DAMAGE SYSTEM FROM SWORD OF JUSTICE
By Kevin Dockery copyright 1999

The damage in SOJ is based on the maximum disruption of tissue caused by the impact and energy transfer of a projectile. The disruption is dependent on the amount of kinetic energy inherent in a given projectile, how quickly the energy is transferred to the target struck. The three types of disruption we are most concerned with are first, the actual bullet hole, that is the amount of damage caused by the passage of a projectile of a given diameter, second, the volume of maximum permanent damage to tissue where the tissue is stretched past its recovery point by the shock wave of the projectile, and lastly, the volume of the maximum temporary cavity which is the relatively large space created by the passage of the projectile and its shock wave but is only temporary as the tissue quickly collapses after the wave front has passed.

For our purposes we use the volume of maximum permanent damage where the tissue is no longer viable as representative of the destructive potential of a given round and its effects on the body. The type of projectile striking greatly effects the area of damage as the speed of energy transfer varies with the bullet type. The common full metal jacketed military ball rounds do not readily transfer their energy and retain their shape well which results in very deep wounds, often completely penetrating the body, while affecting relatively little tissue. To increase the wounding power of the standard military ball round the so-called "tumbling" round was developed. the tumbling round gets its name from it being designed to quickly become unstable and tumble end-over-end when striking a relatively soft target such as tissue. The tumbling action causes the projectile to quickly shed its energy in the target in a much more efficient manner than the standard ball round and this transfer gives the "tumblers" their reputation for "stopping" or, more correctly, wounding power.

For those who are not restricted by international agreements such as the Hague and Geneva Conventions other bullet types than jacketed ball may be used to increase the wounding potential of a particular ammunition. The most common method by far to increase the efficiency of a round is to utilize a deforming round of some type that increases its frontal surface area after striking a target. This increase of surface causes the projectile to shed its velocity much faster and so transfer the energy to the target. The difficulty in using the deforming projectile is to, one, design it to perform consistently with irregular target media, that is clothing, hard and soft tissues, and possible interference such as windows, branches etc., and two, to allow the round to have ballistic stability and not destroy itself on its way to the target. The most common type of round is some variant of the soft nosed hollow point that has a metal jacket with a portion of the projectiles soft lead core exposed at the tip and an indentation in the tip as well. The speed of the bullet is also significant as the energy of the round increases in proportion to the square of the velocity while only increasing as a proportion to one-half of the increase in weight. What this means is that a faster moving bullet will have a greater energy than a somewhat heavier bullet moving at a slower rate. This is why so many police and other agencies are moving towards using light deforming projectiles moving at a high velocity. The older school of thought preferred the heavier, slow moving rounds which would quickly shed their more limited energy into a target without the concern of a round deforming according to design. The modern designs of deforming projectiles limits their not performing to specification and removes much of the argument towards the older schools of thought.

The most recent development in deforming projectiles is the pre-fragmented rounds presently available commercially as the Glaser line of ammunition. In the Glaser the normal metal jacket of a projectile is filled with a quantity of fine, #12, lead shot which is sealed in place by a plastic end cap. The effect of this projectile is for it to pass hard materials, such as boards, windows, etc., intact while quickly dumping its energy when it strikes a soft target such as tissue. This energy dump is caused by the jacket of the projectile being retarded from moving forward by the resistance of the tissue while kinetic energy forces the shot inside the jacket to burst through the plastic nose cap and disperse throughout the tissue much as a small shotgun shell. The effect of all this is an extremely devastating round that has little potential for ricochet or overpenetration of the target.

The results of the above make the Glaser the most effective round in terms of wounding potential with the various other types being less effective in terms of energy transfer. The chart given below ranks the various types of projectiles according to their effectiveness in transferring energy.

BULLET TYPE	Bf	BPf
PRE FRAGMENTED (GLASER)	10	124
LIGHT JACKET HOLLOWPOINT	5	59
JACKETED HYDRA-SHOCK	5	44
COPPER HOLLOWPOINT	4.5	62
TUMBLER	4.5	19

HEAVY JACKETED HOLLOWPOINT	3.5	56
LIGHT JACKETED SOFTPOINT	3	119
REVERSED HOLLOW WADCUTTER	2.5	51
SEMIWADCUTTER, KEITH-STYLE	2	22
HEAVY JACKETED SOFTPOINT	1.5	43
TARGET WADCUTTER	1	70
ROUNDNOSED LEAD	1	27
FULL METAL JACKETED	1	17

The bullet factor (Bf) was developed from outside research and was based on the averaging of the volume of the permanent wound cavity in Fackler-formulation ballistic gelatin for several calibers of a given bullet type.

To calculate the approximate volume of the permanent wound cavity the following formula is used;

FORMULA A

$$\frac{Me \times CS}{10} \times Bf = \text{Total Damage}$$

Where:
Me = Muzzle energy in Ft/Lbs
CS = Cross section of projectile in In^2
Bf = Bullet factor (from chart)
Total Damage = The total volume of tissue disruption in In^3

The result of the above calculation is the total amount of tissue disruption from a given projectile traveling through tissue until it came to a stop. To determine the amount of penetration a projectile will have in tissue the following formula is used.

FORMULA B

$$\frac{Mv \times Bdia}{BPf} = \text{Penetration}$$

Where;
Mv = Muzzle velocity in feet per second
Bdia = Bullet diameter in thousandths of an inch
BPf = Bullet penetration factor (from chart)
Penetration = Penetration in tissue by projectile in inches

Divide the total damage of the projectile as determined by Formula A by the penetration of the round from Formula B this will give you the amount of disruption for every inch of travel in tissue of the bullet.

For the use of the game the description for damage of a given round is shown by a pair of numbers separated by a slash (/). the first number is the penetration factor of the round and is the result of Formula B, the second number is the result of dividing the result of Formula A by Formula B and rounded off to a two place decimal. Example;

9x19mm Full metal jacketed NATO ball
Bullet weight - 123 grains
Muzzle velocity - 1099 fps
Muzzle energy - 330 ft/lb
Bullet diameter - .355 in
Cross sectional area - 0.10 in^2

Formula A

$$\frac{330 \times 0.10}{10} \times 1 = 3.3$$

Formula B

$$\frac{1099 \times .355}{17} = 22.949 = 23$$

$$\frac{\text{Formula A}}{\text{Formula B}} = \frac{3.3}{23} = 0.14$$

resulting in the damage for a 9mm NATO round being 23/0.14 which means the bullet does .14 cubic inches of disruption for each of its 23 inches of possible penetration.

As the body is of limited thickness many of the more powerful rounds will completely penetrate it and continue on. The average thickness of the body is as follows;

Torso and Head	9 inches thick
Legs	6 inches thick
Arms	4 inches thick

These numbers are of course averages but are sufficiently accurate for our uses. The total amount of damage (disruption) received by the body would require the disruption of the round to be multiplied by the remaining penetration of the round after any armor resistance has been accounted for. A maximum multiplier of 9 would be used only if a torso or head was struck.

For ease of play damage is written as follows when describing a round/weapon combination, ignoring armor resistance;

PENETRATION/DISRUPTION (DISRUPTION x 4 <Arm>)(DISRUPTION x 6 <Leg>)(DISRUPTION x 9 <Torso-Head>)

Using the earlier example of the standard 9x19mm NATO ball round it would be described as follows;

23/.14 (.56)(.84)(1.26)

If the round does not have a penetration of 9 or greater, the last bracket to have penetration reach it would have the maximum amount of disruption the round can give.
Example, 9x19mm Silvertip JHP

7/2.43 (9.72)(14.58)(17.01 MAX)

Example, 9x19mm Glaser
5/9.54 (38.16)(47.7 MAX)

BODY STRUCTURE

To utilize the information given above the body's physical structure has to be simulated. For the purpose of this example the body will be represented by "Body Points" determined by multiplying the Constitution of the character by his Strength and dividing by 10 (this is assuming a 1-100 point characteristic rating system). The resulting number of Body Points is divided into the various portions of the body according to the following chart;

PART	BODY %	250 pt MAN
HEAD	8%	20
NECK	1%	3
TRUNK	37%	93
(ZONE 1)	(9%)	(23)
(ZONE 2)	(10%)	(25)
(ZONE 3)	(9%)	(23)
(ZONE 4)	(9%)	(23)
SHOULDER (EA)	1%	3
UPPER ARM (EA)	3%	8
ELBOW (EA)	1%	3
LOWER ARM (EA)	2%	5
WRIST (EA)	1%	3
HAND (EA)	1%	3
THIGH (EA)	10%	25
KNEE (EA)	2%	5
CALF (EA)	3%	8
ANKLE (EA)	1%	3

FOOT (EA)	2%	5

NOTE: As fractions of numbers are to be rounded up to the next whole number the total of the body parts often ends up slightly higher than the original total of body points.

These body parts percentages are based on human engineering studies done in the United States and Europe and are representative of a standard male of approximately 20 to 40 years of age.

HEAD DAMAGE

DISRUPTION	CHANCE OF DEATH	CHANCE OF UNCONSCIOUSNESS
4.0	99%	99%
3.8	90%	99%
3.4	80%	99%
2.9	70%	99%
2.5	60%	99%
2.1	50%	99%
1.7	40%	99%
1.3	30%	76%
0.9	20%	48%
0.4	10%	24%

Any disruption greater than 40 striking the head causes effective decapitation of the target.

Any hit on the neck has the same effect as if the strike was on the torso in zone 1. An additional effect of any strike on the neck with a disruption over 1 prevents the target from being able to cry out. Any strike with a disruption over 16 effectively causes decapitation of the target.

TORSO DAMAGE

	DISRUPTION			
DEATH %	ZONE 1	ZONE 2	ZONE 3	ZONE 4
99%	10	12.5	20	25
90%	9	11.2	18	22.6
80%	8	10	16	20.1
70%	7	8.7	14	17.6
60%	6	7.5	12	15
50%	5	6.3	10	12.5
40%	4	5	8	10
30%	3	3.7	6	7.5
20%	2	2.5	4	5

10%	1	1.3	2	2.5

Disruption of less than .05 is a slight wound and has little or no immediate effect.

If a limb, or portion of a limb, takes a hit or an accumulation of hits that causes it to receive more disruption than it has body points, the limb, or all portions of the limb from the wound outwards, no longer functions. For example if the upper right arm of a 250 body point character received a hit from a 9x19mm JHP (7/2.43) it would receive a disruption of 9.72. With the upper arm having 8 body points it would have received more disruption than its structure could accept and the entire right arm would be useless except for the shoulder.

MULTIPLE HITS

The reaction of the body to multiple hits of individual discrete projectiles is in direct proportion to the square of the number of hits. To simulate this, the total amount of disruption from a rapid series of hits is added together and the result is applied to the body as if it were a single hit striking the torso in zone 2. Note; the disruption total is not subtracted from the torso but each individual hit can be accounted for from the specific site of impact at the gamers descretion.

WOUND SHOCK

At any time that the body receives a serious wound, disruption of 0.1 or greater, it reacts in a number of specific physiological ways, commonly collectively referred to as shock. The most obvious of these reactions is a very rapid lowering of blood pressure and a limiting of organ function, especially the kidneys, liver, heart, and brain. The result of these reactions is often rapid unconsciousness while the body attempts to recuperate and limit the damage it has received. Excitement, with its correspondingly high adrenal output, can stave off unconsciousness for a length of time, possibly to the point where first aid measures prevent a severe shock reaction from taking place. Extreme agitation or excitement has even been known to completely mask any reaction to damage until the adrenal level has returned to normal at which time the body often goes into even deeper shock than the wound would apparently warrant.

A very specific reaction to receiving a bullet wound is a nervous reaction that causes violent physical movement of the body, commonly referred to as "knockdown". Knockdown will rarely occur from the simple energy transfer of the bullet impact overcoming the inertial mass of a body, but it is instead more along the lines of a protective reflex of the body. Interference with normal nerve function, such as from drugs or from extreme agitation with its correspondingly high adrenal output, can prevent the knockdown reaction from taking place.

The following chart relates the chance of either knockdown or shock unconsciousness taking place according to the amount of damage received by the body.

	DISRUPTION TO CAUSE	
CHANCE	KNOCKDOWN	UNCONSCIOUSNESS
99	34	51
90	30.5	46
80	27	41
70	23.5	36
60	20	31
50	17	25.5
40	13.5	20.5
30	10	15.5
20	7	10.5
10	3.5	5

BLAST/SHOCK DAMAGE

There is damage received by the body from exposure to explosions that is received by the body as a whole and not any specific area as in the case of projectiles or fragmentation. The most notable effects to the individual by an explosion, and those which we shall address here, are stunning, unconsciousness, and death. The body is stunned when it has received either a sudden violent physical shock of a non-penetrative nature, or an overwhelming attack on the senses such as hearing and sight. When the body is stunned it is incapable of immediate coherent action and is disoriented but is conscious and capable of movement to a limited degree. Unconsciousness occurs when the shock has completely overwhelmed the body's systems and the neural centers temporarily shut down. With sufficient force the shock wave of a blast front moves through the body separating tissues and rupturing the tissue/air interfaces of the lungs. The heavy internal bleeding and massive tissue damage quickly results in death even though there may be no external wounds visible.

As stun damage is relatively limited it is represented by stun points the number of which is directly equal to the percent chance of the individual effected of being stunned. When a character has been stunned they cannot perform an intended action or reaction until the stun has worn off. stunning lasts normally from 2 to 8 seconds. The character will receive stun points anytime they are in the area of effect of an exploding device with the stun points dropping off in the same manner as blast points. The maximum number of stun points that any explosion can have is 100 with 99 being the preferred maximum.

Blast points are representative of the shock wave presented by the blast front as it moves through an object or individual. The amount of damage and its concurrent blast points are directly proportional to the amount of explosive fired as well as its brisiance. Brisance is the "shattering" effect of a blast front with the accepted international standard being TNT with an arbitrary rating of 1.0. With TNT being the standard it is also used as the basis of our damage system with each gram of TNT having 1.5 Blast and 1 Stun point (350 Blast, MAX <100> Stun per 1/2 lb). Blast points drop by 50 for every meter from the point of explosion. The effect of blast points on the individual is found on the following charts;

DEATH

BODY POINTS	BLAST POINTS RECEIVED FOR PERCENT CHANCE OF DEATH									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
500	125	156	188	219	250	300	350	400	450	500
450	113	141	170	198	225	270	315	360	405	450
400	100	125	150	175	200	240	280	320	360	400
350	88	110	132	154	175	210	245	280	315	350
300	75	94	113	131	150	180	210	240	270	300
250	63	79	95	110	125	150	175	200	225	250
200	50	63	75	88	100	120	140	160	180	200
150	38	48	57	67	75	90	105	120	135	150
100	25	31	38	44	50	60	70	80	90	100
50	13	16	20	23	25	30	35	40	45	50

UNCONSCIOUSNESS

BODY POINTS	BLAST POINTS RECEIVED FOR PERCENT CHANCE OF UNCONSCIOUSNESS									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
500	63	79	94	110	125	150	175	200	225	250
450	57	71	86	100	113	137	158	181	203	225
400	50	63	75	88	100	120	140	160	180	200
350	44	55	66	77	88	107	123	141	158	175
300	38	48	57	67	75	90	105	120	135	150
250	32	40	48	56	63	76	88	101	113	125
200	25	31	38	44	50	60	70	80	90	100
150	19	24	29	33	38	46	53	61	68	75

100	13	16	20	23	25	30	35	40	45	50
50	7	9	11	12	13	16	18	21	23	25

RELATIVE EFFECTIVENESS

Since the basis for the explosive damage tables is TNT but it is not the only explosive in common use the relative effectiveness of an explosive in relation to TNT can be used to apply it to the damage system. With TNT being equal to 1.0 on the scale other explosives can be compared with it by multiplying the weight of explosive being used by the RE factor found on the following chart:

RE VALUES

EXPLOSIVE	RE
PETN	1.66
RDX	1.50
COMPOSITION B	1.35
C3 or C4	1.34
TETRYL	1.25
Tetrytol	1.20
Amatol 80/20	1.17
TNT	1.0
Military Dynamite	0.92
Blasting Gelatin	0.92
Nitrostarch	0.86
60% Commercial Dynamite	0.83
50% Commercial Dynamite	0.79
60% Gelatin Dynamite	0.76
40% Commercial Dynamite	0.65
Black Powder	0.55
60% Ammonia Dynamite	0.53
50% Gelatin Dynamite	0.47
50% Ammonia Dynamite	0.46
Ammonium Nitrate	0.42
40% Gelatin Dynamite	0.42
40% Ammonia Dynamite	0.41

BREACHING CHARGES

Since the majority of military uses of explosives involves blasting a hole in an object the following chart is provided. The chart shows the quantity of explosive needed to blast a man-sized, approximately 1 meter wide, hole in a concrete wall. If the wall is made of rock or masonry multiply the required amount of explosive by .5.

THICKNESS OF CONCRETE	TNT REQUIRED
.5m or less	4.7 kg
.6m	6.4 kg
.8m	12.3 kg
.9m	17.6 kg
1.1m	28 kg
1.2	42 kg
1.4m	59.6 kg
1.5m	64.2 kg

A one pound (.45kg) block of TNT will blow a man sized hole through a normal wooden wall (less than 12 cm thick).

FRAGMENTATION DAMAGE

Fragmentation weapons of various types cause the majority of wounds on todays battlefields. The weapons have developed greatly from the deeply notched, heavy fragmentation bombs of earlier years with most weapons today utilizing some form of controlled fragmentation. Controlled fragmentation allows the lethality and area of effect of a weapon to be designed within relatively small parameters. Earlier weapons used simple casings of cast iron or steel with a core of high explosive. Many of the casings had deep external serrations intended to guide the body in breaking along the lines. Later research established that the external serrations had little if any effect on the breaking up of the weapons body which tended to break into several large fragments and a quantity of metal dust. New studies after World War Two showed that internal serrations did indeed guide the breaking of the casings into somewhat regular fragments. Other methods found to work included notched internal coils of wire, metal balls contained in a double-walled casing , and metal balls embedded in a plastic matrix that made up the body of the weapon. With most of the world's militaries using one or another of these methods to produce controlled fragmentation weapons an average fragment can be described. The fragment would be a 2.5mm (.1 inch) cube or ball weighing 0.064 grams (1 grain) and having a velocity of about 1000 meters per second (3280 fps) giving it 24 ft/lbs of energy.

Due to fragments and their nature not fitting the protocols used to produce the damage formulas shown for projectiles, the damage for a fragment was determined by other researches and is given here;

5/(2.28 MAX)

The damage is stated for six fragments and that is the average number of fragments to hit an individual target and have effect. With the circular area of effect from an exploding fragmentation weapon, all targets within the area of effect would receive the same damage as shown above. Since the damage received is from multiple hits, the total of the damage, as shown above, would be taken as affecting the Torso in Zone 2.

EXAMPLE OF THE "QUICK KILL SYSTEM"

QUICK KILL RANGE OF DISRUPTION: DEATH	QUICK KILL RANGE OF DISRUPTION: UNCONSCIOUSNESS	QUICK KILL RANGE OF DISRUPTION: KNOCKDOWN	PERCENT CHANCE OF
	2.3 - 7.8		10%
		1.8 - 5.3	10%
2.7 - 4.3			20%
	7.9 - 13.0		20%
		5.4 - 8.5	20%
4.4 - 5.9			30%
	13.1 - 18.0		30%
		8.6 - 11.8	30%
6.0 - 7.7			40%
	18.1 - 23.0		40%
		11.9 - 15.3	40%
7.8 - 9.4			50%
	23.1 - 28.3		50%
		15.4 - 18.5	50%
9.5 - 11.0			60%
	28.4 - 33.5		60%
		18.6 - 21.8	60%
11.1 - 12.7			70%
	33.6 - 38.5		70%
		21.9 - 25.3	70%
12.8 - 14.4			80%
	38.6 - 43.5		80%
		25.4 - 28.8	80%
14.5 - 16.1			90%
	43.6 - 48.5		90%
		28.9 - 32.3	90%
16.2 - 17.7+			99%
	48.6 - 53.5+		99%
		32.4 - 35.8+	99%

To use the Quick Kill table find the range of disruption that the damage you are using (use the 9 x disruption quantity) falls into for Death, Unconsciousness, and Knockdown. As the various reactions are listed according to their level of importance the first positive roll prevents any of the lesser reactions needing to be resolved.