water may lie frozen in ice caps, melting only at certain times of the year to nurture what life exists. Depending on their climate, they may be classified as *desert/cold* or *desert/hot*. Mars is an extreme example of a desert/cold world. Mars as it was once thought to be – with canals and seasonal vegetation – is a mild example of a desert/cold world. Some desert worlds are very old; they once had more water but lost it to space.

Orbit Locations

This rule assumes that Bode's Law is a special case of a universal rule of geometric progression in orbit spacing. Details will vary from system to system in a predictable way. Generate the orbital spacing for each system follows:

Roll 1d and multiply the result by 0.1 AU. This gives the distance (D) from the sun of the first, or *innermost,* planetary orbit. If the star is very large, this distance may be within the star's inner radius; in that case, the orbit will be empty.

Next, set the distance from the first to the *second* orbit. This is 0.2 AU for a red subdwarf (M-VI). For any other star, it is either 0.3, 0.35, or 0.4 AU (determine randomly). This is the *Bode constant* (B) for that system; the radius of the second orbit is (D+B).

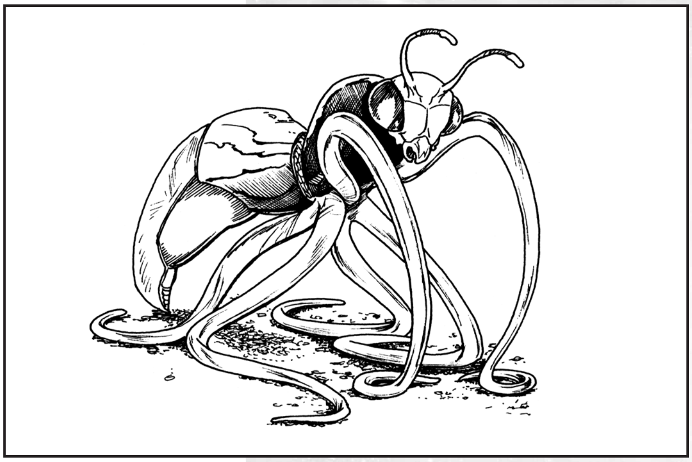
The third orbit is the same distance from the second orbit that the second orbit is from the first, so its orbital radius is (D+2B). Thus, if the first orbit is at 0.2 AU, and the second is another 0.4 AU out at 0.6 AU, then the third orbit will be at 1 AU.

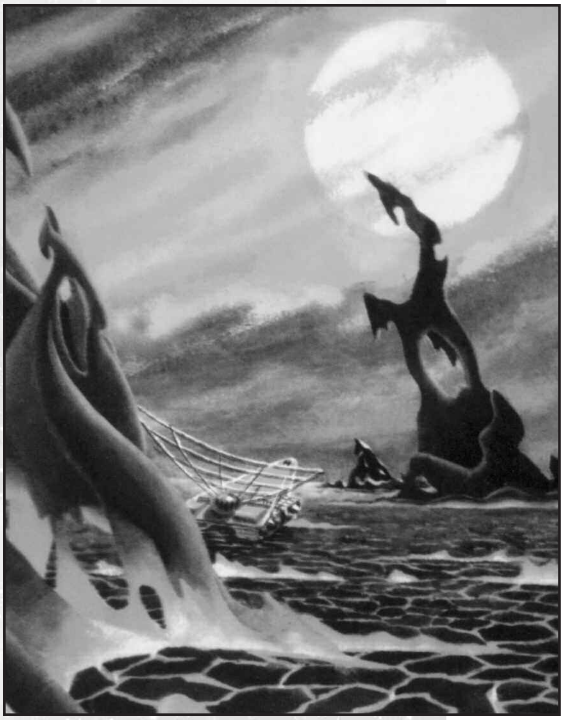
The radius of the fourth orbit is (D+4B); the fifth, (D+8B); the sixth, (D+16B), and so on, doubling the B component each time.

Our own solar system has a D value (inner orbit) of 0.4, and a B value (Bode constant) of 0.3.

According to this formula, the equations for the first 13 orbits of a star system are:

Orbit 1: D
Orbit 2: D + B
Orbit 3: D + 2B
Orbit 4: D + 4B
Orbit 5: D + 8B
Orbit 6: D + 16B
Orbit 7: D + 32B
Orbit 8: D + 64B
Orbit 9: D + 128B
Orbit 10: D + 256B
Orbit 11: D + 512B
Orbit 12: D + 1,024B
Orbit 13: D + 2,048B





Rockball: Rockball worlds are usually small worlds made totally of rock, from core to surface. Their surfaces are rock plains, mountains and crevasses, and perhaps craters and dust plains. If there is atmosphere, it is thin; if there is water, it is usually underground. *Icy rockballs* are only found in a star's outer orbits. They are usually coated with ice – their water, and often the atmosphere as well, is completely frozen. *Iceball* worlds consist entirely of frozen liquid and gas, with no rocky core at all. Mercury is a rockball world and Pluto an icy rockball or possibly just an iceball.

Hostile: A terrestrial planet with an atmosphere poisonous to humans. Often, its climate is far too cold, and its freestanding liquid is liquid methane or ammonia rather than water. Nevertheless, such planets may have native life. Hostile terrestrial planets usually occur beyond a star's biozone and may be moons of gas giants. Saturn's moon Titan is a hostile terrestrial world.

Gas Giants

Gas giants are huge planets with thick atmospheres consisting primarily of hydrogen and helium, with occasional methane, ammonia, and nitrogen. Some may have a solid core of ice or rock, while others may be nothing but gas all the way through.

Gas giants come in three general sizes: *small* (30,000-mile diameter, the size of Neptune and Uranus), *medium* (50,000-mile diameter), and *large* (80,000 miles, the size of Saturn and Jupiter). Large gas giants actually produce heat; their infrared radiation may help bring their moons to habitable temperatures. Gas giants more massive than Jupiter exist, but are likely to be much denser (and so may actually be smaller in diameter), as their great mass compresses some of their hydrogen-helium substance into a superdense "degenerate" state – perhaps producing even more heat through minimal hydrogen fusion in the core.

Small and medium gas giants are usually found outside the biozone; closer to their sun, their gases would boil away. Larger gas giants may be found as close to the star as halfway in from the inner limit of the biozone.

Brown Dwarfs: Similar to massive gas giants, these objects are currently classed as *stars* ("L0-L8" or "type T"), and can form binary star systems. Sufficiently advanced technology (or superscience) may make it possible to mine them for resources. Brown dwarfs may be present between star systems; in lower-tech games, this makes them potentially useful as stepping stones to other stars.

Creating Habitable Worlds

Having established the general nature of the planets in a system, the next step is to detail its important world or worlds – which usually means the habitable ones. Of course, not all habitable worlds will be much like Earth; an asteroid belt or a planet without atmosphere would be considered "habitable" if it were worthwhile to establish a colony there.

Size, Gravity, and Density

A planet's size, gravity, and density are interrelated. By specifying any two of these quantities, you define the third. Earth has a diameter of 7,930 miles, a density of 5.52, and a gravity of 1 G.

If you have any two of these factors for another planet, you can find the third one using the following formula: (planet diameter/Earth's diameter) × (planet density/Earth's density) = gravity (in Gs). This simplifies to (diameter × density × 0.0000228) = gravity (in Gs).

Example: Stefan's World has a diameter of 6,644 miles and a density of 6.1. Its surface gravity is 6,644 × 6.1 × 0.0000228 = 0.92 G.

Generating Worlds

Generate worlds for each orbit in the system, depending on the location of the orbit relative to the star's biozone:

Orbits Inside the Biozone

For orbits closer to the star than the biozone, roll 2d:

2-4 – Empty orbit.
5, 6 – Greenhouse world.
7-9 – Hot rockball world.
10, 11 – Asteroid belt.
12 – Brown dwarf (if this is orbit position 1, treat orbit as empty instead).

Orbits Within the Biozone

For orbits within the biozone, where liquid water is possible, roll 2d. If a terrestrial world results, see the later part of this chapter for details of type, atmosphere, and life.

2, 3 – Empty orbit.
4-8 – Terrestrial-type world.
9, 10 – Asteroid belt.
11 – Large gas giant.
12 – Brown dwarf.

Orbits Outside the Biozone

For orbits outside the biozone, roll 1d, adding 1 to the result if the orbit is more than 10 times the outer radius of the biozone. Determine details of terrestrial worlds as above.

1 – Terrestrial-type world.
2 – Asteroid belt.
3 – Empty orbit.
4-6 – Gas giant (see sidebar, p. 162).
7 – Terrestrial-type world; trace or no atmosphere.

Size of Planets

There is no lower limit to the size of a world. At the upper end are the gas giants (p. 154). Huge solid bodies of rock and metal, many times Earth's size, may be possible, but none are known.

Gravity

This is measured in relation to Earth – 1 G is Earth's gravity. Humans may survive at any gravity up to 3 Gs, and can tolerate more for short periods, but long-term settlement is possible only between 0.75 and 1.25 Gs. Outside this range, humans and humanoid aliens will have health and reproduction problems unless they have been genetically modified for a different G-tolerance.

Density and Composition

A planet's density is governed by its composition – the material of which it is made. A large world may have a relatively low gravity if it is made up of light substances; a small world may have a higher-than-expected gravity if its density is high. The composition types, in order of decreasing density, are:

Metallic (Density 7.1+): Mostly silicates (rock), but metals and rare elements are plentiful – a great place for mining. But there's high background radiation, frequent volcanoes and earthquakes, and extra heat (due to internal radioactivity). There's not likely to be much atmosphere, but the strong magnetic field helps to retain any atmosphere captured (perhaps from comets), diverts solar radiation, and provides a colorful aurora. Example: none in our solar system. There are reasons to believe that planet-sized bodies this dense are *very* rare. A world of solid iron would have a density of 8.

High-Iron (Density 6.1 to 7): As above, but less so: a breathable atmosphere is more likely. Composition is essentially earthlike, but with more metal. Example: none in our solar system.

Medium-Iron (Density 4.6 to 6): Even more rock and less iron. Examples: Earth (5.5), Venus (5.2).

Low-Iron (Density 3.1 to 4.5): Density significantly lower than Earth's. Metals are rare – high-tech civilization based on abundance of metals cannot develop. With less interior heat, the climate will be cooler than might otherwise be expected. Volcanoes are rare. The magnetic field is weaker, so the world is less protected from outside radiation. Examples: Mars (4.0), Luna (3.3).

Silicate (Density 1.3 to 3): A very low-density world. Metals are very rare – any civilization will have to use low-density ores (such as aluminum), a major obstacle to development of a high-tech native culture. Volcanoes are rare, as are earthquakes. There is almost no interior heat, and the weak magnetic field lets harmful radiation reach the surface. Examples: Pluto (1.5?), the Jovian and Saturnian moons.

Gas Giant (Density 0.6 to 2.5): An accumulation of frozen gases, uninhabitable by humanoid races. Some gas giants have a central "rockball" core, which will never be seen unless the planet is boiled away by a nova. Others may have a core of solid (metallic) hydrogen. Examples: Saturn (0.7), Neptune (2.3).

Rotation and Axial Tilt (Seasons)

Larger worlds rotate faster and have shorter days, though many other factors affect this. Mars and Earth days are nearly the same, but a Venus day lasts 243 Earth days – *and* Venus rotates in the "wrong" direction. Fast rotation means a stronger Coriolis effect, which encourages hurricane-type weather. Moons, especially large ones, slow rotation. Old worlds tend to rotate more slowly.

So many factors affect planetary rotation that the GM may make the day any length he likes, down to a minimum of about 10 hours for an Earth-sized planet.

Tide Locking: Worlds in the biozone of dimmer stars – type K-V and below – will be tide-locked unless they are recent captures. On such a world, the same side always faces the sun, so there is no "day" or "night," but a permanently hot and a permanently cold side. Only a small band of twilit territory will have the climate shown on the table on p. 157.

Binary/Trinary Orbits and Biozones

Determining orbits and habitable zones in binary and trinary systems is much trickier than with single stars:

If companion stars are in *distant* orbits (over 5 AU), calculate orbits and biozones normally unless the distant star is a giant. In that case, you may need to figure distances from the giant companion to determine if it will interfere with planets in the primary's biozone. As a rule, if the biozones overlap, no planet in the system will have a habitable temperature all the time.

If the stars are in a *medium* orbit (0.1 to 5 AU), worlds will have orbits of less than 2 AU, or else very distant orbits that circle both stars. Livable planets are unlikely.

If companion stars are in *close* orbits (less than 0.1 AU), any planets will orbit *both* stars. Determine orbits and biozones normally for the largest of the two stars, but increase the biozone orbital ranges by one *spectral type* hotter if the companion is larger than a dwarf. Habitable planets will orbit the center of mass of the two stars.

Type of Terrestrial Planets

When it is determined that a planet is terrestrial, the GM may use this table to get a quick description of its type and fill in any desired details from other tables, ignoring results that contradict the basic type. Alternatively, this table may be skipped, and the general description assigned after the details are rolled up.

To use this table, roll 2d:

2-4 – Rockball.
5 – Greenhouse (planet must not be farther from the star than the biozone; gravity must be more than 0.8 G).
6, 7 – Earthlike (planet must be in the biozone). Atmosphere is oxygen-nitrogen (but may still be polluted). Surface water (p. 158) is at least 10%.
8, 9 – Desert (planet must be in the biozone). No surface water. Roll for climate (sidebar, p. 160) to determine temperature.
10 – Hostile. Ignore any oxygen-nitrogen result from atmosphere composition table (sidebar, p. 158).
11 – Icy rockball (planet must be beyond biozone).
12 – Iceball (planet must be beyond biozone).

Size of Terrestrial Planets

To determine the rough diameter, in miles, of a randomly generated terrestrial planet, roll 2d and multiply by 1,000 miles. If you want more precision, use any method you find convenient.

Density and Composition of Terrestrial Planets

To determine the density of a terrestrial planet, roll 3d and divide the result by 10 (giving a number from 0.3 to 1.8). Then roll 1d and add this result. This yields a number from 1.3 to 7.8, averaging 4.55.

This density then gives the planet's composition, as per *Density and Composition* (p. 155).

Stellar Ages and Planetary Density

An optional complication, for those very interested in realism and willing to assign ages to stars: For every billion years by which the star is younger than Sol, add 0.2 to all density rolls. For every billion years by which it is older, subtract 0.2. This means that younger stars have higher-density planets, which is to be expected (see *Stellar Populations,* p. 150). Limiting factors: The galaxy is some 15 billion years old; Sol is about 5 billion years old.

Gravity of Terrestrial Planets

Determine this from size and density, using the formula under *Size, Gravity, and Density* (p. 155).

Determining Axial Tilt

For a random determination of axial tilt, and therefore seasonal effects, roll 2d:

2, 3 – No appreciable tilt, and no seasons.
4-7 – Minor seasonal effects (less than Earth's). Roll 1d and multiply by 3 to get degrees of tilt.
8-10 – Earthlike seasonal effects. Roll 2d and add 20 to get degrees of tilt.
11 – Major seasonal effects (much more than Earth's). Roll 3d and add 30 to get degrees of tilt.
12 – Gross seasonal effects. Roll 1d, multiply by 10, and add 40 to get degrees of tilt, treating anything over 90 as 90.

Axial Tilt: Many worlds are *tilted* – instead of spinning upright in their orbit, they lean one way or another. This gives *seasons:* for half the year, the northern hemisphere is warmer than the southern one, and vice versa. Earth has a 23° tilt; thus, we have summer and winter. GMs may specify any tilt; the normal range is from 30° (Neptune and Saturn) to nearly none (Venus and Jupiter). Worlds with a tilt near 90° (Uranus) will show very strong seasonal effects!

Atmosphere

Although oxygen is a very common element, it is not likely to occur in an atmosphere unless the world has life. Atmospheric oxygen is added by plants breaking down CO_2 to O_2 and by dead life forms decomposing in shallow water or swamp deposits, giving a breathable atmosphere. But even if oxygen is present, a world may have atmospheric trace elements harmful to some or all races. These are most common on metallic worlds . . . but *could* occur anywhere.

An atmosphere is a world's best friend. A thick atmosphere shields against solar radiation (this can make up for the effects of a weak magnetic field). High air pressure increases average temperature by retaining heat, and moderates temperatures – leading to more weather, but less difference between day and night temperatures. Worlds with low-pressure atmospheres are colder (retaining less heat), with less weather but greater extremes in day/night temperatures.

In theory, atmospheric pressure and gravity are directly related – 1-G worlds have Earth-normal air pressure, 0.75-G worlds have atmospheric pressure 75% that, etc. – *if* the world has an atmosphere. If air pressure is less than 20%, humans cannot breathe without artificial assistance. Pressure drops as height increases, depending on gravity – on a high-G world, pressure falls off swiftly, and even a low mountain may require breathing gear for mountaineers. In the real universe, however, other things affect air pressure; e.g., neither Venus nor Mars fit this pattern. Venus has very high pressure, simply because it has a huge mass of atmospheric gas; Mars is missing atmosphere, which is thought to be locked in subsurface minerals and frozen in the ice caps.

In the end, the GM is perfectly free to set the atmosphere he finds most interesting, within the guidelines below. Gas giants will always have extremely dense hydrogen or hydrogen-helium atmospheres. Only the largest asteroids will have even a trace atmosphere.

Atmospheric Pressure

None: No atmosphere at all. Vacc suits and pressurized habitats with artificial air supplies are necessary.

Trace: There are mere traces of gas at some levels of the world's surface, deep in caves or crevices, etc. Artificial life support is necessary. Oxygen, nitrogen, and other "atmospheric" gases will be frozen into "snow" or "ice" on very cold planets.

Very Thin: Atmosphere is extremely tenuous: air pressure is below 0.5× Earth-normal. Explorers will need life support: oxygen, and usually pressure suits as well.

Thin: Atmospheric pressure is lower than Earth's: 0.51-0.8× Earth-normal. If enough oxygen is present, humans will find the air completely breathable with the aid of a respirator, and can even breathe it for short periods unaided. Early theories on Mars pictured this kind of atmosphere.

Standard: 0.81-1.2× Earth-normal. Breathable by humans without artificial aids, if enough oxygen is present. These are the most earthlike atmospheres.

Dense: Pressures greater than Earth's: 1.21-1.5× Earth-normal. They are still breathable, with some difficulty, if O_2 is present. Dense atmospheres may seem "soupy" to regular humans, and asthma sufferers will find breathing very difficult.

Very Dense: Pressures much greater than Earth's: over 1.5× Earth-normal. A reducing respirator is required to breathe, even if O_2 is present.

Superdense: Pressures up to several hundred times Earth-normal. Only the sturdiest structures can maintain earthlike internal pressures and survive. In the outer zone, frozen or near-liquid atmospheres may qualify as superdense. Nothing less than an EAVS (p. 62) or battlesuit (p. 85) – if that – will make it possible to get around on the surface of these worlds. Venus has a superdense atmosphere.

Atmosphere Types

Oxygen-Nitrogen: Generally earthlike atmosphere; almost impossible to find except as a result of life similar to Earth's. Earth's atmosphere is 77% nitrogen, 21% oxygen, and 1% argon, with traces of water, CO_2, and other gases. Nitrogen and argon are inert; the oxygen percentage is vital. Earth's biological and geological processes hold it at 21%. Too little oxygen is inconvenient, but too much is deadly – see sidebar.

Polluted: Polluted atmospheres are basically oxygen-nitrogen, but contain contaminants. This can be organic matter (like pollen), volcanic ash, industrial pollutants, or naturally occurring noxious chemicals (like sulfur compounds). Pollutants range from merely irritating to deadly. Filter masks (or combination filter/respirators) are normally sufficient to allow these atmospheres to be breathed. The GM should determine the exact pollutant; on a newly discovered world, Planetology rolls (sometimes at a hefty penalty) may be necessary to discover the pollutant's existence before it is too late.

Exotic: Exotic atmospheres (see sidebar) consist of assorted non-breathable or poisonous gases; there may also be corrosive constituents. Self-contained oxygen supplies, and often protective or pressure suits, are necessary to survive in these atmospheres. (Alien races may thrive in exotic atmospheres.)

Corrosive: These very deadly atmospheres (see sidebar) require well-protected artificial life support for survival. Unprotected humans will die quickly and painfully. Vacc suits or protective suits with self-contained air supplies are necessary. Most metals will quickly be destroyed by such atmospheres, especially those with even a trace of chlorine or fluorine.

Climate

Next, the world-builder should choose the world's climate. This is the average temperature of all points on the 30th parallel, night and day – tropics will be warmer, mountains and poles will be colder. This table describes ten typical climate ranges, in degrees Fahrenheit.

Climate Type	Low	Avg.	High	Comparisons
Very Hot	100°	120°	140°	Record high for U.S.: 134° in Death Valley
Hot	90°	110°	130°	Death Valley, CA in July
Tropical	80°	100°	120°	African desert in July
Warm	70°	90°	110°	Phoenix, AZ in July
Earth-normal	60°	80°	100°	New Orleans, LA in June
Cool	40°	60°	80°	Knoxville, TN in April
Chilly	20°	40°	60°	New York City, NY in March
Cold	0°	20°	40°	Huron, SD in December
Very Cold	-20°	0°	20°	Fairbanks, AK in February
Frozen	-40°	-20°	0°	Whitehorse, Yukon in January

Naturally, orbital distance affects climate. A world at the inner edge of the biozone will be hot, and one at the outer edge will be cold. A world in the middle can have any climate the GM chooses, because of other factors. For instance, Earth would be much colder if not for the heat still being released from its molten core. Internal radioactives and the "greenhouse effect" can also warm up a world. Interstellar gas can block sunlight; cloud or ice surface can increase *albedo* and reflect heat, cooling a planet. Planets in a multiple system can receive extra heat from other suns. Thus, it is quite possible for a world to remain habitable even though it is slightly outside the nominal biozone.

Moons for Terrestrial Worlds

To determine what moons orbit a terrestrial world, roll as shown for each type of *moon.* The result gives the number of that type of moon.

Moonlets: 1d-4
Small Moons: 1d-4
Medium Moons: 1d-5
Large Moons: 1d-5

Modify each roll by -1 for a world of less than Earth's diameter (8,000 miles or less), or +1 for a world of over 1.5 Earth diameters (12,000 miles or more).

Length of Day

For a random determination of the length of a planet's day, roll 2d:

2 or less – 2d×10 days.
3 – 1d×12 days.
4 – 1d×5 days.
5 – 2d×10 hours.
6 – 1d×10 hours.
7 – 7d hours.
8 – 6d hours.
9 – 5d hours.
10 – 4d hours.
11+ – 3d hours.

Modifiers: -4 for orbital position 1, or -2 for orbital position 2; -1 if the world has a large moon or binary companion; -1 for a diameter less than half Earth's, +1 for a diameter more than 3 times Earth's, +2 for a diameter more than 6 times Earth's, or +3 for a diameter more than 9 times Earth's.

Terrestrial Atmospheres

To determine a terrestrial world's atmosphere, roll 2d for *pressure*. If atmosphere exists, then roll 2d for *composition:*

Pressure

3 or less – None.
4 – Trace.
5 – Very Thin.
6 – Thin.
7-9 – Standard.
10 – Dense.
11 – Very Dense.
12+ – Superdense.

Modifiers: -1 for each full 20% decrease in planet's diameter relative to Earth, or +1 for each 20% increase in diameter; -3 if the planet is beyond the star's biozone, or -6 if the planet orbits at a distance more than 10 times the maximum biozone radius; -2 for a world of an M-type star, or -1 for a world of a K-type star.

Composition

6 or less – Exotic – see *Exotic Atmospheric Gases* (below).
7-9 – Oxygen-Nitrogen.
10 – Polluted.
11+ – Corrosive.

Exotic Atmospheric Gases

To find the exact composition of exotic, corrosive, and superdense atmospheres, roll 1d-2 for the number of gases that make up the atmosphere (minimum 1). Then roll on the appropriate table below; add 1 for a planet within the biozone, 2 for a planet *closer* than the biozone. If only one gas is present in an exotic atmosphere, it will not be a corrosive.

The first gas rolled will make up 1d × 10% of the atmosphere; the second will make up the remainder, with trace amounts (under 1%) of any other gases present.

Exotic or Superdense Atmospheres

1 – Hydrogen; methane also present.
2 – Methane; hydrogen also present.
3 – Carbon oxides.
4 – Corrosive – roll on next table, using the same modifiers.
5+ – Nitrogen.

Corrosive Atmospheres

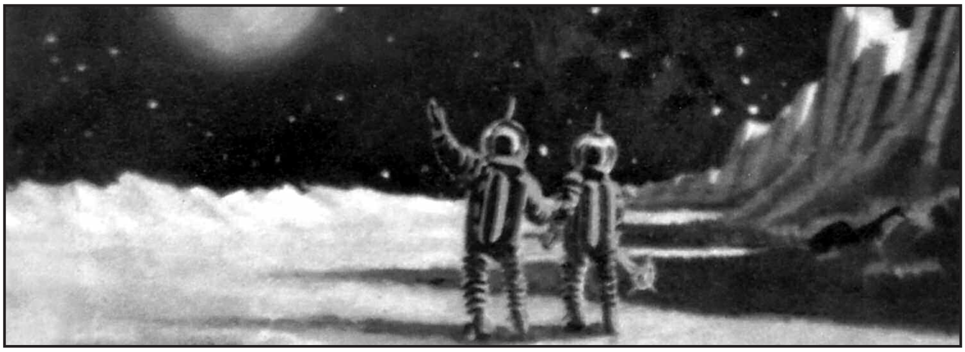
1, 2 – Ammonia.
3 – Chlorine.
4 – Fluorine.
5 – High-Oxygen.
6 – Nitrogen Oxides.
7 – Sulfur Compounds.
8 – Water Vapor.

Continued on next page . . .

It is important to note that climate is an *average!* Earth, as shown on the table above, has "Earth-normal" climate, but local temperatures span the whole table. A world with a "hot" climate overall might have some Earth-normal areas at the poles, and large areas at the equator so hot they are unusable. If the world has axial tilt, seasons will affect the temperature at a given time and place without changing overall climate.

Surface Water

Most planets start with water; it is a common compound. On inner planets, it evaporates and is lost; on outer planets, it freezes solid. Terrestrial worlds with under 10% surface water are desert worlds. Those with 10-40% water will be dry and arid except near ocean areas. Those with 40%-80% water can be relatively earthlike, depending on the climate. Surfaces of over 80% water will be humid unless the climate is cool or colder; then they will be icy.



Primary Terrain Types

Almost every type of terrain can be found *somewhere* on any planet, if the appropriate plant life has evolved. But the prevailing terrain on a world is governed by its climate and the amount of water present. The following types of terrain may be found on earthlike and hostile terrestrial worlds; most can be found on greenhouse and desert worlds as well. Rockball worlds almost always look "hilly/rough."

Desert/Barren: Low, flat, barren plains, perhaps covered with sand or dust in low dunes. Prevalent on older planets with less than 30% surface water, or any world with under 10% surface water. Can occur even on worlds with more water if the land areas are cut off in some way from the seas.

Icy/Barren: As above, but drifted with snow and ice. Prevalent on chilly to frozen worlds with more than 30% surface water; also common on cool worlds with under 50% surface water.

Hilly/Rough: Mostly bare, rocky terrain, with small hills, boulders, and debris, crevices and ravines, etc. Prevalent on younger planets with less than 30% surface water. Can include cratered terrain and rough glaciers.

Mountainous/Volcanic: High, rocky mountains, jagged peaks, cliffs, or volcanoes (active or dead). Most likely on geologically very young worlds with less than 30% surface water.

Plains/Steppe: Low, flat expanses. Not as dry as desert/barren. May have abundant rivers and lakes, moist soil, etc. Common on worlds with 30-60% surface water; also found in the center of large continents, or behind mountain ranges, on wetter worlds. Plant life, if any, is characterized by grasses, low shrubs and bushes, and tough weeds.

Forest/Jungle: These only exist if vegetable life does. Can range from lightly wooded areas to densely packed forests and jungles. Usually abundant near rivers, lakes, and other bodies of water. Common on cool or warmer worlds with more than 40% surface water. (Hostile terrestrial forests might be some other form of immobile alien life, or even forests of crystal, minerals, etc.)

Marsh/Swamp: Low, wet areas, often near large bodies of water and almost always including areas of surface water themselves. Mud, quicksand, and very moist ground are abundant. If vegetation exists, lush water plants and other life forms are common. Likely if surface water is over 90% and the world is cool or warmer; very likely if the world is tropical or warmer.

Mineral Resources

Some planets become important because of their mineral resources; others are crippled for lack of resources. Roll 2d for each of the following categories to determine the abundance of that resource, modifying the roll as indicated:

Gemstones/Industrial Crystals: Diamonds, emeralds, rubies, sapphires, industrial silicon, etc. -3 to abundance roll.

Rare/Special Minerals: These can include rare earths, or unusual elements or compounds not normally found on other worlds. -2 to abundance roll.

Radioactives: Uranium, radium, thorium, etc. -2 to abundance roll.

Heavy Metals: Gold, silver, platinum, cobalt, etc. -1 to abundance roll.

Industrial Metals: Iron, tin, copper, zinc, etc. +1 to abundance roll.

Light Metals: Sodium, aluminum, lithium, etc. +3 to abundance roll.

Organics: Carbon, fossil fuels, etc. Organic deposits often indicate that life once existed on this world, even if it no longer does. However, lifeless worlds may have "organic" compounds; some scientists believe that Saturn's moon Titan has hydrocarbon oceans!

The roll is further modified for planet type: +4 for metallic, +2 for high-iron, -1 for low-iron, -3 for silicate, -1 if surface water is at least 90%, +1 if surface water is 30% or less. These modifiers do *not* affect the roll for organics. Look up the final modified roll on the following table:

6 or less – Almost entirely absent.
7, 8 – Scarce even for local use; imports will be required if industry requires the material.
9 – Ample for local use, but no real surplus.
10, 11 – Plentiful; worth export if there is great demand.
12+ – Extremely plentiful! Certainly worth export if there is any demand.

Moons

Many worlds have one or more moons; the bigger the planet, the more moons are likely. Gas giants may have *giant* (Earth-sized) moons. *Large* moons are 25-45% Earth size (Titan and Mercury). *Medium* moons are 10-25% Earth size (Luna and Iapetus). *Small* moons are 5-10% Earth size, and may be unrounded chunks of rock (Tethys and Ceres). *Moonlets* are orbiting boulders, less than 5% Earth size (Phobos and Vesta). Size, density, and gravity of moons are related just as for planets (see pp. 154-155).

Rotation. Moons create tides on their mother planet. Multiple moons create complicated ocean currents. Everything else being equal, the tidal effects of a moon will slow the world's rotation. The details depend on the masses, distance, and the age of the planet-moon system – GMs have plenty of room to fudge most desired results. Many moons will be tide-locked – the same side always faces the mother world.

Separation. For habitable worlds, the distance between centers of moon and planet must be at least 2.5 times the planet's radius (Roche's Limit). As the separation between moon and planet increases, so does the chance of the moon retaining its own atmosphere.

Composition. Large and medium moons will be less dense than their mother world, unless they are *captured* moons; small moons and moonlets vary widely. Exception: Moons of gas giants are usually denser than the mother world.

Orbital plane. Most moons orbit in the plane of the mother world's equator. Wildly canted orbits are rare and less stable.

Exotic Atmospheric Gases (Continued)

Determine relative percentages as above, except that high-oxygen always means at least 30% oxygen. Other gases may be present in trace amounts, including inert gases such as helium, neon, argon, krypton, and xenon, or more deadly ones such as carbon monoxide.

Hydrogen: H_2 is abundant in the atmospheres of gas giants, and is frequently found in smaller quantities in other atmospheres. It is extremely flammable. Its atoms are so small that they can penetrate protective suits, and when in contact with the oxygen inside can be set off explosively by a spark. Exotic atmospheres high in hydrogen are extremely dangerous.

Methane: Nearly always found with hydrogen, and vice versa, although concentrations vary widely. It is highly flammable.

Carbon oxides: CO and CO_2. This is an expected atmosphere for an "earthlike" world with no life. Plant life, when it develops, breaks the carbon compounds down to free oxygen.

Nitrogen: Inert and unbreathable; poisonous (causes "the bends") in high partial pressures. But this is relative; Earth has 77% nitrogen.

Ammonia: NH_3 is highly poisonous and water-soluble; if there is liquid water, the ammonia will be dissolved in the seas, not free in the atmosphere.

Chlorine and Fluorine: Both deadly poisons to terrestrial life, either could nurture completely alien beings. These gases are so reactive that they aren't likely to be present in noticeable quantities unless a life process is replenishing them. Even then, HCl and HF are far likelier than the pure gases. Chlorine in an atmosphere may result in strange visual distortions.

High-Oxygen: Atmosphere at least 30% oxygen, possibly with ozone (O_3). This would be very flammable, very corrosive, and quite unbreathable; it would send human beings into a laughing jag even as it killed them by drying out their eyes and lungs. Some sort of life must be present to release this much oxygen. Oxygen reacts with hydrogen, methane, and CO, so it won't be found in the same atmosphere.

Nitrogen Oxides: These are nitrogen-oxygen compounds that are always corrosive. Nitric acid vapor may be present in the atmosphere as well.

Sulfur Compounds: These might include hydrogen sulfide (flammable, rotten-egg smelling), sulfur trioxide (a corrosive irritant), or sulfur dioxide (suffocating).

Water Vapor: May be plentiful on a world inside the biozone, where temperatures rarely or never drop below 212°F. Corrodes metals.

The Biosphere

A planet's biosphere is its envelope of life – its flora, fauna, and microorganisms. The exact nature of each world's life should be decided by the GM, often in connection with a specific adventure. However, the table below will allow a broad determination of what types of life exist.

This table is primarily for Terrestrial worlds within the habitable zone. It may be used with other types of worlds, but life will be truly alien there, if it exists at all. The information given is about what could be learned by observation from orbit; details are up to the GM.

To determine the dominant native life form on the planet, roll 3d and apply the *Life Roll Modifier* for the star's type and class (see table, p. 152). The needs of the campaign can be taken into account by applying the modifiers under *Frequency of Habitable Worlds* (p. 31). Consult the table below to learn what kind of life is present on the world.

7 or less – No life, and therefore no oxygen atmosphere.
8, 9 – Proto-organisms: single- or multi-celled microorganisms, including algae, protozoa, amoebas, etc.
10 – Lower plants: equivalents of lichens, mosses, and fungi.
11 – Higher plants: equivalents of ferns and flowering plants.
12, 13 – Lower animals (IQ 2-3): equivalents of insects, fish, and amphibians.
14-16 – Higher animals (IQ 4-6): equivalents of reptiles, mammals, and birds.
17 – Near-intelligence (IQ 7): no civilization.
18+ – Intelligence (IQ 8+): civilization or the potential for civilization. Tools, fire, and language.

Lower forms than the dominant one will usually still exist. The GM may roll again from the choices given under dominant type – e.g., to determine whether insects, fish, or amphibians are the dominant type, if "lower animals" is rolled.

If intelligence exists, the GM should define its type, tech level, society, etc., using the rules in Chapter 11.

Completing the System: Other Worlds

Most star systems will have a number of worlds. We will assume that Bode's Law (see sidebars, p. 152-153) will prove more-or-less universal, but that different systems will have different types of orbital spacing.

To determine system orbits, use the system described in the sidebar on p. 152, unless the campaign background requires that this particular system *not* follow Bode's Law for some reason. Make sure that you have at least one orbit in the biozone if the system is to contain a habitable world. Note that some orbits may be empty.

Details About Uninhabitable Worlds

The GM can add as much detail as he wants about worlds not in the biozone. In general, close-in worlds are dense and airless. Worlds outside the biozone are usually less dense; they are also less likely to have a useful atmosphere. Outer planets are likely to be gas giants; little detail will usually be needed.

Asteroid belts may replace one or more worlds per system. An asteroid belt is an orbit filled with small planetoids, most of which will be no more than a few miles in diameter. Asteroid belts may include small rockball or ice worlds. Asteroids with even thin atmospheres are *rare,* but a few have water in the form of ice. Asteroid belts may be the remnants of a destroyed planet, or just a world that never formed. Individual asteroids are scarce within the belt; except when clusters orbit together, they won't be encountered in masses, despite bad SF movies.

Random Climate Choice

When creating a habitable world randomly, roll 3d to set its climate, as per the climate table on p. 157. Subtract 1 from the roll if the world is part of a multiple-star system. Add 3 if the world is actually a moon of a gas giant; add 2 if it is a planet of a type M, or 1 if it is a planet of a type K.

2-5 – Very Hot
6, 7 – Hot
8 – Tropical
9 – Warm
10 – Earth-normal
11 – Cool
12 – Chilly
13 – Cold
14, 15 – Very Cold
16+ – Frozen

It is quite possible for a world in the biozone to be hotter than "very hot." A world with an average temperature of 160°, for instance, could have liquid water and even native earthlike life, but Earth humans couldn't survive there unaided (except perhaps at the cooler poles). Earthlings, being warm-blooded, can adapt to cold more easily than they can to heat.

Surface Water

For a terrestrial world in the biozone, the surface covered by water will be (2d-2) × 10%. This gives a result between 0% and 100%. However, no liquid water will be present if there is no atmosphere or a very thin atmosphere; it will escape to space.

By definition, worlds outside the biozone are unlikely to have liquid water; it will escape to space on inner worlds, freeze or escape on outer ones. The likeliest possible exception is a large moon of a gas giant, which may get enough heat from its primary to have liquid water; roll as for any other terrestrial world.

Terrain

Roll 2d to determine the primary terrain type for any terrestrial world. A second roll may be made to determine a secondary terrain type.

2-4 – Barren. Desert if world is cool or warmer (roll again if surface water is over 30%), otherwise icy.
5, 6 – Hilly/Rough. Roll again if surface water is over 70%.
7 – Mountainous/Volcanic. Roll again if surface water is over 30%.
8 – Plains/Steppe. Roll again if surface water is over 80%.
9, 10 – Forest/Jungle. Roll again if there is no plant life, or if surface water is under 40%.
11, 12 – Marsh/Swamp. If surface water is under 70%, increase it to 70%.

Asteroid Types: Three types of asteroids are common. Most are small, but some are the size of small worlds or moons (e.g., Ceres). *C-Type* asteroids are dark (low reflectivity), with brittle bodies made of fine opaque material and hydrated (water-rich) minerals. *S-Type* asteroids have stony/iron compositions. *M-Type* asteroids have nickel/iron compositions and are rarer than other types; these are the ones that belters look for. Any of these may have a usable amount of ice on the surface or within.

Rogue worlds, not fitting the normal orbit pattern, may be added. If they orbit within a few AU of other worlds, they create an unstable situation and are therefore recent – perhaps captured from another system. Such captured worlds may have eccentric orbits, becoming much hotter during the part of the year when they approach the sun most closely. If such a world stays within the biozone the whole year, any life it harbors may be very unusual.

Unusual System Objects

Objects with these properties might be found in an otherwise-normal star system:

Unusual shape. Nature creates irregular shapes through impacts and volcanism, which gravity then works to smooth. The spin of a planet also works to make it bulge at the equator, while flattening it at the poles. For this reason, planets are seldom perfect spheres (if one is, suspect it of having an artificial origin). Large or dense worlds may be conspicuously flattened at the poles. Small worlds maintain more irregularities than larger worlds – at the extreme, moonlets are often square chunks rather than small balls. On an irregular world, portions may extend above the planet's atmosphere.

Dying world. This planet is being destroyed – possibly by a moon in a decaying orbit, with tidal forces causing planet-wide volcanism and earthquakes. Death may also come from outside: a wanderer or other foreign object approaching too near, a prolonged meteor storm, or a star threatening to explode. Or the inhabitants might destroy their planet through warfare.

Dead world. This planet once had life, but most or all of the biosphere has been destroyed. The atmosphere is not likely to be breathable.

Captured world. When stars approach closely, planets from one star may be "captured" by the other. Outer worlds are more likely to be captured than inner worlds. Captured worlds have eccentric orbits, often varying from the plane of the new solar system. If an inhabited world is captured by a new star, few higher life forms are likely to survive . . . but ruins may be found.

Retrograde-revolution world. Normally, all worlds in a system orbit in the same plane and in the same direction. A "retrograde" world, orbiting in the "wrong" direction, is almost always artificial or captured.

Inclined orbit. A world with an inclined orbit (one set at an angle to the system's normal orbital plane) is likewise probably a captured world. Such worlds may be very hard to find, especially if they are far from the sun and do not approach the orbits of any "normal" worlds.

Elliptical orbit. Most orbits are nearly circular, but a world can take an elliptical orbit due to a near-collision or other accident. Such a world will have very extreme "seasons" affecting the whole planet, and the native life will have some very strange adaptations. In extreme cases, a world spends centuries in frozen darkness, then has a brief spasm of glory as it plunges around the sun, burning off its atmosphere. If an elliptical orbit crosses that of other worlds, a collision will eventually occur unless the elliptical orbit is also inclined.

Binary planet. Two planets in the same orbit, revolving around one another. They do not need to be identical. Tidal forces will be very strong (if the worlds are too close, the tidal pull will tear them apart), and the worlds will be tide-locked unless their relationship is recent. Formation of such a system is improbable (suspect Precursor involvement!), but it is stable once formed. Moons are possible, but will orbit at a distance from the system's center equal to at least three times the worlds' separation. If such a system fails, the worlds may disintegrate or take up elliptical orbits (see above).

Length of Year

To determine the length of a planet's year, you need to know the mass of the star (see table, p. 152) and the radius of the planet's orbit. Use the formula:

P = Square root (D^3/M), where
P = the length of the planet's year, in Earth years.
M = the mass of the star, in solar masses.
D = the radius of the planet's orbit, in AU.

In a campaign, you may want to know the number of local days in the local year. To find this, simply multiply the length of the local year by 8,766 hours (the number of hours in an Earth year). This gives the number of hours in the local year. Divide by the number of hours in the local day (see *Length of Day,* p. 157). The result is the number of local days in the local year.

Humidity

Humidity – the amount of water vapor in the air – is important to most species. Earth averages 50% humidity. Anything below 30% is uncomfortably dry; anything above 70% is muggy. At 100%, it rains.

The presence of liquid water makes higher humidity likely, but there are many other factors involved. To assign humidity randomly, roll 2d-2, multiply by 10%, and add 10% of the world's surface-water percentage; e.g., a roll of 6 on a world with 50% water would give 45% average humidity. Average humidity over 100% is impossible – 100% means it rains all the time.

Water and Other Liquids on Uninhabitable Worlds

Metallic, iron, or silicate worlds in outer orbits will be almost totally covered with "ice," which may include many compounds other than water. Oxygen, nitrogen, and other "atmospheric" gases will be frozen out on very cold planets. Asteroids may have ice, though it will not be on the surface.

If hostile and greenhouse terrestrial worlds with superdense atmospheres have any liquid at all, it will likely be methane, ammonia, or sulfuric acid. Worlds with exotic or corrosive atmospheres will have a liquid appropriate to their atmospheric composition and orbital position.

Gas giants have no liquid water; there will be solid H_2O on the surface and possibly traces of water in the atmosphere.

Gas Giant Types

To randomly determine a gas giant's type, roll 3d. Subtract 2 for an M-type star or 1 for a K-type star; if a "brown dwarf" result is rolled for either of these star types, roll again and accept this second result, whatever it is.

3 – Brown dwarf. No other planets or moons in system.
4 – Brown dwarf. Part of normal planetary system.
5-8 – Small.
9-12 – Medium.
13-18 – Large.

Moons for Gas Giants

To determine what moons orbit a gas giant, roll as shown for each type of *moon.* Modify the roll by +1 for a large gas giant, or by +2 for a brown dwarf. The result is the number of that type of moon.

Moonlets: 3d
Small Moons: 2d
Medium Moons: 1d+1
Large Moons: 1d-3
Giant Moons: 1d-5
Small Gas Giants: 1d-7

Gas Giant Special Features

Roll 3d to see if a gas giant has some special feature. Add 3 to the result for a brown dwarf, or 2 for a large gas giant.

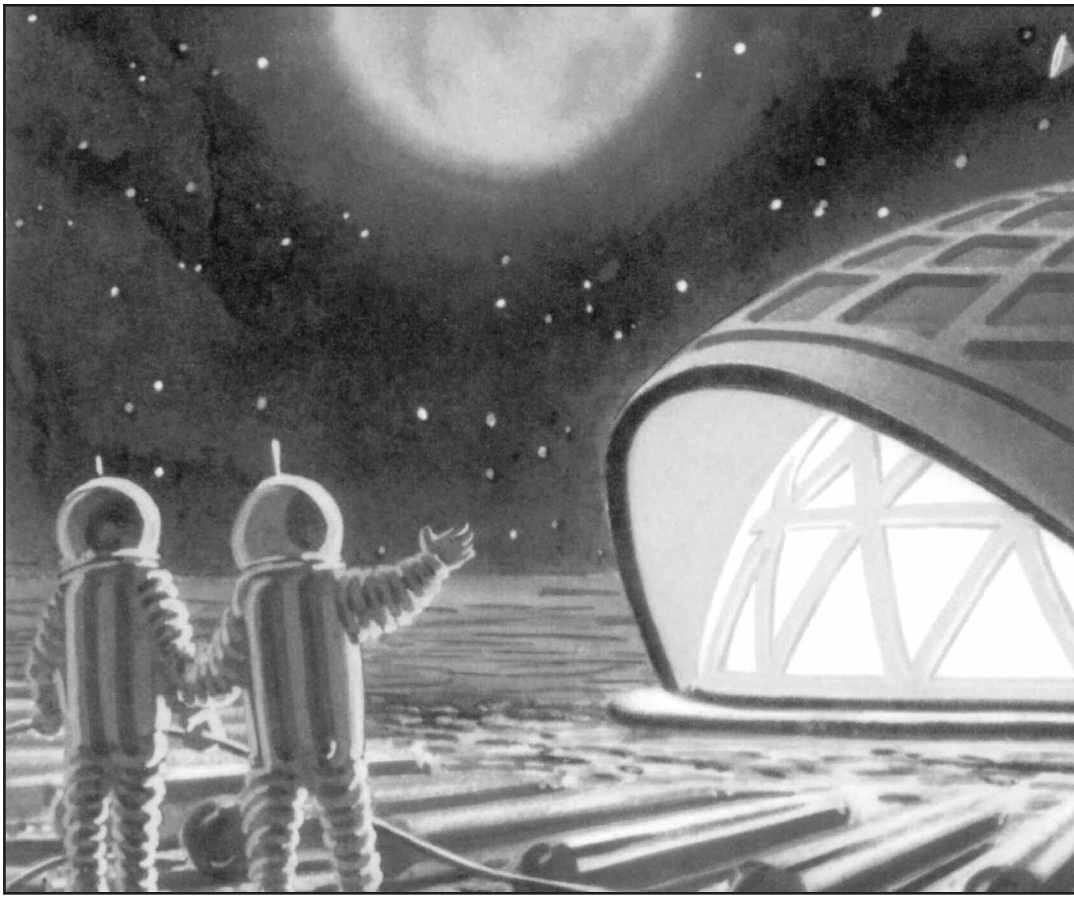
3-9 – No special feature.
10 – One moon has a retrograde or inclined orbit.
11-13 – Faint ring, like Uranus'.
14 – Spectacular ring, like Saturn's.
15 – "Asteroid belt" of small moons and moonlets.
16 – "Oort belt" of cometary slush-balls.
17 – Twice as many moons as rolled originally.
18 – Roll twice more.
19-21 – Produces enough heat to warm its moons; has at least one large or giant moon of habitable temperature (roll as for terrestrial worlds, disregarding uninhabitable results).

Asteroid Types

To randomly determine an asteroid's type (see p. 161 for definitions), roll 3d:

3-5 – M-type.
6-8 – S-type.
9-17 – C-type.
18 – Icy – roll again for type.

Most asteroids are small – house-sized up to mountain-sized. Very large asteroids, like Ceres and Vesta, are rare in our solar system, but relatively easy to find. An ordinary optical telescope can spot them. The GM can make a given asteroid this big on a roll of 5 on 5d, or assign large asteroids to suit the campaign.



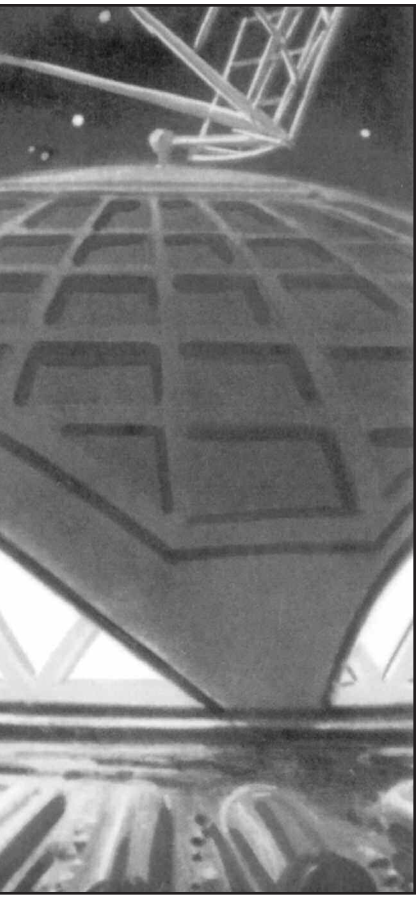
Double planet. Two identical-mass planets in the same orbit, but on opposite sides of the sun. If either world has a moon, the moon's mass is added to the world's when matching masses. Inhabitants of one world may not know of the other until STL space travel is developed. Double planets are extremely rare in nature, but can be engineered at TL13+.

Rosette. This is a formation of three or more planets of approximately equal mass, equally spaced in a single orbit around a star or other object. It could be natural, but it is far likelier to have been engineered at TL13+.

Eccentric star. This seems to be a normal star most of the time, but has storms or seasons, hundreds or thousands of years apart, in which it changes its nature. It might abruptly become warmer or cooler – enough to change a habitable world's climate – and possibly increase the amount of hard radiation it emits. Flares may erupt from its surface, producing a lethal barrage of radiation that could kill the crew of an unshielded ship, knock out its instruments, or sterilize a world. An eccentric star might also have unstable magnetic fields, snaring unwary spacecraft among its inner worlds. A world of an eccentric star might be colonized before the danger was detected, or the ruins of an extinct culture might be found there.

Habitat jungle. A densely populated solar system (whose inhabitants probably lack FTL travel) may begin filling orbits around its star – say, within one AU – with space habitats. After a few thousand years of growth, there could be millions of them, with a combined surface area greater than that of several planets!

Artificial world. A world – probably the size of a small planet or a large moon – built by intelligent life. Artificial worlds may be built in an uninhabitable system, to allow colonization or for use as military posts; they might also be built to ease population pressures for a society without FTL drive. Artificial worlds are expensive, and generally built only for compelling reasons. A TL13 artificial world may be constructed like a spacecraft, and might be mobile. A TL14 artificial world is built from planetary debris; it will have odd density and composition readings (and may be geologically unstable).



Ringworld. First envisioned by Larry Niven, this structure is a flat band circling a star within its habitable zone. The inner surface faces the star; the ring's rotation creates centripetal force or "gravity" on this surface. Even a small ring has many times the surface area of a planet. Usually, a ringworld is alone in a system, as worlds from this and neighboring systems have been used to construct it. Constructing a ringworld is a huge undertaking, even for a TL14 society.

Dyson sphere. As proposed by Dr. Freeman Dyson, this is a light spherical shell of solar collectors entirely surrounding a star. The star is hidden from sight within the shell, where its total energy is trapped and used by its creators. From the exterior, the sphere is dark and can be detected only by the heat it gives off. Some SF writers have suggested making a *solid* Dyson sphere that could be inhabited. If the sphere is rotated, the centripetal force will create "gravity" that is strongest at the equator, falling off to nothing at the poles. Often, it will be the only body in a star system, as the natural planets of this and neighboring systems have been dismantled to create it. The radius of the sphere should be the same as the distance at which a habitable world would orbit. Even the smallest such body would have a huge habitable area – many billions of times larger than that of any single planet. Construction of a habitable Dyson sphere is impossible below TL14, and a monumental task even at TL15; unfinished or failed spheres might also be encountered. Dyson spheres intended merely for energy collection may be possible by TL12.

Solar husbandry. A civilization that can build a ringworld or Dyson sphere may run out of planetary and asteroid resources, and begin sucking elements from its sun. One way to do this is to construct a ring of particle beams in orbit (possibly built into a Dyson sphere or ringworld) to create a "magnetic bottle" around the star. This pinches the star, causing it to eject matter. The ejecta is mostly hydrogen, which can be used to fuel nuclear fusion and produce other elements. This might also be used as a weapon (or even a giant plasma drive . . .). Reducing a star's mass substantially can increase its lifetime (up to billions of years), but its power output is reduced by a greater factor.

Other artificial structures are also possible – for instance, a structure like a huge compact disc, with the star located in the hole.

Planetary Records

On the next page is an example of a completed Planetary Record; a blank form appears on p. 176.

The map uses an "equal-area icosahedral" projection. Each hex represents the same amount of area. Size of a hex depends on the size of the planet. Multiply the world's diameter by 0.07 to determine the distance across one hex.

Unless specified otherwise, the north pole is at the top of the map, in the hex formed by the joining of the five points. Because this tends to distort the polar areas, a circular area centered on the north pole is also shown at the top of the map, and an area centered on the south pole is shown at the bottom.

The zero meridian line and the equator are shown as dashed lines. Lighter dashed lines connect hexes that are divided on the map. If this map were cut out and folded up, it would form a 20-sided "globe."

Specific points of interest are shown by a letter, keyed to text.

Miscellaneous Debris

In addition to planets, asteroids, and moons, star systems usually have lots of assorted orbiting trash – meteor swarms, comets, etc. These may be placed by the GM as necessary (usually as a space encounter for some special purpose).

It's probable that most or all systems have a cometary belt similar to the Oort Cloud of our own solar system. This is an area of small ice/methane bodies, orbiting at about 50,000 AU and beyond, from which the system's comets originate. To determine if an Oort Cloud exists at the rim of a star system, roll 1d. On a roll of 1-4, the system has a definite cometary cloud; on a 5, the cloud is unusually sparse (only half normal density); on a 6, there is no cloud.

The presence of a cometary belt is likely to be important only to spacefarers whose ship uses hydrogen as fuel or reaction mass, and who are stranded on the fringes of a star system. But it's always good to know what's out there . . .

Terraforming

Terraforming is the process of making a world habitable. Its difficulty depends on the current state of the world. Mars, for instance, could probably be made very earthlike in a few hundred years if we just crashed a few ice asteroids to give it more water, and set up a big solar mirror to raise the temperature. Venus would be a lot harder; it would have to be cooled down, and its entire atmosphere *changed.* And less earthlike worlds would be harder yet to terraform.

Terraforming is certain to be a very lengthy process . . . measured in tens, if not hundreds, of years. Once the world's temperature and chemistry are right, an appropriate ecology has to be introduced. The higher the tech level, the more worlds can be terraformed, and the faster the process becomes. TL8 could terraform Mars as described above. TL10-11 should be able to use nanotechnology and self-replicating machines to do even a Venus-type job quickly. At TL13, worlds themselves can be moved to the star's biozone – we could terraform Titan!

We may also meet aliens who know how to reshape worlds. And their ideas of "terraforming" are likely to be very different from ours! The more advanced both sides' terraforming technology is, the more worlds will be useful to both races, and the more likely conflict becomes. "Look, Zort! It's oxy-nitrogen right now, but we could G'voontform it in just a few megacycles!"

Unusual System Phenomena

If star systems are being created randomly, a system will contain something unusual only on a roll of 12 on 2d. To determine the specific "special effect," roll 3d and consult the table below. Entries marked with an * may be ignored (do not re-roll) if the GM does not want extremely high tech levels, superscience, or science-fantasy elements in his campaign.

3 – Sentient world.*
4 – Artificial world (TL14+).*
5 – Artificial world (TL13).*
6 – Double planet.
7 – Elliptical-orbit world.
8 – Captured world(s).
9 – Dead world(s).
10 – Unusually shaped world.
11 – Eccentric star.
12 – Inclined-orbit world.
13 – Retrograde-revolution world.
14 – Dying world.
15 – Binary planet.
16 – Ringworld.*
17 – Rosette.*
18 – Godstar.*

Science-Fantasy Phenomena

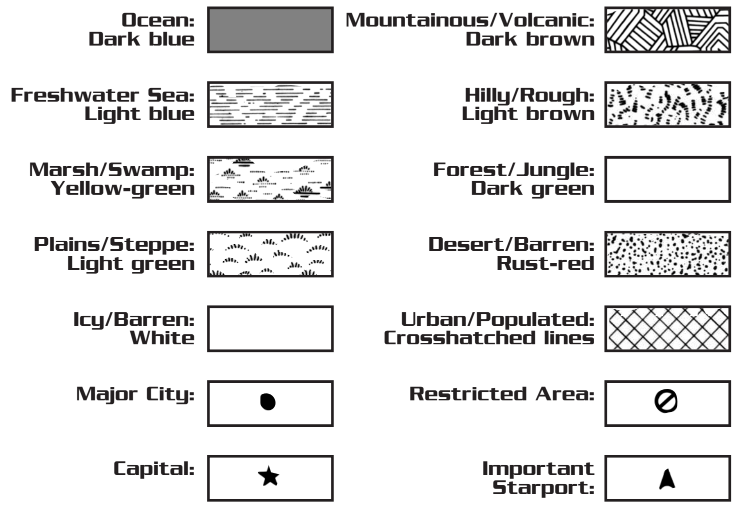
Sentient world. On the fringes of science fantasy are worlds which are alive and self-aware. The life might be in the world itself, or it may be a "total consciousness" of the combined life on the world. In the latter case, the world entity might have control of all native life forms. A sentient world might be childlike or very wise, and may be friendly, suspicious, or resentful of intruders. It will often be very alien in its thought processes. Its powers are entirely up to the GM; it may or may not be able to communicate, and may or may not have control of its own weather, seismic processes, etc.

Godstar. A sentient star, essentially similar to a sentient world.

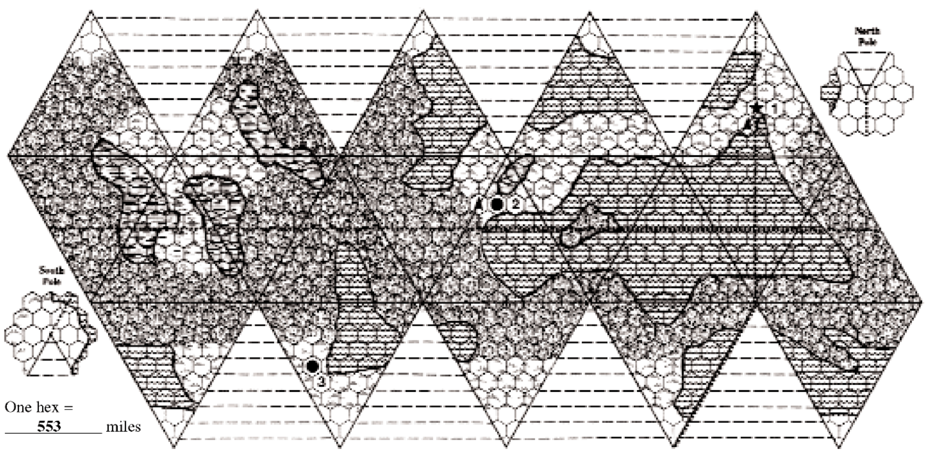
Zone of improbability. An area in which, for reasons either natural or artificial, some of the normal laws of nature are suspended. Effects can range from amusing but trivial (wavelengths of light are shifted) to potentially catastrophic (entropy is slowed or reversed; intelligence is lowered) to ludicrous (inanimate objects talk).

Map Key

This key shows suggested colors, for those making their own maps, and standard black-and-white symbols.



PLANETARY RECORD: REDUGUN



One hex = 553 miles

Planet type **Earthlike** Diameter **7,900** mi. Gravity **.96** G Density **5.3** Composition **Medium-Iron**
Axial Tilt **46°** Seasonal Variation **High** Length of Day **47 hrs.** Length of Year **100** days/ **.27** Earth years
Atmosphere: Pressure **.98** (**Normal**) Type and Composition **Nitrogen (77%), Oxygen (20%), Other (3%)**
Climate **See *, below** Temperatures at 30° latitude: Low **42°** Average **80°** High **119°**
Surface Water **32%** Humidity **58%** Primary Terrain **Forest**
Mineral Resources: Gems/Crystals **Scarce** Rare Minerals **Scarce** Radioactives **Adequate**
Heavy Metals **Plentiful** Industrial Metals **Plentiful** Light Metals **Ext. Plentiful** Organics **Plentiful**
Moons **None**

Biosphere: Dominant life form **Large mammal-equivalents. Dringels are sentient. Some carnivores grow *very large.***
Other significant life forms **Complete biosphere. Trees grow extremely large.**

Civilization: Population(s) **64.3 million humans; 100 million (?) Dringels** Tech Level(s) **9** Control Rating **3**
Society **Feudal with strong hereditary caste divisions. Duelling is common at all social levels, but not *between* levels.**
Starports **Class III at Castle Stark (#1); Class III (small) at New Tethys (#2)**
Installations **Free Trade League office; university at Southkeep (#3)**

Economic/Production **Agricultural/mining economy. Exports include steel, copper, lumber, fine furs.**
Economy based on cheap Dringel labor.

Other Notes: **Map key: 1. Castle Stark (capitol) 2. New Tethys 3. Southkeep**
*** Short year reduces seasonal variation to Terran proportions, despite major axial tilt**

System Information:
Star Name **Torsk** Type **K6 VI** Location **Old Frontiers -2/4/-6**
Biozone **0.2-0.3** Inner Limit **0** Number of Planets **8**

Planet	*Orbit*	*Distance*	*Type*	*Diameter*	*Density*	*Gravity*	*Atmosphere*	*Notes*
Redugun	1	**.3**	**Earthlike**	**7,900**	**5.3**	**.96**	**Oxygen-Nitrogen**	**Detailed above**
Havant	2	**.7**	**Hostile terrestrial**	**3,800**	**4.2**	**.37**	**Thin CO_2-Nitrogen**	**Primitive plant life**
Rhyl	3	**1.1**	**Gas Giant**	**37,000**	**2.0**	**1.69**	**Hydrogen-Methane**	**–**
Truro	4	**1.9**	**Iceball**	**2,100**	**5.1**	**.25**	**Trace Nitrogen**	**–**
Torbay	5	**3.5**	**Gas giant**	**85,000**	**1.5**	**2.92**	**Hydrogen**	**Faint ring**
Solihull	6	**6.7**	**Icy rockball**	**7,750**	**3.6**	**.64**	**None**	**–**
Stoke	7	**13.1**	**Gas giant**	**39,500**	**2.4**	**2.17**	**Hydrogen**	**Spectacular ring**
Ayr	8	**25.9**	**Gas giant**	**62,300**	**.9**	**1.28**	**Hydrogen-Helium**	**Only 3 moons**
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							

CHAPTER 11 CIVILIZATIONS

For each world with intelligent life, native or otherwise, the GM should determine basic facts important to the adventurer: the general structure of the society, tech level, basis of the economy, and existence of important facilities.

Population

The GM may assign population as he chooses, or calculate it based on the world's history and environment. The Population Rating (PR) is the "order of magnitude" of the world's population. Increasing the world's PR by 1 multiplies the actual population by a factor of 10.

There are three good ways to set PR. For a random determination, just roll 2d-2.

To assign PR according to campaign needs, base it on the following:

0: Less than 10. Research team, shipwreck survivors, etc.
1: 10-99. As above, or a very small startup colony.
2: 100-999. The smallest likely startup colony, or a military base.
3: 1,000-9,999. A fairly small colony (equivalent of a small town).
4: 10,000-99,999. A growing colony or very large military base.
5: 100,000-999,999. Equivalent to the population of a small city.
6: 1 million-9,999,999. Equivalent to a single large city.
7: 10 million-99,999,999. A huge city, like New York; a large colony.
8: 100 million-999,999,999. A very large and successful colony.
9: 1 billion-9,999,999,999. A long-settled world or homeworld.
10: 10 billion-99,999,999,999. A severely overpopulated world.

Calculating the Population of Colony Worlds

It is also possible to calculate PR mathematically, based on the history of the world in your campaign. The initial PR might be anywhere from 2 (a very small colony) to 5 (a huge colony ship or fleet). Growth of the original colony depends on how hospitable the world is. On a wholly earthlike world, with medical technology of at least TL5, a human population will increase by a factor of 10 every 100 years, up to the maximum population for the planet (see below).

Non-earthlike environments will reduce this *increase factor,* as shown below. If the increase factor is 0, population on the planet is static; if the increase factor is negative, the world is so hostile that population is in decline.

Gravity: For gravity significantly different from the species' native gravity, subtract 2 × the number of G-increments of gravity difference; e.g., humans on a 1.4-G world (two G-increments' difference) would subtract 4, while humans on a 0.4-G world (three G-increments' difference) would subtract 6. Races (or variants) with the Improved G-Tolerance advantage can tolerate a wider range of gravities.

Composition: Subtract 4 if the world is metallic. Subtract 2 if it is high-iron or silicate.

Climate: Subtract 4 if the climate is 40° too hot or 100° too cold (very hot or frozen for humans), or 2 if the climate is 30° to hot or 80° too cold (hot or very cold for humans). Racial Temperature Tolerance will extend these ranges.

Atmosphere: Subtract 2 if the atmosphere is thin or less, or if it is polluted; subtract 3 if it is both, or if it is exotic or corrosive. Certain racial and biotech adaptations presented in ***GURPS Bio-Tech*** would eliminate these penalties: Low-pressure Lungs would remove the penalty for thin atmospheres, while Filter Lungs would remove the penalty for polluted atmospheres.

Other factors: Continual war, savage or toxic native life, disease, etc., will also lower the increase factor. Deliberate attempts to increase the population (mass cloning, etc.) will have a meaningful effect only if a significant portion of the world's resources go toward the effort!

Example: Saphronia has 0.75 G; that's one G-increment, so subtract 2 from the increase factor. Its composition is low-iron, and its climate is warm (no effect from either). It has a thin atmosphere: subtract 2. Its increase factor is thus (10 - 2 - 2) = 6. Thus, the population is multiplied by 6 every 100 years. If it started with a population of 1,000 and has been colonized 400 years, it will now have a population of $1,000 \times 6^4$, or 1,296,000.

Native Intelligence

When intelligent life is encountered, the GM may get basic information about it by rolling 3d on the table below. Add 3 if the planet is hostile; subtract 1 if it is earthlike. Assume that a native race is perfectly adapted to its environment unless the settlement is a colony or the world is a dying one.

4 or less – Human colony (perhaps lost).
5-8 – Cold-blooded, four limbs.
9 – Cold-blooded, six limbs.
10 – Warm-blooded, four limbs.
11 – Warm-blooded, six limbs.
12 – Insect- or crab-like.
13 – Boneless or worm-like.
14 – Plant-like.
15 – Two races living in a symbiotic relationship; roll twice more.
16 – Roll 2d on the *Psychological Oddities* table, and again on this table at a +2.
17+ – Physically very unusual; roll 2d on the next table.

Physical Oddities

2, 3 – Energy eater.
4 – Gaseous.
5 – Shapeless.
6 – Roll twice more on this table, discarding contradictions.
7 – Roll 2d on the *Psychological Oddities* table, and again on this table.
8 – Possesses a sense humans don't have, such as radar.
9 – This is an outpost; race is not native to the planet and is not adapted to it.
10 – Artificial or mechanical life.
11, 12 – Silicon-based metabolism.

Psychological Oddities

These creatures have cultures very different from the humanoid patterns described in the rest of this chapter. The GM may add details as he chooses.

2, 3 – Simply incomprehensible to mankind.
4 – Hive culture (telepathic).
5 – Hive culture (non-telepathic).
6 – Dislikes other intelligent life.
7 – Extremely short life span.
8 – *Secretly* xenophobic: dislikes other intelligent life.
9 – Ignores attempts to communicate.
10 – Secretive; avoids *all* contact!
11, 12 – Moves/thinks *very* slowly.

Maximum Population

Maximum population is determined by TL and usable space. Earth has some 40 million square miles (only about 20% of its surface) of livable land, and a PR of 9 (currently something over 6 billion). It probably has a maximum PR of 10 (over 10 billion, less than 100 billion). For a world of comparable area, then, maximum PR is 8, plus 1 for every TL above 6, to a maximum of 10. Remember to modify this for habitable area; e.g., a Dyson sphere could conceivably have PR 18-19!

Alien Populations

Alien races will have environmental requirements that depend on their homeworlds, and may even start with an increase factor different from 10. For instance, small creatures can build higher populations in a given space, and herbivores, not needing to maintain food animals, can sustain higher population densities (up to ten times higher) than carnivores. If a world has multiple races with different requirements, figure each race's PR separately. If they live in wholly different environments, one world could support "full" populations of two or even more races – one terrestrial and one aquatic, for instance.

Tech Levels

Each world has a tech level, from 0 up. Most worlds will have the same TL as the campaign. Possible exceptions include:

Society TLs. A particular interstellar society may have a different TL. For instance, in a TL10 campaign, one empire might be TL9 – its advanced technology must be imported, and cannot even be repaired locally. A society or world may be given a "split TL" to show this: TL10/9 means that TL10 gear is available but not produced locally.

Colonies. A new colony is generally at least one TL lower than the world or society that colonized it. It may have the use of advanced technology, but the devices cannot be repaired or replaced locally.

Backward worlds. A world newly introduced to interstellar society will have a TL between its level when discovered and the larger society's TL. Cultures resistant to change (such as 17th-century China) may advance slowly, while ambitious cultures (19th-century Japan) might leap several TLs in a century. An interstellar society might enforce "non-interference" or stable-growth regulations, controlling the spread of advanced technology. Again, a split TL is possible: barbarians with stolen blasters might be TL8/4.

Regressed worlds. On these worlds, a high technology is being (or has been) lost. This may be due to philosophy (a religious movement that rejects "mechanical brains," for instance), isolation (a colony cut off from its mother society, unable to replace its aging high-tech devices), or loss of the tech-educated segment of society through war or disease.

Advanced worlds. For game balance, GMs should be cautious about worlds with a higher TL than the campaign. One option is to have a few worlds advanced in a single field, perhaps balanced by retardation in another – the Somisians, for example, have TL10 medical technology, but no starflight. Advanced societies might also restrict the spread of their knowledge.

Worlds with an overall TL above that of the campaign should not be randomly generated; any that exist should be created by the GM for a specific reason!

Natural Environments

To determine the natural environment of nonhuman intelligent life, roll 2d, discarding any result that contradicts what is already known about their world:

4 or less – Underwater
5, 6 – Water
7-10 – Land
11 – Underground
12 – Air

If the natural habitat is on land, use the planetary terrain table (p. 160) to determine what type of land environment the natives prefer. Do the same if they live underground or in the air (unless they are fliers who never land) to find out what type of terrain they live under or above.

Underwater: These beings live their entire lives underwater, and may die if they leave the water for more than a very short time.

Water: These beings live in the water, but not necessarily under it. They may float on its surface all their lives, or live underwater but not be able to breathe underwater, like whales and dolphins.

Land: These beings live on land, in one (or more) of the various terrain types described earlier. You may roll more than once for their native terrain, if you wish them to be found in more than one type of environment.

Underground: These beings are burrowers who live under the surface all or part of their lives, or who are primarily cave dwellers.

Air: These beings spend most or all of their lives in the air. True fliers, floaters, and some gliders will fall into this category.

Racial Templates

GMs who want to know the exact character abilities of an alien species (especially one intended for use as a PC race) should see the racial template design system on pp. CI173-180 and use the information generated by the tables on pp. 166-168 as guidelines when selecting specific traits.

Random TLs

Tech level is based on the TL determined for the campaign by the GM. To determine relative tech level randomly, roll 3d:

3 – *Anomalous.* Roll 1d+1 to determine TL, but they have star travel. Somehow, the barbarians got some starships – now they have advanced weapons, and perhaps a hostage world or two doing manufacture and repair.

4, 5 – *Retarded in a science.* Same TL as the campaign, but retarded in technology in one field – see the *Sciences* table.

6, 7 – *Retarded in an art.* As above, but see the *Arts* table.

8, 9 – *Primitive.* Roll 1d to determine the world's TL.

10 – *Developing.* TL is 1d lower than the TL of the campaign.

11 – *Slightly retarded.* Same TL as the campaign, but manufactured items tend to be larger, heavier, costlier (+10%), or less user-friendly.

12 – *Modern.* TL of the campaign.

13 – *Slightly advanced.* Campaign's TL, but products are beautifully styled, compact, inexpensive, or easier to use.

14-16 – *Advanced in an art.* Same TL as the campaign, but advanced in one of the arts – see the *Arts* table.

17, 18 – *Advanced in a science.* As above, but see the *Sciences* table.

Sciences (roll 2d):

2-4 – Biology and medicine.
5 – Weaponry.
6 – Sublight space travel.
7 – Power generation.
8 – Communications or sensors.
9 – Computers or robotics.
10, 11 – Air or surface transportation.
12 – FTL travel.

Arts (roll 2d):

2, 3 – Games and diversions.
4 – Social science or history.
5 – Mathematics.
6 – Visual arts.
7 – Finance and commerce.
8 – Performing arts.
9, 10 – Music.
11, 12 – Other arts.

In ascending order of campaign impact, an advance might mean:

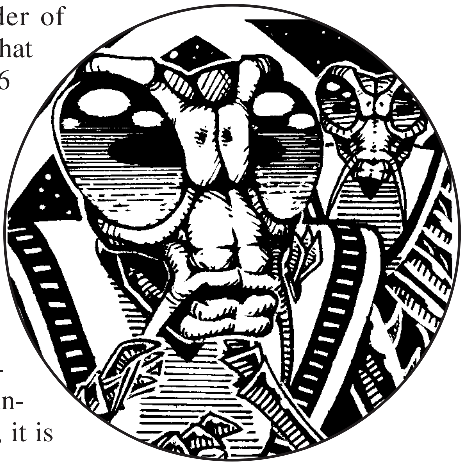
- The society has a *breakthrough* in the field. Its equipment – though still campaign TL – is noticeably improved.
- The society can construct a specific device from an advanced TL, though no other items from that TL are available.
- The society has advanced an extra TL throughout the field.

In a retarded society, the opposites apply.

Planetary Societies

Mankind has lived under dozens of different societies; aliens will no doubt have dozens of their own. And the possible differences in planetary societies are far greater than those of interstellar nations! For adventurers used to the sophisticated spaceways, an unusual society can be a death trap.

Some possibilities are listed below, in order of increasing Control Rating (CR; see p. 172). Note that global societies are likely only at TL8+. At TL6 and 7, a world may harbor several different societies; at TL5 and below, there are likely to be hundreds.



Anarchy

There are no laws. Order is maintained by the social conscience, or the strength and weaponry, of the population. An anarchy may be a lawless mob, or a crew of clear-eyed, strong-backed pioneers. Usually CR 0 – but if all your gun-toting neighbors disapprove of what you're doing, it is effectively illegal!

Athenian Democracy

Every citizen (the definition of "citizen," of course, can vary) votes on every action the society takes. In a low-tech society, this works only for groups under 10,000. In a high-tech society, any number can discuss and vote electronically. Usually CR 2 to 4.

Representative Democracy

Elected representatives form a congress or parliament. If the citizens are vigilant and informed, this is a benevolent government. If the citizens are badly educated, government policies will be bad but popular (bread and circuses!). If citizens are apathetic, government may be dominated by factions or special interest groups. In all cases, secret conspiracies may operate to control the society. Usually CR 2 to 4.

Clan/Tribal

The society is one large, interlocking family, made up of cooperating clans or tribes. Rule is usually by the clan elders. Customs and tradition are very important. Younger clan members may feel forced to conform, or may be rebellious about their lack of influence; seniors may channel this energy by encouraging sports, recreational combat, or outworld adventuring. Usually CR 3 to 5.

Caste

As for Clan/Tribal, but each clan has a set profession – for instance, if the Arrin family is a warrior clan, then all Arrins are soldiers of some sort. Those who don't follow their clan profession become clanless (a Social Stigma) unless there is a system for adoption into a new clan. Clans are often arranged in a social hierarchy; e.g., administrators outrank warriors, who outrank street sweepers, and so on. Individuals are expected to associate only with those of equivalent status. There may also be rivalries among clans of the same type (different warrior families, for instance). Usually CR 3 to 6.

Dictatorship

All government is in the hands of a single ruler – king, dictator, or warlord. Successors may be chosen by inheritance, single combat, election, or any number of other means. If the ruler is a king, this is a *monarchy.* This sort of government can act faster, for good or evil, than most representative governments. Usually CR 3 to 6.

Many dictatorships and other totalitarian states, if they endure long enough, develop a "balance wheel" in the form of custom. Though the ruler's will is law, there will be unwritten laws which even he may not violate with impunity.

Technocracy

Engineers and computer programmers rule in the name of efficiency. Everything is carefully planned; of course, plans can go wrong. The better the technocrats are at running things, the less oppressive they will be; if they're incompetent, they will also be dictatorial. CR can range from 3 to 6.

Theocracy

A theocracy is ruled by a religious group or leader; freedom of religion is unlikely, and there is no distinction between religious and civil law. Theocracies range from totalitarian religious dictatorships to benign utopian societies. In either case, the leaders may or may not believe in their own religion; "miracles" may be faked or *genuine.* Usually CR 3 to 6.

Corporate State

This is similar to the interstellar corporate state; see p. 22. The world is ruled by corporate officers, usually chosen by a board of directors; most citizens are employees of the corporation. Society runs smoothly – it has to, or it won't be profitable. Usually CR 4 to 6.

Feudal

Similar to monarchy (see *Dictatorship,* above), but subsidiary lords retain power. The ruler, therefore, must be careful to maintain the support of the lesser lords, or be overthrown. Each lord rules his own territory, so laws and personal freedom vary from dominion to dominion. If the lord's rule is harsh, he will restrict ownership of high-tech items to protect himself! Usually CR 4 to 6 for commoners.

Multiple Societies

If there is no world government, the worldwide political situation may be:

Diffuse: There are dozens, if not hundreds, of clans, nations, and groups; no one can make any claim to world domination.

Factionalized: GMs may roll 3d to determine the number of major governments – which may be of extremely different types. Anyone can flee justice by jumping the nearest border. Mercenaries may be welcome. Everything from scheming to warfare is going on, as factions strive for control – often with off-world assistance.

Coalition: The world is dominated by a few of the larger societies, which may bicker among themselves but which usually present a united front to outsiders. GMs may roll 1d to determine the number of major governments. A powerful homeworld run by a coalition, whose members each have their own off-world colonial empires, can make an interesting campaign.

Restricted Worlds

A world may be placed on "restricted" status by outside societies. Depending on the interstellar society, the Survey, the Patrol, or even the navy may intercept ships approaching such a world. The degrees of restriction are:

Embargoed: All trade with this world is prohibited. Unless the interstellar society is very weak, the embargo is enforced by Patrol or navy ships. Visitors are carefully searched to prevent smuggling.

Hazardous: This may be a navigational hazard within the system, unusually vicious native life, or a poisonous atmosphere or ecosystem. Automatic warning buoys may be posted in systems posted as hazardous.

A world may also be posted as hazardous due to danger to visitors – the political climate may be extreme, or a local religion or culture may be easily offended.

Prohibited: No contact is allowed except by special government permission. Prohibited ratings may be given because a system is very hazardous (or because visitors might help spread the hazardous item), or harbors a technological or military secret (Precursor ruins or a captured enemy base). Developing sentients may be protected by declaring their homeworld prohibited. Or a society may protect itself from dangerous cultures by declaring them off-limits. Prohibited worlds are usually patrolled by the Patrol, navy, or Survey. Depending on the danger, trespassers may be forcibly removed, prevented from leaving, or destroyed on sight.

Protected: Contact with this world is permitted but strictly limited, in order to protect local life or native culture. Depending on the danger, visitors may undergo medical quarantine, be prohibited from carrying equipment above a certain TL, or required to disguise themselves as natives.

Reserved: Reservation worlds are currently off-limits for colonization or development.

Special Variations

One or more of these situations may apply to most society types listed above:

Bureaucracy: Government has fallen to a self-perpetuating bureaucracy. The bureaucrats, not elected, are insulated from public pressure. Government seems to run very smoothly – or if there are difficulties, you aren't told about them. But there are high taxes, many laws, and lots of red tape. The government is unresponsive to citizens. There may not be a free press. CR 4 or higher.

Colony: A dependent member of a larger society. It is ruled by the mother society, usually through a governor. The colonists may have an elected council (through which they influence the governor), an elected representative to the mother government (with nonvoting power), or both, but they have no direct say in their own government as long as their society is a colony. Colonies become *territories,* receiving more self-government, when they reach a set population or development level; territories eventually become full-fledged members of the society. Colonial government will be patterned after that of the mother society.

Colonies tend to be less regimented – rebels and outcasts are welcome if they have useful skills, and laws are loose. There is less government – no welfare bureaucracy, few police outside of major communities – and the TL is lower.

Cybercracy: Administration, and perhaps actual legislation, is controlled by a statewide computer system. Impossible below TL8 and unlikely below TL9. Government may be efficient, or inhuman, or both. CR 3 and up; the system is only as good as its programmers and technicians. Trust the Computer . . .

Meritocracy: No one may enter the government without passing a series of tests. A good meritocracy is likely to have (mostly) competent leaders . . . but this can lead to a rigid caste system. CR 3 and up.

Military Government: All administration is by the military. If led by a single commander-in-chief, the society is totalitarian; if the commander is responsible to a council or *junta* of officers, the society is feudal. Military governments can be strong and honest, but most become dictatorships. CR 4 and up.

Oligarchy: Regardless of the nominal form of government, leadership is in the hands of a small, self-perpetuating clique. CR 3 and up.

Patriarchy: Positions of authority are open only to males. In a *matriarchy,* all the rulers are female. Other than that, any CR is possible.

Sanctuary: A sanctuary world does not extradite "criminals" who may be hunted elsewhere, whether they be true criminals, or religious or political fugitives. There may be a Sanctuary Tribunal to decide each petitioner's fate. Lawmen or bounty hunters from other worlds are outlaws here. A sanctuary risks eventual takeover by the criminal element. CR rarely over 4.

Slave state: In the case of *economic slavery,* you are sold into slavery if you can't pay your debts. The length of the slavery might be preset, or economic slaves may have the chance to earn a wage and eventually buy freedom. Economic slaves are often used as colonists or soldiers. *Racial slavery* – in which a race or caste is held in slavery – is sometimes practiced by xenophobic races. In some cases, mentally inferior (or intelligent but passive) aliens are enslaved by a dominant race; some races have a low-IQ slave sub-race. *Martial slavery* exists when a militant nation raids foes for slaves. In all cases, CR can vary; possibly everyone but the slaves is free.

For the GM, this is a way to get impoverished PCs involved in adventure. Characters might also fight a repressive state by fostering a slave revolt.

Socialist: The government directly manages the economy. Citizens get free or subsidized education, medical care, housing, etc., and the government tries to give everyone a job. The expense of such programs can easily stifle an economy, except possibly at high TLs. Most wealthy states have elements of "mild socialism" in their system of government, such as free or heavily subsidized health care, and "safety-net" welfare benefits for the poor. Like any government expenditure (e.g., strong military defenses, government-run exploration programs, or the building of grandiose monuments), these benefits may push up local taxes.

Random Societies

World Government

To determine the general nature of world government, roll 2d. Subtract 4 from the roll if the world's prevailing TL is 6 or less.

5 or less – No world government; diffuse.
6 – No world government; factionalized.
7 – No world government; coalition.
8 – World government with a special condition; roll on the *Society Type* table, and then on the *Special Conditions* table.
9 or more – World government with no special conditions; roll on the *Society Type* table.

Society Type

To determine a society type, roll 3d and add the world's TL, treating any TL over 10 as 10:

3-6 – Anarchy: no government!
7, 8 – Clan/Tribal.
9, 10 – Caste.
11 – Feudal.
12 – Theocracy.
13, 14 – Dictatorship (details vary widely).
15-17 – Representative Democracy.
18-20 – Athenian Democracy.
21, 22 – Corporate State.
23-25 – Technocracy.
26 – Caste.
27+ – Anarchy: no government!

Special Conditions

Roll 3d on this table only if the *World Government* table indicated that a special condition exists.

3, 4 – Subjugated.*
5, 6 – Slave State.
7 – Sanctuary.
8 – Military Government.
9 – Socialist.*
10 – Bureaucracy.*
11 – Colony.
12 – Oligarchy.*
13 – Restricted World: Hazardous.*
14 – Meritocracy.*
15 – Restricted World: Embargoed.*
16 – Patriarchy/Matriarchy (flip a coin).
17 – Utopia.
18 – Cybercracy (roll again if TL is less than 8).

* Roll 1d. On 1-3, roll for a second special condition.

Subjugated: This world is under outside control, which may be military (an occupying army or garrison) or economic (perhaps with a "puppet government," subservient to foreign masters). CR always 4 or more.

Utopia: A utopia is a perfect society in which all citizens are satisfied. CR always seems low . . . but is it? Real utopias are rare. More often, seeming utopias have some dark secret – a hidden technocracy ruling by mind control, for instance. For sophisticated roleplaying, a sinister utopia is a real challenge. Real utopias make excellent "good guy" societies, to be saved from conquest or other threats. But real utopias, unless threatened by destruction, are boring.

Starports

Starports are graded by their ability to handle interstellar trade. A starport may exist on any world which has star travel, or which trades with star travelers; Class II and below may be present on any world which has space travel.

For a random determination of a world's starport class, roll 3d vs. the target number specified for the class. Check for the *highest* applicable class first; if there is no starport of that class, then check for the next-highest class, etc. A world will usually have several ports of lower class than the main starport, but this rarely affects play.

Class V – Full facilities. Full repair and ship-construction facilities, along with associated Patrol, naval, or Survey bases. Port has berths for hundreds of vessels, multiple landing fields, and every facility imaginable – from crew union halls to high-tech training facilities. A Class V port is present only on worlds of PR 6 or better, on a roll of less than (PR+3).

Class IV – Standard facilities. Full repair facilities and light ship-construction facilities. A Patrol or Survey base is attached. Any world engaged in regular, substantial trade has at least standard facilities. A Class IV port is present only on worlds of PR 6 or better, on a roll of less than (PR+6).

Class III – Local facilities. Repair facilities for common needs; special parts or complex repairs will require off-planet parts, technicians, or facilities. Patrol or Survey may have a base; if not, there will be at least an office. Worlds with limited interstellar commerce have local facilities. A Class III port is present on a roll of less than (PR+9). (If a world does not have at least a Class III starport, there must be a reason why it gets no regular star traffic.)

Class II – Sub-C facilities. These are intended for interplanetary or shuttle craft rather than FTL ships. Only emergency repairs are available for starships, but common fuel types are available. A Patrol office may be found here, perhaps accompanied by a Survey office if the world is isolated. A Class II port is present on a roll of less than (PR+8).

Class I – Emergency facilities. No real starport – only a landing area. Marked by automatic buoys, it might be a cleared-off, flattened space or a small orbital station. If FTL message beacons or drones exist, one should be present. A Class I port may be unmanned, or it may have local customs and security offices. Emergency parts and fuel are stored nearby. If qualified technicians are available, the buoys will have contact information. Class I facilities are present on a roll of 14 or less.

Class 0 – No facilities. There isn't even a designated landing site – ships planning to land must look for suitable terrain. If the world has a high enough tech level, there will be an airport, parking lot, or wide roadway.

Orbital vs. ground ports. Depending on the campaign's FTL technology, starports may be in orbit or on the ground. Ground ports service shuttles and landing-capable starships; an orbital port allows non-landing starships to dock, and provides shuttles to the surface. If a world has two ports, the older often has poorer facilities, lower rates, and a less-selective clientele.

Space Colonies

At TL8+, one or more large, self-sufficient colonies housing tens of thousands or even millions of people may be established in space rather than on a planet. A classic space colony is a hollow torus or cylinder many miles across, spun to provide gravity. (If artificial gravity can be generated, colonies may be any shape.) Extensive solar panels or huge reactors provide power. On the inside surface are farms, parks, shops, and houses, while the hub contains factories, docking bays, and control rooms. Giant windows let light inside. A space colony may be so large that it has weather. Space colonies may be located just about anywhere. In our own solar system, good places for space colonies are the Lagrange 4 and 5 points on either side of the moon's orbit around the Earth: there, the gravity of both bodies balances out, ensuring that a space colony will remain in a stable orbit.

Space colonies may be industrial or agricultural in character. By mining asteroids, a colony could be quite self-sufficient; a large enough agricultural colony could even export food to a planet, helping to feed the teeming millions below. It is up to the GM how high a population will exist in space, but increase factors could easily range from 0 (a system with poor resources and no asteroid belts or low-gravity moons) to 5 (extensive mineral-rich asteroid belts or moons). Add 5 if the colonists are a variant or alien race adapted to survive in zero gravity ("spacers"), or if they have artificial gravity technology.

In game terms, colonies can be designed as huge space stations using the system in Chapter 8. Omit drives (unless the colony is mobile), but install lots of habitat modules.

Control Rating (CR)

Control Rating is a general measurement of the control exercised by a government. The lower the CR, the more freedom exists on the world and the less restrictive the government. Government type does not *absolutely* determine CR; it is possible (and interesting) to have a very free monarchy, or an Athenian democracy where the voters have saddled themselves with thousands of strict rules. The GM can assign the CR as he pleases, or just roll 1d.

CR also affects what weapons can be carried (see p. 74), but especially violent or nonviolent societies will have a separate, modified CR for weapons laws.

When the GM wishes to settle a question of legality or determine how severe government checks and harassment are to visitors to the planet, roll 1d. If the result is lower than the CR, the act is illegal or the PCs are harassed, delayed, or even arrested. If it is higher, they escape trouble, either because the act is legal or because the authorities overlook it. If the CR is rolled exactly, the situation could go either way; play out an encounter or make a reaction roll.

Control Ratings are as follows:

0. Anarchy. There are no laws or taxes.

1. Very free. Nothing is illegal except (perhaps) use of force or intimidation against other citizens. Ownership of all but military weapons is unrestricted. Taxes are light or voluntary.

2. Free. Some laws exist; most benefit the individual. Hunting weaponry is legal. Taxes are light.

3. Moderate. There are many laws, but most benefit the individual. Hunting weaponry is allowed by registration. Taxes are moderate and fair.

4. Controlled. Many laws exist; most are for the convenience of the state. Only light weaponry may be owned, and licenses are required. Broadcast communications are regulated; private broadcasts (like CB) and printing may be restricted.

5. Repressive. There are many laws and regulations, strictly enforced. Taxation is heavy and often unfair. What civilian weapons are allowed are strictly controlled and licensed, and may not be carried in public. There is strict regulation of home computers, photocopiers, transmitters, and other means of information distribution and access.

6. Total control. Laws are numerous and complex. Taxation is crushing, taking most of an ordinary citizen's income. Censorship is common. The individual exists to serve the state. Private ownership of weaponry, or broadcasting or duplication equipment, is prohibited. The death penalty is common for offenses, and trials – if conducted at all – are a mockery.

A well-developed world will have at least one shuttleport or ground starport on every continent.

Special starports. Other starports, not specifically included in a world's rating, include corporate (servicing only one company and its clients), military, Patrol, and government ports. These can usually be used by any ship in an emergency, if the facility isn't secret.

Installations

Many worlds have interesting special features. These may be placed by the GM or rolled randomly. Each facility type lists a number; if a roll on 3d yields this number or less, the facility is present. Chance of some installations is affected by CR, PR, TL, and other factors. If a particular type of installation doesn't exist in your campaign, or is simply of no interest, don't roll for it!

If a world has a PR of 2 or less, the first installation rolled represents essentially the whole population of the planet; it is a special-purpose colony.

Alien enclave. One or more races alien to the world's major population live in segregated "ghettos" or reservations. This may be by their own choice – to preserve their own culture, or from dislike of the other race. Or the major population may dislike *them.* An entire world may be designated an enclave. Present on a roll of 6 or less.

Black market. The market may have a physical location, or it may simply be that illegal goods are easily found through conventional contacts here. If the black market is commonly known, the Patrol is likely to raid occasionally or restrict trade (unless people in high places have been paid off). Interstellar criminal organizations have agents here. Present on a roll of (9-CR) or less.

Colonial office. An office of the colonial authority, whatever that is. On a heavily populated planet, this may be a recruiting center; on a colony, it will be a "compliance" office, with the attitude of the chief administrator set by a general reaction roll. Present only at PR 3 or more, on a roll of (PR+4) or less.

Corporate headquarters. The nerve center of a major interstellar corporation is located here. Industrial operations may or may not be present. In extreme cases, the planet is governed by the company. Present only at PR 6 or more, and local TL 7 or more, on a roll of (PR+3) or less.

Criminal base. "Corporate HQ" for a criminal group. The Patrol will be interested in this world, if it knows about it. Present on a roll of (PR+3) or less.

Espionage facility. This may range from a secret starport to a minor office or spy cell. Civilian espionage organizations may be involved in industrial espionage. Military espionage bases will specifically be involved in spying on enemy capabilities and forces, or (in rear areas) in correlating data. Espionage facilities will be present on a roll under (TL+PR).

If a facility is present, determine its type. Roll 1d: on 1-4, it is civilian; on 5, it is friendly military; on 6, it is hostile military. Roll 1d-2 for the PR of the facility if military, or 1d-4 if civilian. Equipment available will be appropriate to the staff size.

If one espionage facility is present, there may be others (possibly to spy on the first one). Roll again for another facility; if it is present, roll for a third, and continue until a roll fails.

Government research station. Possible research subjects include FTL travel or communications, weapons and power technology, medicine, or Precursor studies. The facility may be known to the public, garrisoned by security troops and ships; or it may be secret, located in remote areas of an inhabited planet, on remote worlds (sometimes protected by a "prohibited" rating), or disguised as some other installation. Present on a roll of 12 or less, on any planet; if one is present, a second is also present on a roll of PR or less. There is a 1 in 3 chance that any station is secret.

Mercenary base. Current home planet for a mercenary company, perhaps with a contract from a local government. Training facilities, depots, and support personnel are here, as well as fighting forces. Present on a roll of 7 or less.

Nature preserve. Most or all of this world is set aside in its unexploited, natural state. These preserves may be used for scientific research (off-limits to tourists), or for light or heavy tourism (safaris, excursions, etc.). Present on a roll of (12-PR) or less.

Naval base. Size and complexity can vary from a main base to a refueling station or observation point. Present on a roll of 10 or less. Roll 1d-1 for the PR of the base itself; this gives a clue as to its purpose. Note that some bases will not be on the populated planet of a system.

Patrol base. As above, but for the Patrol. Present on a roll of 9 or less. Roll 1d-2 for its PR.

Pirate base. This planet may house a full-fledged pirate outpost with its own starport and security forces, perhaps allied with the world's population. Or, on a smaller scale, a single pirate corsair may set down secretly from time to time for supplies and R&R. If the pirate base is public knowledge, the Patrol can be expected to take an interest. Present on a roll of (8-CR) or less.

Prison. Prisons are often built on barren, unsettled worlds (to make escape difficult), or in remote areas on habitable planets. They are rigorously patrolled. Travel to prison worlds is heavily restricted. Prisons are rare; if no facilities other than Patrol or naval bases have yet been generated for the world, a prison is present on a roll of 8 or less.

Private research center. May be funded by industry, by government grant, or (secretly) by criminal organizations. Such centers investigate a wider range of topics than government centers, including many far-out theories (psionics, time travel, alternate universes, perpetual motion, etc.). Present on a roll of (PR+4) or less; if one is present, roll again, up to a maximum of three.

Rebel or terrorist base. These range from hidden fortresses with full FTL facilities to minor hideouts for ships "on the run." Rebels will have contacts among the local population, though the world government is seldom allied. Terrorists typically base themselves on friendly worlds, striking into foreign territory. The Patrol or the navy will take an interest in such installations. Roll as for a Patrol base.

Refugee camp. A holding center for people who have fled their native world due to war or other catastrophe. These are usually run-down, filled with squalor and crime. Refugees are often disliked by the natives; the impoverished refugees are often desperate and militant, scheming to regain their lost lands. Present on a roll of (PR-3) or less.

Religious center. Sacred areas – shrines or temples, often with church administrative and meeting facilities. Some ancient sites may be guarded by the Patrol. Pilgrims are likely. May be off-limits to nonmembers of the religion. Present on a roll of (PR-3) or less.

Special Justice Group office. See p. 22. Present on a roll of (PR-6) or less. There is a 1 in 3 chance that the office is covert, known only to SJG operatives; in that case, it will have an innocuous "cover" function.

Survey base. Roll as for a Patrol base.

University. A prestigious interstellar center of learning, with libraries and research facilities. See p. 24. Present on a roll of (PR-6) or less.

Production Type

A world's production type indicates its place in interstellar commerce. There are a few general types:

Agricultural worlds raise and export crops or animal products. High-tech agricultural goods include gengineered products and harvested microorganisms (algae and yeast). Most such worlds are fairly earthlike.

Government worlds include capitals, administrative centers (with bureaucrats), prison planets, outposts, and military bases.

Industrial worlds research, manufacture, and sell goods. Types include machinery, consumer goods, refined chemicals, highly processed foods, etc. Rare raw materials are often imported, as are workers. Industrial worlds are commonly metallic, so that basic raw materials don't have to be imported; they frequently become polluted.

Mining worlds export raw or processed minerals. These include both industrial metals (aluminum, steel), rare metals (titanium, gold), and rare nonmetals (energy-regulating crystals for FTL drives, perhaps). They are most likely asteroids, or high-iron or metallic planets. These worlds may be exploited in a way that leaves them seriously polluted. However, there may be little population other than mining crews. Gas giants, and the comets of Oort Clouds, may also be "mined" for their gases.

Service worlds might be involved in banking and finance, trade, data processing, communications, education, entertainment and tourism (including gambling and business conventions), or mercenary camps.

Mixed worlds have several types of production. Homeworlds often have a mixed economy.

None: This world takes no part in interstellar commerce. It may not be on most star maps, and it receives only irregular passenger service by starliners. Its society must be self-sufficient, as it has nothing to trade for outside goods.

To determine a world's production type, roll 2d. If the result does not match the information known about that world, roll again.

2-4 – Mining.
5 – None.
6, 7 – Agricultural.
8 – Industrial.
9 – Service.
10 – Mixed. Roll twice more.
11 – Government.
12 – Mixed. Roll three more times.

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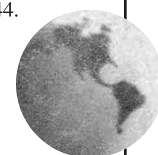


GLOSSARY

Technical and scientific terms, and some common science-fiction abbreviations used in this book:

astronomical unit (AU): The distance from the Earth to the sun, 93 million miles.
biozone: The region around a star at which the temperature allows water to exist as a liquid. This is the region in which a planet can orbit and support terrestrial life without the need for life-support structures.
c: The speed of light, 186,000 miles per second.
escape velocity: The speed at which a ship must travel in order to completely escape a planet's gravitational field. For Earth, this is 6.9 miles per second.
FTL: Faster-than-light.
gigabyte or **gig:** A unit of computer data storage. 1 billion bytes, or 1,000 megabytes.
kiloparsec (kpc): 1,000 parsecs.
light year (ly): 5.9×10^{12} miles.
main sequence: The normal course of evolution for stars. Most stars are "on the main sequence."
megabyte or **meg:** A unit of computer data storage. 1 million bytes.
parsec (pc): 3.26 light years.
rad: A unit of radiation as it affects the human body.
STL: Slower-than-light.

Four Handy Formulas:

- *Formula to determine escape velocity from a planet:*

$$V_E = 6.9 \times \text{Square root of } (g \times R) \text{ miles per second}$$

where V_E is escape velocity, g is the world's surface gravity in Gs, and R is the planet's radius in Earth radii.

See *Ground-to-Space & Space-to-Ground Performance* (p. 130) for the time required to reach escape velocity by various means.

- *Formula to determine planetary surface gravity in Gs:*

$$g = \text{Diameter (in miles)} \times \text{Density} \times 0.0000228$$

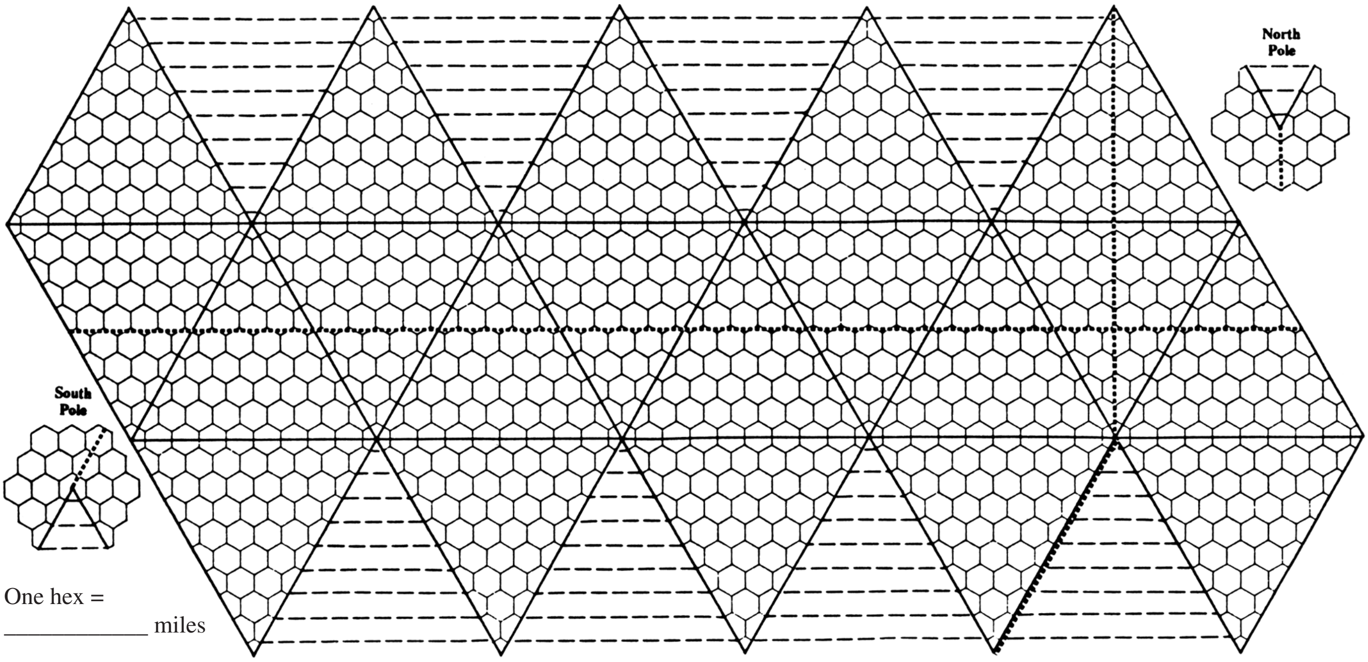
- *Formula for length of planetary year:* See *Length of Year* (p. 161).

- *Formula for time dilation as a ship approaches light speed:*

$$\text{T-ratio} = 1/\text{Square root of } [1-(v^2/c^2)]$$

where v is the speed of the ship and c is the speed of light.

PLANETARY RECORD



One hex = ____________ miles

Planet type ________________ Diameter __________mi. Gravity _______G Density __________ Composition __________________
Axial Tilt _____° Seasonal Variation ________________ Length of Day _________hrs. Length of Year ________days/ ______Earth years
Atmosphere: Pressure ________(________________) Type and Composition ____
Climate ____ Temperatures at 30° latitude: Low _____° Average ______° High ______°
Surface Water _____% Humidity _____% Primary Terrain ____
Mineral Resources: Gems/Crystals ___________________ Rare Minerals ________________________ Radioactives _______________
Heavy Metals _________________ Industrial Metals ____________ Light Metals ________________ Organics ________________
Moons ____

Biosphere: Dominant life form ____
Other significant life forms ____

Civilization: Population(s) __________________________________ Tech Level(s) __________ Control Rating _________________
Society ____
Starports ____
Installations ____
____
____
Economic/Production ____
____

Other Notes: ____
____

System Information:
Star Name ______________________________ Type ________________________________ Location ___________________________
Biozone _______________________________ Inner Limit ___________________________ Number of Planets ___________________

Planet	*Orbit*	*Distance*	*Type*	*Diameter*	*Density*	*Gravity*	*Atmosphere*	*Notes*
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							