GURPS®

Fourth Edition

ULTRA-TECH TOO

Compiled by TEVIET CREIGHTON
Based on material by DAVID L. PULVER and KENNETH PETERS

Contents

Introduction

GURPS Ultra-Tech provides a catalog of futuristic devices for ***GURPS*** campaigns, ranging from realistic, to speculative, to outright fantastic. Perhaps because of this, it has provided fodder for variant interpretations, house rules, and errata, moreso than other ***GURPS*** books.

This supplement brings together the various corrections and variations into a single handy document that can be readily modified or expanded as the author finds new material. It incorporates both the official errata, and the "unofficial" errata by the book's authors, divulged online or in ***Pyramid*** magazine articles published by *Steve Jackson Games*. It also includes new rules or options from these same sources, from online discussions in the *Steve Jackson Games* fora, and the current author's own interpretations.

Publication History

The third edition of ***GURPS Ultra-Tech*** (by David Pulver and Kenneth Peters) updated and revised earlier material to the ***GURPS*** *Fourth Edition* rules. It incoporated material from the first edition of ***GURPS Space*** (by Steve Jackson and William A. Barton), earlier editions of ***GURPS Ultra-Tech*** and ***GURPS Ultra-Tech 2*** (by David Pulver), ***GURPS Cyberpunk*** (by Loyd Blankenship), and ***GURPS Psionics***, ***GURPS Robots***, and ***Transhuman Space*** (all by David Pulver).

The additional material in this supplement includes David Pulver's *Designer's Notes* (`http://www.sjgames.com/pyramid/sample.html?id=6292`), articles in ***Pyramid #3-37:*** *Tech and Toys II* and ***Pyramid #3-51:*** *Tech and Toys III* (by David Pulver and Kenneth Peters), and online discussion between the authors and others at `http://forums.sjgames.com`.

About the Author

Teviet Creighton is a physics professor and gamer living in South Texas. He has written several ***GURPS*** supplements – none published – including ***GURPS Exotics***, a collection of (barely) hard SF races, and ***GURPS Gya***, a hard fantasy gameworld. All supplements including this one were typeset using the `gurps.cls` class file.

Page References

Page references that begin with B refer to ***GURPS Basic Set,*** *Fourth Edition*. Page references that begin with UT refer to ***GURPS Ultra-Tech,*** 3rd edition, first printing.

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Chapter One
Errata

This chapter lists errata to the first printing of ***GURPS Ultra-Tech***. Errata from the official errata sheet are in black; those identified from other sources, or by the author, are shown with color highlighting.

There is not always a clear distinction between an *erratum*, a *suggested rule change*, and an *optional rule*. Roughly speaking, this chapter covers the first two categories: changes that can be assumed to be applicable by default. Optional rules and design switches are covered in Chapter 2.

Ultra-Technology

Adjusting for SM

p. UT16

The table begins with -3, -2, -2, -1. This should be -4, -3, -2, -1.

Styling

p. UT15

Replace with the following rules, to bring it in line with the changes made in the more recently published ***GURPS Low-Tech***.

Styling: Styling alters the device's appearance to appeal to the potential customer's aesthetic sensibilities. Styling grants a bonus to reaction rolls from collectors and potential buyers, and to Merchant skill rolls made as Influence rolls (p. B359) on such people: +1 to rolls for ×2 cost, +2 for ×5 cost, or +3 for ×10 cost.

Core Technologies

Computer Models

p. UT22

Larger computers can (optionally) be powered by power cells, rather than external power. The power cells are not included in the listed weight.

Microframe: Dp/10 hr.
Mainframe: Ep/10 hr.
Macroframe: Fp/10 hr.
Megacomputer: Fp/1 hr.

Customizing Hardware

p. UT23

Under *Compact*, also halve the computer's storage capacity.

Under *Data Storage*, weight should be 0.01 lb. per TB at TL9, in keeping with the stats for data banks (p. UT51).

Machine Intelligence Lenses

pp. UT27-28

Under *Mind Emulation*, the Complexity requirements are "(IQ/2)+4" (matching the formulae on p. UT220) instead of "(IQ+5)/2".

Note that Complexity requirements for all Machine Intelligence Lenses (AIs, Mind Emulations) are based on average racial IQ rather than IQ. Remove the "Complexity-limited IQ" taboo trait.

The *Weak Dedicated AI* lens should end with "a Complexity equal to or greater than its (IQ/2)+1, rounded up."

Microbot and Nanobot Swarms

p. UT35

Under Microbot (TL10), delete the sentence "They may have any chassis (see below) except Dust or Aerostat."

Swarm Chassis

pp. UT35-36

For the Dust chassis type, remove the "(Nanobot only)" condition. The first sentence should read: "The swarm resembles a cloud of dust motes (nanobot swarm) or a sprinkle of sand grains (microbot swarm) unless examined using Microscopic Vision . . ."

Scout Robot

p. UT80

Add "Perk: Accessory (Tiny computer) [1]," raising its points to 37.

Gravitic Tools

p. UT85

The stats for *Gravitic Waldos* are: $5,000, 2 lbs., A/2 hr. LC4.

Self-Replicating Swarms

p. UT92

Include disassembler swarms among the possible types of self-replicating swarms.

Swarm Types

p. UT37

In the *Swarm Type Table*, "Self-Replicating" should refer to page UT92. Disassembler swarms should also be listed among the types of swarms that may be self-replicating.

Attaché Case (TL9)

p. UT38

This item can hold up to 20 lbs. (or two cubic feet), as listed on p. UT97.

Electronic Ecstasy

p. UT40

The Neurostimulator should be TL10^: it is basically a type of low-power neurolash (p. UT165).

Communications, Sensors, and Media

Causality Communicators

p. UT45

These should be TL10^, not TL11^.

Housing, Tools, and Survival Gear

Food Vats

p. UT74

These are essentially a type of *vatfac:* see p. UT91 for statistics.

Gravity Screen Chambers

pp. UT78-79

These should be listed as using "external power" rather than "0.25 kW".

Covert Ops and Security

Exophase Field Generator

p. UT96

Increase the encumbrance limit to extra-heavy, in keeping with other field generators.

Laser Microphones

p. UT105

The second to last sentence should end "bug stompers and privacy field white-noise generators (pp. 62, 188) never do."

Privacy Field

p. UT106

The *diameter* of the field (not the radius) should be 4 yards. Larger fields are possible: increase the weight and cost proportionally. Power should be "external"; alternatively, a D cell (not included) will power it for 20 hr divided by diameter.

Beamed Audio Sound System

p. UT108

The description should note that this is the same device as a Sonic Projector (p. UT52), which is why no stats are listed here.

Robobug

p. UT111

Power requirements should be 2AA/1 hr for the TL9 model, and 2AA/4 hr for the TL10 model.

Weaponry

Mounted Lasers

pp. UT115-116

The Semi-Portable Laser table entry should list the weight as 70/20p, not 70/Ep, since this is a chemical laser.

Rainbow Laser Table

p. UT117

All items under the table section "Beam Weapons (Rifle)" should be TL11.

X-Ray Laser Table

p. UT118

Both the X-Ray Strike Laser and the X-Ray Laser Cannon should be Acc 18.

Gamma-Ray Laser Table

p. UT118

The Graser Carbine should do 5d(10) damage and the Graser Rifle should do 6d(10) damage.

Electrolaser Table

p. UT120

The Electrolaser Carbine should have an armor divisor of (2).

Death Beam Setting

p. UT122

A neural disruptor with a death beam setting has its LC reduced to 2.

Antiparticle Beam Table

p. UT124

To match the description, add "^" to all TLs, and "rad sur" to all damage entries.

Omni-Blaster

p. UT124

Omni-Blasters should also be superscience, as given on p. B280. However, it would make sense to allow electrolaser-blasters using the rules for Combination Gadgets on p. UT16.

Sonic Stunners

p. UT125

Sonic Stunners as described are superscience, in the same manner as neural disruptors: treat them as TL10^.

Sonic Weapon Table

p. UT126

The Tactical Screamer should be TL9^, and all Sonic Stun weapons should be TL10^.

Plasma Gun Table

p. UT128

As noted in the description, these weapons do not use standard power cells, but plasma fuel cartridges. In the Weight column, replace C with 0.5, 2C with 1, Dp with 5p, Ep with 20p, 5Ep with 100p, and 10Fp with 2,000p.

Fluid Projectors

p. UT134

Each "shot" from a spray can, spray tank, underbarrel vortex projector, or vortex pistol, contains 3 "doses" of gas. Each "shot" from a backpack vortex projector contains 10 "doses" of gas.

A spray can holds 10 shots (30 doses).

A spray tank holds 100 shots (300 doses): the same as a 100mm biochemical warhead.

The underbarrel vortex projector should have a range of 20.

Non-cinematic Vortex Ring Projectors are unlikely to inflict actual injury: add the No Wounding (nw) modifier to their crushing damage.

Conventional Smallarm Table

pp. UT137-138

The Heavy Pistol has a Bulk of -2.

All 7.5mm pistols on this page should do pi- damage.

The Machine Pistol should be RoF 10, not RoF 3.

The Shotgun Barrel of Urban Assault Weapon should have a damage of 4d+4 pi++, not 1d+1 pi.

The Storm Carbine and Storm Rifle do pi+ damage.

The Storm Rifle should be Acc 5, not Acc 4.

The Storm Chaingun does pi+ damage.

The Tank Cannon does 6d×25 pi++ damage.

Conventional Ammunition Table

p. UT139

Under "Rifle and PDW Ammo," the 5.7mmCL ammunition has a WPS of 0.009, and a CPS of $0.18.

Gas-Powered Air Gun Table

p. UT140

The Ice Gun has an armor divisor of (0.2).

Electromagnetic Gun Table

p. UT142

The Gauss Rifle, 4mm does pi- damage like the other 4mm weapons on that page.

The Portable Railgun has an Acc of 7. Its ammo type is 10mm, not 10mmG.

The Railgun, 40mm does pi++ damage.

Electromagnetic Gun Ammunition Table

p. UT143

The 10mmG ammunition type should be just 10mm.

The 40mm ammunition has a WPS of 0.6, and a CPS of $6.

Grav Guns

p. UT143

Grav gun projectile speeds are around ten miles per second. Remove all references to near-light speeds.

Hand Grenades

p. UT146

Add the following grenade size:

Large Grenade: This football-sized grenade or satchel charge has the same effect as a 100mm warhead. It *can* be thrown, by strong characters or troops in powered armour, but is more often placed. $160, 4 lbs.

Armor-Piercing Hardcore Explosive

pp. UT152-153

This ammunition has a quadruple cost multiplier, just as in ***GURPS High-Tech*** p. 170.

Biochemical Liquid Table

pp. UT153

The number of doses for the 64mm warheads should be ~~65~~ 81, and the doses for the 100mm warheads are ~~250~~ 324.

Disassembler Nanoglop

p. UT161

For Replicator Nanoglop, the page reference should be to p. 92.

Physical Weapons

pp. 162-164

To clarify design intent, and bring the ***Ultra-Tech*** physical weapons into full compatibility with the later ***High-Tech*** and ***Low-Tech*** books, the following changes are suggested.

Superfine Blade: This is a weapon-quality grade (see *Melee Weapon Quality*, p. B274). Superfine blades are -3 to break when parrying (see *Parrying Heavy Weapons*, p. B376). Superfine weapons cost six times list price (this replaces other multipliers for superfine listed in ***Ultra-Tech***).

Monowire Blade: This is a blade-composition option (see *Blade Composition*, p. B275). The cutting edge is completely replaced by the cutting wire; the bulk of the blade becomes a reinforced backing. All blade-quality options are available, but they only affect breakage chance, not weapon damage or armor divisor. Ignore the reference to p. B406 (that applies to monowire whips).

Monowire Whip: For other rules, see p. B406.

Vibroblade: This is a blade-composition option. Armor divisor is (3), or (5) if combined with superfine.

Hyperdense Blade: This is a blade-composition option. It is already superfine quality. Change TL to TL11^.

Nanothorn Blades: This is a blade-composition option. It is already superfine quality.

Only *one* weapon-quality grade and *one* blade-composition option can be applied to a weapon. Note that all TL8+ melee weapons are fine quality by default (p. B274).

Electric Stun Wand Table

p. UT165

The armor divisor should be (0.5), as described in the text above.

Neurolash

p. UT165

The Neurolash and Neuroglove should be TL10^, as given in the table. The Tunable Neurolash should be TL11^.

Warbot

p. UT167

Add "Perk: Accessory (Microframe computer) [1]", raising its points to 290.

DEFENSES

Space Biosuit

p. UT179

The last sentence of the entry should read "a small computer" instead of "a standard computer."

Barrier Screens

p. UT191

Power requirement should be "industrial power", or a power cell (not included in listed weight). An E cell provides power for 25 hours *divided* by the generator's weight in pounds; an F cell for 10× as long.

Tau-Shield

p. UT195

Last paragraph should begin: "The tau-shield's C cell. . . "

MEDICAL AND BIOTECH

Automedic

p. UT197

The entry contains the statement that automedics "do not add their equipment modifiers when the automed uses its own skills." This refers only to the *quality bonuses* for those pieces of equipment (which are already included in the automed's skill levels), not (for instance) the basic +(TL-4) modifier for high-tech surgical techniques.

Boosted Reflexes

p. UT210

Change the Basic Speed bonus to +1.

Mind Emulation ("Ghost") Programs

p. UT220

Note that the Complexity requirements are based on average racial IQ. Remove the "Complexity-limited IQ" taboo trait.

VEHICLES

Hovertank

p. UT226

The TL should be listed as TL10. Add to its description: "A railgun-equipped hovertank is TL10, while one with a plasma cannon is TL10^."

Tilt-Rotor Transport

p. UT229

In the third paragraph, replace "Piloting (Light Airplane)" with "Piloting (Heavy Airplane)."

Flight Pack and Thruster Pack Table

p. UT231

The Helipack should have Lwt. 0.4, to match the 200 lb. weight in its description.

Chapter Two
New Items and Rules

This chapter lists gadgets and items that did not appear in ***Ultra-Tech***, drawn mostly from David Pulver's *Design Notes* and Kenneth Peter's article in ***Pyramid #3-51***. The chapter also gives some *optional* rules or "design switches" (as opposed to *suggested* changes or errata listed in Chapter 1). As noted there, the line between "suggested" and "optional" rule changes is somewhat vague.

Many of the optional rules aim for greater realism. There are two ways in which an ultra-tech gadget can be unrealistic. It may be *superscience*, where the underlying principles of the technology go explicitly beyond what current science accepts as plausible. It may be *cinematic*, where the underlying technological justification sticks to known scientific principles, but the effects are presented in a way that is implausible or exaggerated for dramatic purposes. Some gadgets are both superscience *and* cinematic: they explicitly introduce new scientific principles, and then apply them inconsistently for the sake of interest or playability. Several of the optional rules presented here offer more plausible or "realistic" variants, even in the case of superscience gadgets. Others simply provide extra colour, detail, or extensions of the existing rules.

Ultra-Technology

The following option can apply to *all* TL9+ gadgets.

Improvements with TL

Some gadget descriptions explicitly state how they improve with tech level: e.g. most of the items listed under *Communicators* (p. UT43). If not, then assume that the *only* improvement is an increase in capacity of any power cells that the device uses, by a factor of 4× per TL up to TL11, and 2× at TL12. This increases the shots, duration of operation, etc. E.g. a TL12 laser pistol (p. UT115) still does only 3d(2) damage, but gets 33 × 4 × 2 = 264 shots. Of course, by TL12, *graser pistols* are available (p. UT118), which get only 33 shots with TL12 power cells.

If a gadget *does* list improvement by TL, then its endurance remains as listed: the increased energy capacity goes towards improving its performance.

In either case, the improvement applies only to devices *designed and built at the higher TL*. To jury-rig a device to use power cells of higher or lower TL, see the rules on p. UT19.

Core Technologies

Power, both computational and energetic, is fundamental to ultra-technology, so the following new items and design switches can have far-reaching implications.

Power

The authors of ***Ultra-Tech*** had originally assigned items a power consumption or output in real-world units, but ultimately decided that technical vagueness would be more conducive to suspension of disbelief. However, there are occasions when specific numbers are needed; e.g. to know how long it will take your fusion generator to recharge your Gatling laser's E cell.

Design Switch: Real-World Power

Assume that a TL9 C cell stores 90 kJ (0.025 kWh) of energy. Each step up or down in size increases or decreases storage by a factor of 10. Storage increases by ×4 at TL10, ×16 at TL11, and ×32 at TL12. Thus an E cell (×100) at TL10 (×4) stores 10 kWh of energy.

External power can be anywhere from a few kW to many MW for a large installation. Following the rule in ***High-Tech*** p. 14, assume that any power generator described as *semi-portable* (including solar power arrays) can produce up to 10 kW, while a *portable* generator can produce up to 2 kW.

(Note that the improvements at TL9+ are mostly in the area of fuel efficiency and new fuel sources, *not* so much in generating capacity.) Thus, for instance, a semi-portable generator can recharge a TL10 E cell in an hour.

A device that *consumes* external power can be assumed to require up to 10 kW; devices drawing more than this are listed as requiring "industrial power". For scalable items with no set maximum size, if no specific power is listed, assume they require up to 1 MW per ton of mass.

Nuclear-Enhanced Mana Area (NEMA) Reactors (TL7^)

These technomagical fission reactors form the cornerstone of the thaumatologically enhanced civilization of ***GURPS Technomancer***. They exploit the close relationship between radiation and necromantic magic to produce both electricity and exotic oz particles that can be readily channeled by those with Magery. NEMA reactors create a high mana zone that mages can use, in addition to providing an almost unlimited source of energy.

The mana-enhanced power is carried away from the reactor using power cables sheathed with stabilized ectoplasm, allowing it to be tapped thousands of miles away at technomagical enchanting centers. Models at TL8^+ incorporate "passive safety" design elements (i.e., blessed sodium cooling, low-enrichment necronium, rune-inscribed fuel rods). These features almost eliminate the possibility of critical core meltdowns and hostile entity materializations. Nonetheless, the reactors still require physical shielding and Resist Radiation (***GURPS Magic***, p. 182) enchantments, and their fuel is just as dangerous as a mundane fission reactor.

Large NEMA reactors are vast complexes that also contain fuel-processing facilities, mana-active waste-storage pools, and research annexes secured by armed guards, combat mages, and multiply redundant Pentagram (***Magic***, p. 124) wards. More compact models can be used in spacecraft (see ***GURPS Spaceships 7:*** *Divergent and Paranormal Tech*, p. 13, and the *Practical Astromancy* article in ***Pyramid #3/30:*** *Spaceships*). Portable models have obvious military and exploration applications.

Expedition NEMA Reactor (TL9^): A heavily warded semi-portable NEMA fission reactor that can power an entire expedition base is $150,000, 2,000 lbs. LC1. It also creates a one-yard-radius zone of high mana around the reactor. It uses highly enriched uranium and necronium fuel rods that can power the reactor for up to 50 years; refueling and maintenance is $75,000. A mage in contact with the reactor or the ecto-shielded power cables can draw up to 3 energy per second to power his magic using the oz current. Drawing all of the electrical power with the use of Draw Power (***Magic***, p. 180) doubles this amount.

NEMA Mana Fields

Nuclear reactions slightly weaken reality in ***GURPS Technomancer***, enhancing magic around them by creating high fluxes of exotic oz particles, which can then be manipulated by wizards as *mana*. Fission and fusion reactors create a small zone of very high mana immediately around the core, dropping off to a band of high mana for a few yards outside of the reactor housing.

This mana field can be hidden with Conceal Magic (***Magic***, p. 122). Suspend Mana (***Magic***, p. 125) simply suppresses the high mana zone; it does *not* impact the operation of the reactor or prevent magic energy from being transported through the no-mana zone using ecto-shielded cables.

Quantum Nucleonic Reactor (TL9^)

Still a promising candidate for a real-world emergent superscience (p. UT10), quantum nucleonic reactors produces power using the precisely controlled release of energy from a nuclear isomer (e.g., hafnium-178 activated by a beam of x-rays). Quantum nucleonic reactors produce radiation, but they require less shielding than conventional fission reactors. Additionally, the fuel poses much less of a proliferation or radiological contaminant threat.

A lighter, safer replacement of the fission generator (p. UT20) that uses quantum nucleonic technology is $200,000, 100 lbs. LC3. Its internal fuel supply operates it for up to 15 years; refueling and maintenance is $20,000.

Zero Point Energy Reactor (TL11^)

A zero point energy reactor (ZPER or "zipper") applies exotic physics to tap the tiny fluctuations of electromagnetic fields in the churning "quantum vacuum" of otherwise empty space between atoms. It can charge a typical TL11 E cell in two minutes. $5,000, 10 lbs. LC3.

Computers

In retrotech settings (p. UT10) based on TL6 projections of the future, computers are often monstrous assemblages of sparking wires and glowing vacuum tubes that require the careful ministration of techno-savants to manually feed them programs in the form of punch cards. At TL7, the image is that of starships filled with banks of refrigerator-sized mainframes, flashing diagnostic lights and spinning magnetic tape readers. Now, in our enlightened age of TL8 fiction, we imagine future computers to be much like they exist now, just smaller and with bigger storage capacities.

The truth is, computer technology is advancing so rapidly, and serves so many masters, that any speculation is invariably going to look quaint in the near future. However, based on physical limits for computational tasks, it's possible to set some benchmark values – an applied example is the rescaled Complexity ratings given in *Thinking Machines* from ***Pyramid #3/37:*** *Tech and Toys II*.

Cinematic Hardware

GURPS Complexity is only loosely tied to the number of instructions or floating point math operations that can be computed per second. Storage capacities are given in real-world units – terabytes or gigabytes – but canny readers may have noticed that this too is mostly a cosmetic detail, as only a few entries list storage requirements for their recorded information or databases (e.g., VR environmental databases on p. UT54-55, and the 100 TB requirement for an archived mind emulation noted on p. UT220). This is *intended*, as the reality is that programs and databases bloat in size as data-storage densities increase; consumers and researchers abhor capacity vacuums and will push the limits of their data networks and analysis tools to fill them!

Design Switch: Technical Vagueness

With this design switch, Complexity *and* storage capacity are both treated as "set dressing", decoupled from real-world computational capacities. Instead, Complexity conflates computational speed and data storage capacity. It may be rated in *teraquads*, *megapulses*, *brain values*, or other vague, but cool-sounding terms. This is a convenient method of avoiding arguments between players familiar with real-world computer technology, who might otherwise try to fact-check any perceived inconsistencies.

Realistic Hardware

The opposite approach to technical vagueness is to make plausible projections of computational technology based on historic trends and physical principles. ***Ultra-Tech*** never ties specific technologies to higher-TL improvements over modern silicon-based transistor processors, as befits a "generic" system suited to both cinematic and realistic campaigns. However, for added verisimilitude, here are some possibilities in a conservative or hard-science-fiction setting (p. UT9):

TL9: Molecular circuits using quantum-interference switching, with holographic memory and data storage systems.

TL10: Stabilized degenerate-matter processors with macromolecular lattices that store information in the form of localized conformation changes or charge separations.

TL11: Femto-scale "computronium" processors with data stored in layers of high density matter.

TL12: Micro-singularity information processing units, with bulk data stored in high-temperature plasmas (may be mistaken for bombs by less sophisticated cultures).

Design Switch: Moore's Law

The standard TL progression for computer hardware on p. UT22 is extremely modest, with computing power increasing by 100× (+2 Complexity) and storage by 1,000× between TL8 and TL9. In reality, both computing power and storage have increased by a factor of roughly a million between the nominal start of TL8 (1980) and the time of writing (2018). The above descriptions of possible TL9+ hardware make a case for continuing this progression. While the standard progression is suitable for retrotech settings (p. UT10) that de-emphasize the role of computers, a hard-science setting may aim for something more realistic.

With this design switch, *triple* the usual Complexity increases for TLs beyond 8: +6 per TL from TL8 to TL10, then +3 per TL thereafter. Complexity is *approximately* equal to the base-10 logarithm of computational power in operations per second: i.e. Complexity 3 for processor speeds of a few kHz, Complexity 9 for speeds in GHz, etc. (This roughly mimics the TL progression given in ***Pyramid #3/37*** without changing the standard definition of Complexity within a TL.)

Storage capacity increases at a corresponding rate: ×1 million per TL from TL8 to TL10, then ×1,000 per TL thereafter. However, the *initial* TL8 values for storage capacity should first be divided by 10,000 to bring them in line with typical early-TL8 capacities.

The standard computer models from p. UT22, and ***GURPS High-Tech***, p. 20, should be adjusted as follows:

Tiny Computer (TL8): A handheld computer, such as a programmable calculator or smartphone. At TL9: Complexity 7, 0.1 TB storage. $50, 0.05 lb., 2A/20 hr. LC4.

Small Computer (TL8): A tablet or notebook computer. At TL9: Complexity 8, 1 TB storage. $100, 0.5 lb., 2B/20 hr. LC4.

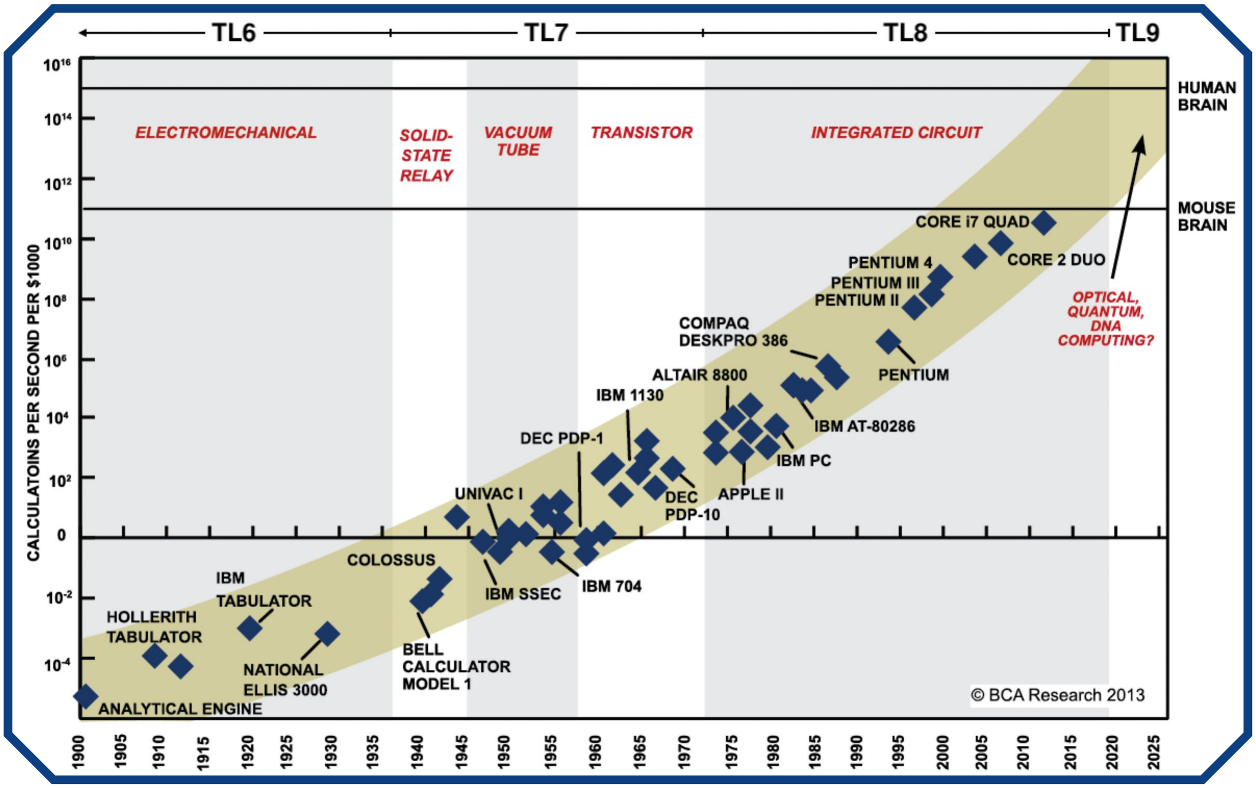
Medium Computer (TL8): A typical desktop computer. At TL9: Complexity 9, 10 TB storage. $1,000, 5 lb., 2C/20 hr (or external power). LC4.

Microframe Computer (TL7): A cabinet-sized machine. At TL9: Complexity 10, 100 TB storage. $10,000, 40 lb., external power. LC3.

Mainframe Computer (TL6): A server or cluster taking up a small room. At TL9: Complexity 11, 1,000 TB storage. $100,000, 400 lb., external power. LC3.

Macroframe Computer (TL6): A *powerful* mainframe or server farm. At TL9: Complexity 12, 10,000 TB storage. $1,000,000, 4,000 lb., external power. LC3.

Megacomputer (TL6): A computer the size of a small building. At TL9: Complexity 13, 100,000 TB storage. $10,000,000, 40,000 lb., external power. LC2.



Data Storage: The storage capacities listed above include both working memory and other incorporated storage (though the distinction between these seems to be narrowing as of late TL8). At TL9, additional storage capacity is $10 and 0.1 lbs. per TB.

Computing Technologies

When designing computer hardware (above) at other TLs, select one of the following options:

Mechanical (Early TL6): -12 to listed Complexity; replace TB with bytes.

Electromechanical (Late TL6): -11 to listed Complexity; replace TB with 0.01 kB.

Vacuum Tube (Early TL7): -10 to listed Complexity; replace TB with 0.1 kB.

Transistor (Late TL7): -9 to listed Complexity; replace TB with kB.

Microchip (TL8): -6 to listed Complexity; replace TB with MB.

Molecular Circuitry (TL9): Listed Complexity and storage.

Degenerate Matter (TL10): +6 to listed Complexity; replace TB with EB.

Femtocomputer (TL11): +9 to listed Complexity; replace TB with ZB.

Micro-Singularity (TL12): +12 to listed Complexity; replace TB with YB.

At TL8+, you may generically specify hardware of "mid" and "late" TL, with Complexity and storage intermediate between the listed values for that TL and the next. E.g. a "mid-TL8" computer would have -4 to Complexity and replace TB with 10 MB.

Contrary to the rule for *Alternate Technologies* in ***High-Tech*** p. 20, harware with Complexity 0 or less *can* be built, but historically never was: actual TL6 computing devices were dedicated calculators rather than general computers.

Examples: Babbage's hand-cranked Difference Engine weighed about 4 tons, making it a Mechanical Macroframe with the Dedicated (calculator) option (p. 12): Complexity 12 - 12 + 1 = 1, or roughly 10 integer calculations per second. The first general computer was ENIAC, a 30-ton Vacuum Tube Megacomputer: Complexity 13 - 10 = 3, or a few kHz operation cycle. An early home computer such as the Apple][would be an early TL8 medium computer, with similar computational power as ENIAC: Complexity 9 - 6 = 3. A high-end 2015-era laptop would be late TL8 (-2 to listed Complexity), and might be either a fast small computer or compact medium computer: Complexity 9 - 2 = 7, or tens of GHz computing speed, including parallelism.

Additional Models

In addition to improving performance of existing computer models, TL9+ computing technology allows for new types of computer that couldn't be built *at all* using earlier technologies. The following models assume the use of the Moore's Law design switch (p. 10).

Grain Computer (TL9): A computer the size of a grain of sand, used as a node in embedded networks or a microbot brain. At TL9: Complexity 1, 100 kB storage. Negligible cost, weight, and power (a network of a million of these has the same Complexity as a tiny computer; see *Network Swarm*, p. 13). LC4.

Cell Computer (TL10): An exotic-matter computer a few microns wide (the size of a cell). At TL10: Complexity 1, 100 kB storage. +3 Complexity and ×1,000 storage each TL past 10. Negligible cost, weight, and power (a network of a trillion of these has the same Complexity as a tiny computer; see *Network Swarm*, p. 13). LC4.

Living City (TL10): A computer the size of a city or small asteroid (a few miles across). Stats include fusion reactors to power it for decades (given access to seawater). At TL10: Complexity 26, 1,000 YB storage. +3 Complexity and ×1,000 storage each TL past TL10. $100 trillion, 200 billion tons.

Planetary Brain (TL11): A computer around the size of Earth (8,000 miles across), this machine would likely be constructed out of the diamond core of a gas giant rather than converting a Terrestrial planet. Complexity 39 at TL11, 42 at TL12. $1 septillion ($\$1\times10^{24}$). Fusion power plant included.

Godstar (TL12^): A neutron star converted into computronium and powered by micro-singularities or a stabilized black hole. Does not violate any known laws of physics, but the engineering involved is currently superscience. Complexity 48 *or higher* at TL12^. $\$1\times10^{30}$, 2 Solar masses, 20 miles across.

Additional Options

Dedicated (TL6): The computer hardware is devoted to a specific program, and can run only that program. This includes *all* historical TL6 computers. A typical ultra-tech example is a hardware neural net running an AI or mind emulation. Increase Complexity by +1, multiply cost and weight by ×2.

Biocomputer (TL9): A biocomputer is constructed from neurons, but organized as a traditional computer rather than a brain. Multiply cost and weight by ×2 (this includes a support network for nutrients, waste, and heat management). *Reduce* Complexity by 1.

Quantum (TL9): This replaces the description on p. UT23. The computer is built to take advantage of quantum effects, allowing its processors to enter a *superposition* of multiple states to perform many operations simultaneously. Reduce Complexity by -6 at TL9 or -3 at

TL10; quantum computing is the default at TL11-12. The effect of quantum computing is best described as simplifying certain calculations that would be practically *impossible* with ordinary computers. One example is cracking public-key cryptography (p. 15); others include database searches or optimization searches (such as finding the best routes on a map).

Electromagnetic Hardening

By default, ***Ultra-Tech*** computers have no particular resistance to ionizing radiation or electromagnetic pulses (see *EMP* in ***GURPS High-Tech***, p. 196, and EMP warheads on p, UT157). Realistically, early-TL7 vacuum tube electronics are automatically considered *hardened* against radiation and electromagnetic interference (as noted on ***High-Tech*** p. 21), and electromechanical systems are essentially immune. This could plausibly apply to ultra-tech optronics, nanomechanical, or exotic-matter systems as well, depending on how they are implemented.

Design Switch: Rugged Electronics

With this design switch, *all* ultra-tech computers have +3 to HT to resist the affliction effect linked to electromagnetic pulses or surge attacks, for no increase in cost and weight. Purchasing the Hardened option increases the bonus to +5.

Software

If using the Moore's Law design switch (p. 10), the Complexity of programs should also be increased to match the typical systems they will run on. Increase Complexity by +4 for any software listed as TL9, +8 for TL10 software. +10 for TL11 software, +12 for TL12 software.

The *Software Cost Table* on p. UT25 should be adjusted for the new program Complexities at each TL. Combined with the *Program Cost Table* in ***High-Tech*** p. 22, this gives the following progression:

Software Cost Table

Complexity	*Cost (TL9)*
Complexity 1	$0.1
Complexity 2	$0.3
Complexity 3	$1
Complexity 4	$3
Complexity 5	$10
Complexity 6	$30
Complexity 7	$100
Complexity 8	$300
Complexity 9	$1,000
Complexity 10	$3,000
Complexity 11	$10,000
Complexity 12	$30,000
Complexity 13	$100,000
Complexity 14	$300,000
Complexity 15	$1,000,000
Complexity 16	unavailable

TL6-7: multiply the cost by 10,000 (equivalently, add 8 to Complexity to find the equivalent TL9 cost).

TL8: multiply cost by 1,000 (or +6 to Complexity).

TL10: divide cost by 1,000 (or -6 to Complexity).

TL11: divide cost by 100,000 (or -10 to Complexity).

TL12: divide cost by 10,000,000 (or -14 Complexity).

Treat Weak AIs (pp. UT25, 28) as TL9, with Complexity equal to (IQ/2) + 5. Non-volitional strong AIs may be considered *late* TL9 (+6 Complexity), giving Complexity (IQ/2) + 8. Fully-volitional AIs are TL10, with Complexity (IQ/2) + 11. A mind emulation (pp. UT27, 220) has Complexity (IQ/2) + 12, based on *racial* IQ, or 1 less (i.e. the same as a volitional AI) if the species has the Fixed IQ taboo trait.

Microbot and nanobot swarms should have IQs of 3 × (TL-9) and 3 × (TL-10), respecitvely, replacing the formula on the *Swarm Statistics Table* (p. UT37).

Benchmark Complexities

Complexity 1: As fast as a human at basic arithmetic, but far more consistent and accurate . . . and the computer doesn't get bored.

Complexity 2: Cracks TL6 cryptography in a matter of hours.

Complexity 3: Can perform numerical integration for TL7 physics research, or play Pong.

Complexity 6: Can run a multitasking operating system with graphical interface.

Complexity 9: Can perform video editing or play a modern (2018) first-person video game in high definition.

Complexity 12: Can run immersive VR that is indistinguishable from reality for up to 100 "players" (with direct neural interfaces).

Complexity 15: Can run complex physics simulations, make completely accurate daily weather predictions, or beat humans at any algorithmic game.

Complexity 18: Can emulate up to 10 human brains (to algorithmic equivalency) in real time, or run immersive VR for up to 100 million people.

Complexity 21: Can accurately model global weather two weeks into the future.

Complexity 24: Can model a human being down to the subatomic level.

Complexity 27: Can functionally emulate every living human being in real time.

Complexity 33: Can model an entire ecosystem down to its individual cells.

Complexity 48: Can model the entire evolutionary history of a world, including all its life forms and the minds of its inhabitants, in a few seconds.

Network Swarm (TL10)

This is a swarm of microbots or nanobots optimized for computing. It can have any chassis type, including Dust. The swarmbots have basic senses allowing locomotion (if they have a mobile chassis), or to determine their precise location relative to each other and external positioning signals (p. UT74). For additional sensory or manipulation ability, they are often "stacked" with suveillance swarms (p. UT106) and other swarms, which they can interface with using their radio, laser, and infrared communicators. A one square yard swarm has the same Complexity as a tiny computer of its TL (p. UT22), but only 1% of the storage capacity. $500/square yard. LC4.

Machines as Characters

Reknowned science fiction editor John Campbell challenged writers to "Write me a story about a creature that thinks *as well as* a man, but not *like* a man." Machine intelligences, built by design rather than natural evolution, have often been cast for this role.

Unfazeable

p. B95

Stereotypical robots will often have this advantage, taking in stride situations that would alarm or terrify ordinary people. However, it is not *required*, and may not even be realistic: AIs often exhibit seemingly irrational behaviour in situations outside their normal operating parameters. The Unfazeable advantage indicates particularly stable and robust programming, especially simple AIs built with a predictable "safe mode" of operation for dealing with unexpected circumstances.

Machines *lacking* this advantage are subject to Fright Checks (pp. B360-361), reflecting irregular responses to strange or unusual situtations. In non-silly campaigns the GM should have replacements for physical effects not suited to machines (such as FP loss, "lose your lunch", "hair turns white", etc.). The simplest approach is for AIs to substitute a Confusion Check, as described in ***GURPS Powers*** p. 85, in place of any Fright Check.

The GM and players should also consider what "primal" instincts would trigger such responses – depending on the AI's purpose and programming, these might be very different from natural intelligences. For instance, an AI subject to Asimov's Laws of Robotics would have little fear of personal destruction, but could have a fit if a human were threatened or injured in its presence. A computer designed to process information accurately and without distortion might behave erratically when ordered to conceal information for reasons of security.

Abnormal behaviour can sometimes be induced as a tactical ploy: see "Defeat Them With Logical Paradoxes" under *Cinematic Combat*, p. UT34. If a character confronts an AI with a contradiction in its main programing, he may force a Confusion Check as above, with modifiers set by the GM, and may even influence the type of response in the case of a bad failure. Unfazeable robots would be immune to such ploys.

Personal Gear and Consumer Goods

Not all gear for adverntures is "adventuring gear". Most ultra-technology will be motivated by comfort and convenience, rather than peril.

Household Manager System (TL9)

An array of sensors and microcommunicators scattered through a house and its appliances. They keep track of the state of the household chores, tracking dirty dishes, laundry, etc. +1 (quality) bonus to Housekeeping skill and may coordinate housebots or cleaning swarms. It is not a burglar alarm, except indirectly (e.g., a bloody corpse may signal as a "mess" to be cleaned up). $1,000.

Anti-Sex Pheromones (TL10)

This "don't-hit-on-me" perfume produces pheromones that actually cause sexual disinterest in people of a specific sexual orientation. It is popular for people who do not wish to be sexually harassed. Anyone who has Lecherousness who is within two yards or downwind gets +2 to their control roll if the only viable subject in the area is using anti-sex pheromones, or if the pheromones are in the area. People without Lecherousness also experience reduced desire. Someone attempting to use Sex Appeal on someone who is exposed to these pheromones will have a -2 (if that person is susceptible to them). The effects linger for a minute after they have been breathed. $10/dose. LC4.

Communications, Sensors, and Media

Imaging Lasercomm (TL9)

The idea of using a lasercomm to project images is not supercience, but the rules for *Laser Retinal Imaging* (p. UT44) are highly *cinematic*. In reality, a lasercomm projected at a subject's eye cannot "paint" a message on the retina, but will instead be focused on a single point. (That is, after all, the entire purpose of the eye's lens!)

However, an imaging laser communicator *could* display a message on a nearby wall, the recipient's hand, or other conveniently-located opaque surface that is visible to both the recipient and the communicator. This may be used as a realistic substitute for a laser retinal imager. The aimed "attack" has the usual size modifier for the size of the target surface. It otherwise follows the same rules on p. UT44.

Neutrino Transmitter (TL10)

As noted under *Neutrino Communicator* (p. UT45), a neutrino *transmitter* does not require superscience. Build it as a TL10/11 neutrino communicator with the Transmit-Only option (p. UT46), and simply leave off the ^ modifier. *Receiving* a neutrino transmission requires either a standard (superscience) neutrinocomm, or a neutrino detector (below).

Neutrino Detector (TL9)

These devices detect neutrinos produced by fusion or antimatter reactions, including those that occur in stars, generators (p. UT20), neutrino communicators (above and on p. UT45), and propulsion systems (***GURPS Spaceships*** p. 23). At the GM's discretion, other technologies that might generate neutrinos or neutrino-like particles include total conversion and "reactionless" engines (***Space-***

ships pp. 23-24), exophase fields (p. UT96), disintegrators (p. UT130), ghost particle beams (p. UT131), any or all force field generators (pp. UT190-195), and matter transmitters (pp. UT233-235).

Neutrino detectors are normally passive sensors, but they can also "scan" a target if there is a detectable neutrino source *behind* it. Treat as imaging radar (p. UT65) that can map out the *inside* of a target, but with -24 to skill (due to the transparency of matter to neutrinos): this is normally offset by scanning targets with a large size modifier. Range is limited only by the distance at which it can detect the neutrino source (often a neutrino transmitter, p. 14).

Very Large Neutrino Detector (TL9): +6 to detection. Does not require superscience technology (unlike the smaller detectors). $500,000, 1,000 lbs., external power. LC4.

Large Neutrino Detector (TL11^): +12 to detection. $50,000, 100 lbs., D/24 hr. LC4.

Medium Neutrino Detector (TL11^): +6 to detection. $5,000, 10 lbs., C/24 hr. LC4.

Small Neutrino Detector (TL11^): No modifier to detection. $500, 1 lb., B/24 hr. LC4.

Add +6 to detection per TL after introduction.

Jump Communicators (TL10^)

This directional comm teleports energetic subatomic particles (e.g., mesons or anti-particles) across space, where they arrive and decay with enough energy to be noticed by a properly-tuned receiver (but without enough energy to inflict any damage). They must be aimed at known coordinates; if the receiver is moving and not already in communication by this or other means, the GM may require an Electronics Operation (Comms) roll to successfully transmit (takes 10 seconds per attempt).

They cannot be intercepted in transit, since they vanish and then reappear, rather than traveling through space. They can penetrate anything except a reality stabilizer (p. UT194) or other device that blocks matter transmission. It may be a precursor to actual matter transmission (MT) technology, or it may be that particles are all that can be transported.

Light speed and faster-than-light jump versions are both available.

Very Large Jump Communicator (TL10^): 50 mile range. $200,000, 1,500 lbs., F/10 hr. LC2.

Very Large Jump Communicator (TL11^): 500 mile range. $20,000, 60 lbs., 2D/10 hr. LC2.

Large Jump Communicator (TL11^): 50 mile range. Includes video screen. $6,000, 6 lbs., 2C/10 hr. LC2.

Medium Jump Communicator (TL11^): 2,000 yard range. $2,000, 0.6 lbs., 2B/10 hr. LC3.

Small Jump Communicator (TL11^): 200 yard range. $500, 0.06 lbs., 2A/10 hr. LC3.

Micro Jump Communicator (TL11^): 20 yard range. $100, neg., AA/1 wk. LC3.

Multiply ranges by ×100 per TL after introduction.

Tachyon Communicators (TL12^)

A T-Com is a directional communicator using a modulated beam of faster-than-light particles (tachyons). A tachyon beam is not affected by intervening objects, but the user must know the exact location of the receiver . . . so interstellar communication works best between fixed relay points rather than mobile ships, unless some other means of communication is also used. The beam travels at 1 parsec per hour (57 AU per second). Tachyon beams may not penetrate reality stabilizers (p. UT194).

Large T-com (TL12^): 10 parsec range. $60,000, 400 lbs., 2E/1 day. LC3.

Medium T-com (TL12^): 1 parsec range. $20,000, 40 lbs., 2D/1 day. LC3.

Small T-com (TL12^): 0.1 parsec range (20,600 AU). $2,000, 4 lbs., 2C/1 day. LC3.

Cryptography

Realistically, encryption and decryption capabilities vary significantly by TL, and the rules on pp. UT46-47 are hugely optimistic. The following rules work well with the *Moore's Law* design switch on p, 10.

For mathematical cyphers (including public-key cryptography), first decide on the Complexity of the encryption algorithm. This is the Complexity of a system that can encrypt messages essentially in real time (with latencies of a second or less). A system can run a higher-Complexity encryption program at the usual increase in time: +1 Complexity for 10 seconds, +2 for 2 minutes, etc. For simplicity, assume that decryption takes the same amount of time (though many present-day implementations are much slower decrypting than encrypting).

Cracking encryption by brute force requires a system with Complexity 2 to crack a Complexity 1 encryption, *doubling* for every +1 to the encryption Complexity. That is, a Complexity 2 encryption requires Complexity 4 to crack, Complexity 3 encryption requires Complexity 8 to crack, and so on. This assumes cracking in about 3 seconds; typically a supercomputer may take *weeks* (+5 to effective Complexity) or *years* (+7 to Complexity) per attempt.

Quantum computers (p. 12) are much more effective than ordinary computers at cracking cryptography: the required Complexity is just *twice* the encryption Complexity.

Even if an encryption scheme is mathematically "uncrackable", the *implementation* may contain weaknesses or back doors, either inadvertent or deliberate. A successful Cryptography skill roll can discover such an exploit, reducing the encrypting system's effective Complexity by

1. A critical success may give a greater reduction, or (at the GM's discretion) might uncover a "back door" that bypasses the encryption entirely.

One-Time Pads

These are a secure alternative to mathematical cyphers. The only way to "crack" a message encoded with a one-time pad is to obtain a copy of the pad, so security in distributing and authenticating pads is of paramount importance. *Quantum communications* (p. UT47) is mentioned as one method of securing these exchanges, but this requires a secure quantum link carrying at least as much data as the messages to be encoded. Another popular choice is *multiple encryption*. Typically, three or more sets of one-time pads are sent by different methods (e.g. telecommunication *and* multiple couriers). Messages are then encoded using one pad from each set. To decode the message, an attacker must first intercept *all* of the pads exchanged.

Messages encoded with one-time pads are still vulnerable to *traffic analysis:* inferences about the parties' plans based on the timing and volume of messages exchanged. Traffic analysis can be thwarted by *masking* the communication channel: i.e. exchanging a continuous stream of "dummy" messages among which the "real" messages can be seamlessly inserted. This may or may not be feasible depending on the bandwidth required.

Stage Equipment (TL9)

This is a set of portable gear including multiple directional sonic comms, spotlights, and 3D media screens designed for sound stage, dance floor, etc. Use several for large venues. $20,000, 200 lbs., 10D/20 hr. LC4.

Empathic Interfaces (TL10)

Empathic interfaces are neural interfaces that incorporate additional equipment similar to a veridicator (p. UT107). They can translate the user's emotional state into a digital signal.

Empathy Upgrade (TL10): This is a hardware upgrade of a neural interface. It can record feelings and translate them into particular values ("he's registering happy"). A computer or other device that is linked to the neural interface can then be set to respond in accord with a particular emotion. This should be pre-set, e.g., "if I'm frightened, turn on the force screen" or "if I get curious, activate my camera." An empathic neural interface is 1.5× as expensive as any other interface.

Emotion Interpreter (TL10): This software provides the equivalent of the Empathy advantage but only in situations when it is run on a computer that is receiving input from someone using a neural interface with an empathy upgrade. Note that the user of an emotion interpreter does not need a empathic neural interface; only the subject requires one. However, if the user does have neural interface with an empathy chip, he can set it so that it will let him experience the incoming emotions (as his own brain is triggered to manufacture the appropriate electrochemical signals).

Complexity 4 software, LC4.

HOUSING, TOOLS, AND SURVIVAL GEAR

General equipment may be background "colour", critical adventuring gear, or the underpinnings of an entire civilization.

FOODSTUFFS

Traditional methods of growing, storing, and processing foods do not vanish with the arrival of ultra-tech nutritional pastes, fauxflesh, and custom-engineered plants and animals. In fact, archaic methods and foods may be *preferred* over their technically superior replacements: Some people might have serious concerns about the long-term effects of "frankenfoods" with their nutrient and drug additives. In other cases, it could simply be fashionable to shun them and grow your own wheat from 2,000-year-old lineages as a hobby.

It is also realistic for "old style" home-grown food to be another mark of high Wealth – it proves you have a lot of time, resources, and space available, if nothing else! Furthermore, while vat-grown or chemically synthesized food paste may be nutritionally complete and resource-efficient, it could be considered the kind of thing that only the indignant and desperately poor regularly eat. Likewise, companies don't specify what "helpful" nanodrugs they dose processed food with, so if you can afford better food . . .

The selection and brand of foods people eat is as much a component of maintaining their Status as the choice of living accommodations and clothing!

Food Additives (TL9)

These are quirk-level *Ultra-Tech Drugs* (p. B425) that strengthen short-term memory, trigger especially weird dreams, induce sexual arousal, cause mild hallucinations, or have other desirable effects. They are used to improve normal meals and beverages, and as nutritional supplements. Particularly useful compounds, such as cognitive enhancers, may be added to the drinking water and baby food, which could justify widespread IQ boosts and other neurological enhancements. In more dystopian futures, they have a "social engineering" payload, such as causing Horrible Hangovers or reducing Will.

Nanopaste (TL11)

This form of programmable matter coats what are effectively nutritional supplements. New flavors and textures can be programmed into the paste, and hundreds of variations can be selected right from the packaging. A one-day supply is $20, 0.5 lbs.

Environmental

Grab this high-tech diving gear for exploring the Earth's last frontier or oceans on other worlds!

Liquid Breathing Rig (TL9)

A liquid breathing rig consists of an assisted breathing system (with mask) and a tank of sterile oxygenated liquid. A recycling system treats used liquid and recharges it with oxygen from a separate air tank (p. UT176). (Artificial gills cannot be used at extreme depths because there is not enough usable oxygen to extract.)

The system provides Pressure Support 2 and eliminates the usual problems associated with breathing high pressure gases, allowing arbitrarily fast descents and ascents without decompression. However, breathing the liquid is tiring – even light exertion costs 1 FP per hour – and speaking is impossible. Usually worn with a drysuit. $20,000, 20 lbs.

Demolitions

All ultra-tech explosives listed here have the following properties.

Detonators: These create small precursor explosions powerful enough to detonate the main charge. They include a micro radio communicator (p. UT43) for remote triggering. This can be disabled and replaced with a timer (built-in) or optical cable (p. UT43). $20, neg. weight, LC3.

Insensitive: Small explosive charges are needed to detonate the explosive. Standard impact, friction, heat, and sparks have no effect (e.g., lighting it on fire, shooting it, or hitting it with an electrolaser).

Legality: Standard explosives are LC2.

Malleable: The explosives can be mixed with a plasticizer to give them a variable consistency (usually between that of clay and toothpaste).

Taggants: Embedded taggants (p. UT89) are standard on all legal explosives. Packaged explosives may also include a homing beacon (p. UT105) and other security.

Toxic: These explosives should not be consumed, even on a dare. Eating a small amount of ultra-tech explosive causes 2d toxic damage and both retching and seizures (see *Afflictions*, pp. B428-429) after a 15-minute delay, with *no* HT roll to resist. Burning explosives will not detonate (see above), but will produce hazardous fumes. As an area-effect respiratory agent, it has a 10-second delay and HT-2 roll to resist, and causes retching.

See ***High-Tech***, pp. 181-183 for additional *optional* rules, in addition to the basic guidelines for *Explosions* (pp. B414-415).

Standard Explosives

Ultra-Tech explosives rely on more energetic molecular structures (e.g., octanitrocubane), the use of super-fine nanopowders in filler, metastable materials, and the development of improved techniques for safely encapsulating their lethal cargo. The default explosive fillers for warheads and ammunition are listed in the *Explosives Table* (p. 18), along with their Relative Explosive Force (REF; p. B415) and nominal cost per pound.

Design Switch: Plasma Explosive Replacements

Using explosive power cells may snap the disbelief suspenders of some readers. With this switch, they are replaced by one of the following options. They have the same cost and REF as plasma explosives, but do ordinary crushing explosive damage, rather than burning damage with the surge modifier.

Strained Bond (TL11): These materials store energy by deforming the crystalline lattice structure of carefully organized layers of compressed thin films. Tearing the film releases the stored energy.

Caged Charge (TL12): This stores electrical charges within its specially arranged atomic structure. When the structure collapses this energy is released as heat and light.

Advanced Explosives

Ultra-Tech makes rather conservative assumptions about the power of TL9+ explosives, both for demolition use and explosive filler, in order to keep warhead damage somewhat reasonable and provide a niche for nuclear and antimatter weapons. However, realistic energetic materials could be many times more powerful than the default compounds!

The advanced explosives listed in the *Explosives Table* (p. 18) are difficult to synthesize and have limited applications due to safety or proliferation concerns. The costs reflect late-TL improvements. Multiply cost by at least ×10 for early experimental use.

Explosives Table

Standard Explosives

TL	Type	REF	Cost/lb.	Description	Notes
8	Demex (RDX)	1.4	$40	Extrudable filler	
9	Plastex B	4	$20	Polynitrocubane compound	
10	High-Energy Explosive	6	$40	Metastable solid	
11	Plasma Explosive	10	$100	Explosive power cells	[1]
12	Plasma Explosive	20	$100	Explosive power cells	[1]

Advanced Explosives

TL	Type	REF	Cost/lb.	Description	Notes
8	CL-20	2.3	$40	Hexanitro hexaazaisowurtzitane	
9	VOMEX	15	$20	Advanced thermobaric compound	[2]
10	Isomers	100	$500	Triggered nuclear isomers	[3]
11	Super Isomer	500	$700	Advanced nuclear isomers	[3]

Notes

[1] Plasma explosive damage also has the surge damage modifier (p. B105).

[2] Produces an explosive cloud that is then detonated. Blast radius is increased (see *Explosion*, p. B104); damage is divided by 2 × distance in yards from the blast instead of the usual 3 × distance. Only works in atmosphere.

[3] Isomer explosive damage also has the radiation damage modifier (p. B105).

Nanoscale Thermite (TL9)

Nano-energetic mixtures, broadly known as metastable intermolecular compounds (MIC), replace conventional thermite (***High-Tech***, p. 188) at TL9. However, it is more volatile than conventional thermite and can be very hazardous to handle: 3 points of burning or electrical damage will ignite it prematurely. It cannot be extinguished by any conventional means.

The burning reaction occurs very rapidly once initiated. It does 2d×10 corrosion damage per second to whatever it is touching, along with linked 3d burning damage with the explosion modifier; burning splashes, sparks, and radiated heat are a significant hazard! It will burn for five seconds/pound. $200 per pound. LC2.

Explosive Swarms

A one-square-yard collection of swarmbots (pp. UT35-37) using a modified Pollinator design can carry up to a pound of explosives and a distributed detonation system. Divide the explosion damage by (2 × distance in yards from center of blast).

Manufacturing

One of the driving forces of exponential technological growth is the increasing ease and flexibility of production, reducing the time to “build the tools to build the tools” to develop new gadgets. Specialized and labour-intesive production lines give way to small, automated, and adaptable robofacs, nanofacs, and universal assemblers, ushering in an age where vast material wealth is both increasingly achievable and decreasingly relevant.

The manufacturing capabilities presented on pp. UT89-94 give an optimistic projection of future industry, but some may feel that they stretch the limits of economic realism, or at least playability. Placing such powerful means of production in the hands of citizens (or players) may undercut the mercantile themes of many popular adventure scenarios. GMs may wish to consider the following design switches.

Design Switch: Slower Industrial Systems

With this design switch, reduce the production rate of fabricator, robofac, nanofac, and replicator systems from “per hour” to “per day.” Thus a $100,000 and 100 lb. robotic minifac could fabricate up to $100 or 1 lb. per *day*: enough to double its capacity every 3 years or so.

Design Switch: Slower Microtech Assembly

The slowdown factors on pp. UT89-90 for manufacturing microtech items simplistically use the final weight of the item as a proxy for its delicacy of assembly. Alternatively, assume that the base production rates are for macroscopic assembly only (no parts smaller than about 1 mm). Multiply time by 10 if it requires microscopic assembly (down to micron-scale parts), or 100 if it requires nanometer-scale etching or printing (such as microchip fabrication). *Further* multiply by 2.4 if working from scrap or salvage, rather than packaged components.

This rule may be used in place of the *Slower Industrial Systems* switch, above, to moderate the economic impact of fabricators and robofacs. These systems can achieve high throughput when supported by an established supply chain, but are much slower at manufacturing items (or reproducing themselves) from scratch.

TL9 fabricators cannot perform microscopic assembly, but dedicated production lines, TL10 fabricators, and robofacs can, with the above slowdown factors. Nanofacs (p. UT91) have no slowdown factor for molecular assembly – that is what they do by default – but take 2.4× as long working from raw materials instead of feedstock.

Industrial Antimatter Factory (TL9-12)

A purpose-built facility for production and storage of antiprotons and the creation of antihydrogen. Antiprotons are produced by accelerating protons (or other particles) to energies high enough that, when they collide with a target, a part of the energy is transformed into particle-antiparticle pairs. These are then captured and assembled into antihydrogen.

Antimatter Factory (TL9): A large, optimized antiproton particle-accelerator system. It manufactures antimatter at a cost of $25,000 per microgram, and can manufacture 1,000 micrograms per day. At these prices, antimatter is used in nanogram levels as both a radiation source for medical treatment, and as a catalyst for fusion or fission in small nuclear pellets or warheads, although the latter are very expensive. $25 billion, 125 000 tons. LC1.

Antimatter Factory (TL10): Manufactures antimatter at a cost of $2,500 per microgram and can make 10,000 micrograms per day. Antimatter-catalyzed fusion is common; micrograms of antimatter are routinely used as a catalyst for nuclear weapons. Antimatter is also used to fuel antiparticle beam weapons. $15 billion, 75,000 tons. LC1.

Antimatter Factory (TL11): Manufactures antimatter at a cost of $25 per microgram and can make 100,000 micrograms per day. At these prices, antimatter reactors are used where high-performance power plants are more important than fuel efficiency (e.g., military craft). Antimatter warheads with a yield between conventional and nuclear weapons are introduced (a microgram of antimatter equals about 90 lbs. of TNT). $1 billion, 5,000 tons. LC0.

Antimatter Factory (TL12): It manufactures antimatter with high efficiency at a cost of $5 per microgram and can make 1 gram per day. At these prices, antimatter is used directly in some high-performance rocket engines, and is common in weaponry. However, each pound of antimatter still costs $2.2 billion (and explodes with about 20 megatons yield), so nuclear bombs remain the only cost-effective way to create big explosions. $200 million, 1,000 tons. LC0. In comparison, at TL8, antimatter production, primarily for research purposes, rarely exceeds 0.01 micrograms/year at $60-70 million per microgram.

Antimatter factories are cheaper if they can benefit from solar collection facilities, especially close to the sun, e.g., on Mercury. For such a facility, multiply the start-up cost by four due to the specialized equipment and transportation that is needed, but divide the cost per microgram of antimatter by two. This can be much more efficient.

Antimatter for ***Spaceships***

Antimatter rockets in ***GURPS Spaceships*** assume that antimatter containment systems do not significantly exceed the mass of propellant. This requires much higher storage capacities than listed on p. UT81. A simple adjustment is to boost TL9 storage capacities by 1,000×, with a further 1,000× (rather than 10×) per subsequent TL. Thus:

TL9: A standard 20 lb., $20,000 portable antimatter trap (p. UT82) holds 10 *milligrams*, and runs indefinitely off an integrated antimatter thermoelectric generator.

TL10: A standard trap holds 10 grams (10,000 milligrams).

TL11+: Antimatter can be stored in bulk like ordinary hydrogen (the magnetic trap adds negligible weight).

Although these numbers stretch credulity, they are *not* superscience, but optimistic extrapolations of known technologies.

To bring the *costs* in line with ***Ultra-Tech***, modify the *Fuel Cost Table* on ***Spaceships*** p. 46 as follows: Antimatter-catalyzed propellant (10 milligrams/ton) costs $200M/ton at TL9. Antimatter-boosted propellant (60 grams/ton) costs $120B/ton at TL10. Matter/antimatter fuel (1:1 mix) remains $10T/ton at TL11. Divide cost by 10 for each TL after introduction.

If these costs seem exorbitant, consider the following options:

Design Switch: Cheap Antimatter

Divide the cost of antimatter by 1,000×. *Increase* the production capacities of antimatter factories (above) by the same factor. Logically, the cost of antimatter *reactors* should also be reduced by the same amount; otherwise by TL12 it would cost more to annihilate antimatter than to manufacture it.

Design Switch: Superscience Antimatter

With superscience it may be possible to produce antimatter very cheaply; e.g. by passing ordinary matter through a non-orientable wormhole to reverse its charge. Reduce the cost of antimatter to some bulk amount, say $6,000 per ton. Antimatter reactor costs need not change since they operate on completely different principles. If the transmutation and annihilation processes are combined in the same device, the result is a total conversion reactor.

Covert Ops and Security

These gadgets could be considered standard expedition gear, but for the fact that they see more use in covert operations.

Wrist Line Shooter (TL10)

A smaller cousin to the electromagnetic autograpnel (p. UT96), this is a miniature launcher for a 100′-long carbon fiber line terminating in a gecko adhesive pad (p. UT83) that will stick to anything and support up to 200 lbs. The user can use it to travel by swinging from buildings, tree branches, ceilings, etc. He adds +2 to Climbing skill, and can move at half Basic Move while swinging along. $200, 0.5 lbs. LC3.

Exofield Variants

Exophase fields, as described on p. UT96, are both superscience *and* cinematic: the fact that an intangible person should *fall through the floor* is sufficiently obvious that it is lampshaded in the more self-aware science fiction stories. Additionally, features like the "ghost image" created by an exofield generator would imply at least *some* interaction between exophase objects and ordinary matter. The following design switches address these assumptions.

Design Switch: Realistic Exophase

Since a person in exophase does not interact with ordinary matter, he will effectively be in vacuum, and will require appropriate environmental gear. He will also be unable to stand on the floor: thus he will need a vacuum-capable flight system, such as a contragravity belt or gravity cloak (p. UT231), to avoid falling through the ground.

Design Switch: No EM Interaction

Travelers in exophase are both blind *and* invisible to the normal-phase world. They may still use a gravity ripple communicator (p. UT45) or gravscanner (p. UT63) to maintain contact with the outside world.

Design Switch: No Force Interaction

With this switch, "force" and "gravitic" technologies work on different principles, and only the latter can cross an exophase boundary. Objects in exophase cannot use or be affected by tractor beams, force screens, and the like. Optionally, force screens might affect exophase only if they themselves have certain options, such as Reality-Stabilized (p. UT192). (Logically such gear, when taken into exophase, should also allow interaction with ordinary-phase matter.)

Inquisitor Robot (TL10)

189 points

This is a sinister machine equipped with three flexible weapon mounts and three manipulator arms. The basic model is a cylindrical machine that moves on a cushion of air. Its strength belies its size. It is also called a "torture robot," although its large brain (for its mass) and array of sensors let it analyze behavior and make it very good at psychological manipulation. A typical mix for its weapon mounts might be a pneumohypo, a holdout electrolaser, and a neural lash. Its second mouth is mounted on an arm, and can be used to take samples for its taste sensor.

Attribute Modifiers: ST+1 [10]; HT+2 [20].
Secondary Characteristic Modifiers: HP+4 [8].
Advantages: Doesn't Breathe [20]; Discriminatory Smell (Emotion Sense, +50%) [23]; Discriminatory Taste [10]; DR 10 (Can't Wear Armor, -40%) [6]; Extra Arm 3 (Extra Flexible, +50%; Weapon Mount, -80%) [9]; Extra Mouth 1 [5]; Flight (Low Ceiling, -25%) [30]; Infravision [15]; Machine [25]; Protected Hearing [5]; Protected Vision [5]; Radio (Burst, +30%; Reduced Range 1/10, -30%; Secure, +20%; Video, +40%) [16]; Sealed [15]; Sharp Teeth [2].
Disadvantages: Aerial [0]; Cannot Float [-1]; Electrical [-20]; Maintenance (one person, weekly) [-5]; Restricted Diet (Very Common, Power Cells) [-10].
Perks: Accessory (Compact microframe computer) [1].
Availability: $60,000 (TL10), $15,000 (TL11), or $4,000 (TL12), 64 lbs. LC2.

Lenses

Optionally add the following hardware upgrade.

Contragrav (TL10^) (+15 points): Floats silently through the air, which only increases its menace! Remove Low Ceiling, -25%, giving it Flight [40]; add Silence 1 [5].

Weaponry

The power and scale of ultra-tech weaponry cannot be overstated. Even the most libertarian societies will restrain killing technologies out of a desire to preserve the continuity of civilization in the event of a conflict. Indeed, this is reflected in ***Ultra-Tech*** to some extent by the generally lower Legality Class and higher costs assigned to weapons compared to their ***High-Tech*** equivalents.

Ubiquitous surveillance, even if fiscally or technically feasible, could not preempt all armed criminal activity. (There are significant signal-to-noise issues that make deploying hundreds of thousands of square yards of surveillance swarmbots, for example, rather impractical.) The next best thing is to at least *inconvenience* a would-be malefactor through taxes, restricted production, international bans on "excessive" devices, and so on.

Beam Weapons

These are the archetypal ultra-technology weapons, popular in both hard SF and superscience campaigns.

Lasers

Laser beam weapons exist today, but the technology is still in its infancy, and realistic game effects are still somewhat speculative. Players and GMs may find the following options give a greater sense of realism.

Design Switch: Atmospheric Cover

Some may be bothered by the fact that an x-ray laser cannon can damage a target behind 15 feet of solid concrete, but is completely stopped by 20 yards of ordinary air. With this design switch, media that are opaque to a given wavelength provide *cover DR* (see *Overpenetration*, p. B408) rather than reducing maximum range. Thus, 1/2D and Max ranges correspond to the beam losing focus, and DR corresponds to its energy being blocked.

Infrared Lasers (p. UT114): Water is opaque to IR, and provides a cover DR of 30 per yard. Air is transparent.

Visible Light Lasers (p. UT114), including *Rainbow Lasers* (p. UT116): Water provides cover DR of 3/yard if crystal-clear, 10/yard normally, or 30/yard if murky. Divide these DRs by 10 for blue-green lasers (p. UT114). Air is normally transparent to these wavelengths, but rain, smoke, and fog provide cover DR equal to the vision penalty, as described on p. UT114. Realistically, the maximum cover DR provided by air should be 2/yard, multiplied by the atmospheric pressure. Note that air actually *improves* the focusing of rainbow lasers, whose 1/2D and Max ranges are divided by 10 in vacuum, as described on p. UT116.

Ultraviolet Lasers (p. UT115): Water provides cover DR of 30/yard. Air provides cover DR of 1 per 10 yards, multiplied by atmospheric pressure.

X-ray and Gamma-Ray Lasers (pp. UT117-118): Water and air are both opaque to these wavelengths. For water, cover DR is 30/yard. For air, it is 2/yard, multiplied by air pressure.

For stricter realism, *particle beams* and *antiparticle beams* (p. UT123-124) should have the same cover DR as X-ray and gamma-ray lasers.

Design Switch: Realistic X-Ray Lasers

The combat statistics of X-ray and gamma-ray lasers presented in ***Ultra-Tech*** are somewhat cinematic: realistically, a gamma-ray beam or other penetrating radiation will deliver a lethal radiation dose long before it causes significant burning damage. However, the statistics on p. UT117-118 are reasonable for narrow beams of *non-penetrating* radiation: assume that "X-ray" and "gamma-ray" lasers are both actually soft X-ray weapons, with wavelengths around 2 and 0.2 nanometers, respectively. Their DR divisor is a result of their needle-thin beams rather than any transparency of the armour.

Brain Disruptor (TL11^)

This is a lethal neural disruptor, similar to a *Death Beam* (p. UT122). However, whereas a death beam causes cardiopulmonary paralysis, a brain disruptor simply shuts down the central nervous system entirely. Treat it as a neural disruptor (p. UT121), except the target dies instantly on a failed HT roll. Attempts to scan or upload the victim's brain are at -5 to skill.

While this might seem like a "more advanced" effect, in reality devices that cause permanent brain damage are *more plausible* than ones that induce delicate and finely-tuned sensory-motor effects at a distance. Brain disruptors therefore remain TL11^ (unlike the TL12^ Death Beams), and could plausibly be TL11.

A brain disruptor has the same stats as other neural disruptors. If it also has nonlethal settings, add +50% to cost for each additional setting. LC is reduced to 2.

Particle Accelerators

GMs interested in a rigorously hard SF setting may consider applying the following design switch, from ***GURPS Spaceships 7:*** *Divergent and Paranormal Tech*, p. 22.

Design Switch: Accelerator Tube Limits

Certain weapon systems may require massive linear accelerator tubes hundreds of feet long. This restriction is reasonably applied to charged particle beams (*blasters*, p. UT123), neutral particle beams (below), antiparticle beams (*pulsars*, p. UT124), ghost particle beams (p. UT131), gamma-ray lasers (p. UT118), and X-ray lasers (p. UT117). With this switch, such weapons will only be available for *large* vessels or installations, not in any of the weapon sizes listed in ***Ultra-Tech***.

Neutral Particle Beams (TL10)

These weapons are intended for use in vacuum and trace atmospheres, where a charged particle beam (p. UT123) would rapidly defocus. Instead of light (and negatively charged) electrons, the beam is composed of heavier hydrogen atoms. In order to accelerate the beam, an extra electron is attached to each hydrogen atom. The now-charged heavy ion is accelerated in conventional fashion, but as it exits the accelerator it passes through a tenuous gas that strips away the extra electron, producing a neutral beam.

The extra machinery means that neutral particle beam weapons are more complicated than charged particle beam weapons, appearing one TL later. Neutral particle beam weapons are mostly used as spacecraft weaponry, sometimes with accelerator tubes that are hundreds of feet long. However, semi-portable neutral-beam weapons may be available if vacuum combat is expected; for example, troops operating on a lunar base or in an asteroid belt might be equipped with these weaponry. In vacuum or trace atmospheres their range is not reduced (unlike a charged particle beam). In atmosphere, they can fire a normal electron beam (rather than a hydrogen atom) and will thus perform as an ordinary charged particle beam blaster.

Neutral particle beams otherwise have the same statistics as ordinary charged particle beam blasters on p. UT123, but appear one TL later.

Sonic Weapons

Sonic Nauseators (p. UT125) are somewhat plausible, but the description as given is cinematic. For a more realistic version, remove all reference to acoustic heterodyning: these are focused ultrasound weapons designed to irritate and deafen the target. Effects of a failed HT roll are as listed: Moderate Pain and Hard of Hearing. If the HT roll is failed by 5 or more, the target suffers Deafness and dizziness or vertigo: treat as Nausea, p. B428. (This *can* lead to Retching, per the rules for Nausea, but not loss of sphincter control; that's an urban myth.)

Sonic Screamers (p. UT125) are superscience, but *aquatic* versions are more plausible, and have actually been proposed as anti-torpedo weapons. Intense ultrasonic waves produce cavitation bubbles and shock waves when they strike a target, chewing through material. Use the listed stats, but treat them as TL9 rather than TL9^, and they work only in water (no effect in air). In superscience settings, a weapon that works in both water *and* air costs +100%.

Guns and Launchers

While beam weapons and Gauss guns typify ultra-tech firearms, "conventional" weapons will still likely find a role, especially in the transitional period at early TL10.

Electrothermal-Kinetic Slugthrowers (TL10)

"ETK" guns are similar to both liquid propellant guns and electrothermal-chemical weapons; they are the final evolutionary stage of conventional firearms before a complete transition to electromagnetic weaponry. Instead of relying on the chemical energy of the propellant, they use a powerful electrical charge to vaporize it. The expanding steam and plasma accelerates the round to a very high velocity. They use more energy than an electrothermal-chemical weapon, but less than a gauss gun.

All TL9 conventional slugthrowers can also be available in TL10 ETK versions. They propel projectiles at roughly twice the velocity of a conventional slugthrower. ETK slugthrowers get double their normal piercing damage, double the range, and have 1.5 times as many shots of a conventional-propellant slugthrower. Two-handed weapons (rifles, shotguns, SMGs, etc.) also add +1 to Acc. They are also twice as expensive. They have the same variable velocity setting as LP slugthrowers. Other statistics are the same.

The grip or stock of an ETK slugthrower incorporates a removable B cell (for pistols) or C cell (for SMGs, PDWs, shotguns, rifles), or D cell (for larger weapons) to provide the electrical pulse. Each provides enough power to fire 10 magazines worth of ammunition.

Warheads and Ammunition

Ultra-technology offers the possibility of projectile bodies composed of exotic nanolaminates. Their composition is formulated to add energy to the explosive. Projectiles might also be constructed of solid explosives milled to shape and coated with a thin protective shell.

Reactive Fragments (TL9)

Reactive warhead fragments are compounds embedded in a plastic matrix that undergo an exothermal reaction on impact. When an explosion propels a reactive fragment into a solid target (DR 1+), the composite shock-ignites and reacts violently with oxygen in the air after a short delay. This produces an additional explosion inside the target.

Any warhead that inflicts fragmentation damage (p. B414) can use reactive fragments. The fragments do cutting damage, but with a ×3 wounding modifier (it's an internal explosion, p. B415). Multiply final warhead cost by ×1.2. LC is unchanged. Only works in atmosphere.

Plasma Lance Warheads (TL11^)

Plasma lance warheads are similar to plasma warheads, but generate a highly penetrating shaped plasma jet designed to burn through armor. Plasma lance warheads inflict burning damage with a (10) armor divisor and the surge damage modifiers.

Plasma lance is available for any 10mm or larger round. Hand grenades and mines use the warhead damage. Guns and launchers with plasma warheads replace their normal piercing damage with the warhead damage shown below.

Plasma Lance Warhead Table

Warhead	Damage
10mm	6d (5) imp inc sur
15mm	6d × 3 (5) burn sur
18.5mm	20d (5) burn sur
25mm	6d × 5 (10) burn sur
40mm	6d × 8 (10) burn sur
64mm	6d × 12 (10) burn sur
100mm	6d × 20 (10) burn sur

Plasma lance warheads are 15 times cost. LC1.

2D Force Warhead ("Grav Slicer") (TL10^)

These create a two dimensional hypergravity pulse, usually parallel to the local gravity gradient. This flat disk of expanding gravitational force inflicts cutting damage with a (3) armor divisor. The GM should adjust hit location based on the position of the victims; this can be a nasty surprise if they don't realize what type of grenade was used, since the normal reaction ("hit the dirt") might be the wrong thing to do. If someone drops prone when a "grav slicer" grenade lands near them, any location could be struck. If they time a jump just right, it will miss them, and if they remain still, it may slice off their feet at the ankles. Warheads may be programmed to airburst at a given height (e.g., neck level, torso level, etc.) to maximize a particular effect.

2D force is available for any 15mm or larger round. Hand grenades and mines use the warhead damage. Guns and launchers replace their normal piercing damage with the warhead damage shown below.

2D Force Warhead Table

Warhead	Damage
15mm	1d(3) cut ex
18.5mm	1d+2 (3) cut ex
25mm	2d(3) cut ex
40mm	4d(3) cut ex
64mm	8d(3) cut ex
100mm	8d × 2 (3) cut ex

They are 10 times cost. LC1.

Defenses

Military interests usually drive research into defensive technologies for fixed installations, vehicles, and combat personnel. Nonetheless, considerable economic incentives exist to develop armor for civilians in unstable political or cultural milieus.

Body Armor and Protective Gear

Advanced weapons are extraordinarily deadly, and even the heaviest body armor listed in ***Ultra-Tech*** is rarely proof against a well-directed shot. The best defense is to not be in the line of fire in the first place through stealth and mobility, or strike down foes before they ever get in range. That said, it would be an error to assume that TL9+ soldiers will not wear armor just because it isn't perfect protection – most can still guard against fragmentation, lower TL weapons, and environmental hazards.

Armor Features

Ultra-Tech armor without microclimate systems (p. UT171) incorporate undergarments with moisture-wicking (***High-Tech***, p. 64) properties. Any armor that covers the torso includes attachment points that make it the equivalent of a basic-quality load-bearing vest (***High-Tech***, p. 54). Rigid armor vests provide attachment points for backpacks (***High-Tech***, p. 54) and climbing equipment (***High-Tech***, p. 55). Arm and leg armor have pockets for the insertion of knee or elbow pads (***High-Tech***, p. 71).

Defense Systems

The well-prepared combatant has a few more options.

Cerablate Resin (TL9)

This polymer nanocomposite is spackled on rigid armor to provide temporary protection; it's flexible and subject to the blunt trauma rule (p. B379) if painted on skin or clothing. Cerablate is *semi-ablative* (see p. B47) and loses 1 DR for every 10 points of basic damage it resists.

A typical application of cerablate resin provides DR 10. Enough resin to cover a full-body suit is 4 lbs. and $400. Use the tailored armor rules for partial coverage (p. UT174). LC3.

Multiple Optics (TL9)

Helmets built without a faceplate (p. UT187) can use distributed optical sensors. This provides the advantages of Injury Tolerance (No Eyes) (p. B61) due to multiple redundancies. The extra cameras cost $500.

Force Screens

Superscience defense screens are a staple of space opera, and are endlessly mutable in their appearance and capabilities. The base rules on p. UT190 treat them as generic switchable, regenerating, semi-ablative DR, leaving most of the "flavour" to the optional variants or to cosmetic features.

Force Screen Formulas

The stats listed on p. UT191 easily generalize into formulas, allowing force screens of any size and DR.

Barrier Screens

Wt = DR × D / 40

Wt is the weight in pounds.

DR is the screen's damage resistance, minimum 200.

D is the field's diameter in yards, minimum DR / 40.

Cost is equal to $1,000 times weight in pounds. Power is "external power"; alternatively, an E cell (not included) provides power for 25 hours divided by weight in pounds. Adjust accordingly if other power cells are used. LC3 up to DR 200, LC2 up to DR 2,000, LC1 for higher DR.

Conformal Force Screens

Wt = DR / 30

Wt is the weight in pounds, *excluding* any power cells.

DR is the screen's damage resistance, minimum 60.

Adjust weight for the maximum SM covered (minimum SM+0), as listed under *Adjusting for SM* on p. UT16. Cost is $4,000 times weight in pounds. A D cell provides power for 5 hours divided by weight in pounds. Adjust accordingly if other power cells are used, and remember to add the cell's weight to the final weight of the system. LC3 up to DR 100, LC2 up to DR 1,000, LC1 for higher DR.

Minimum DR and size are suggestions; the GM may allow screens of *any* size, especially at TL12.

More Force Screen Variants

Consider some of the following additional force screen options.

Ablation Options

These options control how a force screen's DR is reduced or recovers as it takes damage.

Ablative: The screen loses DR as it absorbs damage, on a one-to-one basis. Lost DR still regenerates at 10% of maximum DR per second (round down, but with a minimum 1 DR per second). *Double* the screen's DR; other stats remain the same.

Rigid: The screen does not lose DR as it absorbs damage, or regenerates it so quickly as to be essentially instantaneous. *Halve* the screen's DR; other stats remain the same. This option is incompatible with any other regeneration options (p. 25).

Fragile: If damage ever penetrates the field, the generator burns out and must be repaired or replaced. This can be combined with other ablation options. -80% to cost.

Slow: The screen recovers DR more slowly than 10% of maximum DR per turn. The reduction factor is up to the GM (1% per turn is common), and, if *all* force screens have the same factor, does not need to be balanced with any other changes in stats. If fast and slow force screens coexist, then slow screens should be cheaper: -50% cost.

Energy-Shedding Options

Some force screen concepts assume that they *absorb* or *channel* the energy of the attack, rather than simply blocking it. Beam effects are dampened, bullets stop and fall to the ground. The following options are based on – and modify – this assumption.

These options are often combined with the *Precharging* or *Discharging* regeneration options (p. 25).

Prismatic: In some classic space operas, force screens change color as they absorb energy, glowing red to orange to yellow and so on up the spectrum, eventually flaring violet and overloading. Replace the rules for screen ablation with the following: A screen that takes more damage than half its DR in one hit gains one energy level and shifts one color up the spectrum. Screens go from transparent through red, orange, yellow, green, blue, indigo, violet, and finally ultraviolet. If a screen passes ultraviolet, it overloads and its generator is automatically disabled. Screens recover energy levels at a steady rate set by the GM: one level every 10 turns is a convenient number.

Thermal: Like Prismatic, above, except that the colour directly reflects the rate of energy discharge. Instead of the spectral colours above, there are only 5 energy levels: red (3,000K), orange (4,000K), yellow (5,000K), white (7,000K), and blue (10,000K). Energy is shed at a rate proportional to the fourth power of temperature, so going from blue to white takes only 1 turn, white to yellow takes 3 turns, yellow to orange takes 10 turns, orange to red takes 30 turns, and red to clear takes 100 turns. Thus it takes nearly twice as long to discharge completely, but overloading the final energy level requires concentrated fire.

Absorbing: The force screen regenerates DR (or, if combined with Prismatic, recovers energy levels) by shunting energy into power cells. For ordinary force screens, regenerating 4,000 points of DR will fill one TL11 C cell. For other cells, multiply this number by the cell's capacity (i.e. 1,000 to fill a TL10 C cell, 250 for a TL9 C cell, 8,000 for TL12 C cell, 400 for a TL11 B cell, etc.). Recovery rate is unchanged, but only if the generator is connected to a power cell with sufficient unfilled capacity. Often a high-power device (such as a beam weapon) is connected to the same cell to ensure that it remains sufficiently drained. This option adds +100% to the cost of the force screen.

For Ablative screens, each point of DR recovered counts as 10 DR for the above calculation. For Prismatic screens, each *energy level* counts as half the screen's total DR for that calculation.

Deflecting: This option allows the screen to *redirect* (rather than block or absorb) the incoming energy in any direction. Bullets bounce off towards new targets, while beam attacks envelop the field before coalescing into a new stream. However, if *any* damage penetrates the screen, this ability is negated for that attack. The deflected beam has the same damage as the incoming beam, is aimed using the same skill, and has the same Acc up to a maximum of 12. Its 1/2D and Max ranges are unchanged, but subtract the distance already travelled to the screen-defended target. This option has no direct effect on ablation or DR recovery, and can be combined with the Prismatic option, but thematically is more typically used with the Rigid option (p. 24).

Regeneration Options

The default force screen rules generously allow the screen to regenerate DR at a steady rate even when switched off. This raises questions as to whether regeneration requires power (and, if so, what happens if one shuts off power to the generator rather than just "lowering screens"), what happens to any energy absorbed by the screen, etc. The following options adress these issues.

Discharging: If the screen is turned off without having recovered all DR (or energy levels), then it shorts out, disabling the generator until repaired. -20% cost.

Explosive Discharging: As above, exept the remaining energy is released in an explosion, not only destroying the generator but also damaging its surroundings. Basic damage is equal to 10× the remaining unrecovered DR (1× if combined with the Ablative option, or 1/2×DR per unrecovered *energy level* with the Prismatic or Thermal options). Treat it as burning damage with the explosive and surge modifiers. GMs take note that this can turn force screens into improvised explosive devices significantly more powerful than plasma warheads (p. UT158). -40% cost.

Powered Recharging: The screen does not recover DR (or energy levels) when turned off. When turned on, it will return to the same state it was in when it was turned off. Optionally, disabling or destroying the generator may release the remaining energy as per Explosive Discharging. -10% cost, or -30% if it explodes when disabled.

Precharging: When turned on, the screen starts with zero DR (or at the maximum energy level for Prismatic and Thermal options), which must then be recovered at the usual rate. This represents the generator building up a "sink" that will absorb the energy of incoming attacks. Turning the generator off has no side effects, but it will have to regenerate the energy sink the next time it's turned on. -20% cost.

Other Options

A few additional options culled from various sources.

Hardened: The screen is hardened (p. B47) vs. all attacks, e.g., a graviton beam's normal (1/100) divisor vs. screens becomes (1/10). +50% cost.

Two-Way: Screened items may not fire or launch anything the screen stops. If the screen is opaque, people inside the screen cannot see out, or use sensors that would be blocked by the screen. -40% cost.

Reshapable: This option is only available for conformal force screens with the Adjustable option (p. UT191). The screen can be extended from the surface of the wearer to assume a variety of shapes. This requires a Ready maneuver, and the reshaping occurs gradually over the course of a turn. Only relatively simple and smooth shapes can be assumed, as the GM permits: e.g. wings, a blunt pole, etc. In particlar this cannot be used to form sharp points or edges, or to grapple or manipulate objects, other than by pushing them. If reshaping increases the Size Modifier of the enclosed region, *divide* DR by the modifier listed under *Adjusting for SM* on p. UT16 (e.g. 1/5 DR if SM increases by 2): there is no increase in DR for assuming a shape *smaller* than the generator's rating. +50% cost.

Medical and Biotech

It has been said that nothing is certain except death and taxes. Ultra-technology promises to solve the easier of these. Taxes will have to wait.

Uploading Surgery

Destructive uploading (p. UT219) is a *surgical* procedure, despite the fact that the skill rolls are against Electronics Operation (Medical) - 5 and Physician - 5. Other than the skills involved, treat it as a radical cybernetic surgical procedure, with cost and difficulty as listed in the *Surgical Procedures Table* (p. UT207). The -5 penalty is the standard modifier for brain surgery. Normal surgical modifiers apply, including the +(TL-4) for improving surgical equipment *in addition* to any quality modifiers. Ignore the Injury or Recovery Period columns: succeed or fail, the surgery destroys the original brain.

Nondestructive uploading is *not* a surgical procedure, and requires only a basic Electronics Operation (Medical) roll (plus quality modifiers). It can be repeated at no penalty.

Chapter Three

Laser and Blaster Design

This is an updated version of this system optimized for ***GURPS Basic Set,*** *Fourth Edition*. It's compatible with ***GURPS Ultra-Tech***, but can be used without it.

Beam Weapon Design

This is a customized system for building laser and blaster weapons. The weapon designs should be reasonably similar to their equivalents in ***GURPS Ultra-Tech***. (They won't be identical, since ***Ultra-Tech***'s weapons were balanced against each other rather than built using design rules.)

Tech Level

Choose a TL for the weapon; it may be TL9 to TL12. Decide if the weapon will incorporate superscience (TL^) technology.

Example: This will be a TL12^ beam weapon. It's a handgun for the galactic police, to be known as the Vega Machine Pistol. It will incorporate superscience technology. The goal is to design an easily concealed but devastating weapon for undercover Space Patrol officers.

Beam

Select the type of beam, within the limits of the weapon's TL. Force, graviton, and pulsar beams are *always* superscience. Other beams can incorporate superscience (e.g., a "TL9^ super laser" or "TL10^ super blaster") if desired; this will make the weapon twice as powerful as it would be otherwise.

For explanations of damage modifiers, see pp. B104-105 and B111.

Laser (TL9/10): A high-energy laser fires a beam of coherent light, usually in near-infrared frequency. It inflicts tight-beam burning damage with a (2) armor divisor. At TL9, only large (10d+ damage) or chemical (see p. UT114) lasers are available. For more details, see *High-Energy Laser* on pp. UT114-115.

Force Beam (TL10^): These are tightly focused gravitic beams that deliver a powerful kinetic impact. Force beams inflict crushing damage with the double knockback modifier. They can also be set to stun, delivering a beam with a wider impact; on "stun" the beam has no wounding effect (no HP are lost), but it still has its usual double knockback modifier. For additional details, see *Force Beams* on pp. UT128-129.

Blaster (TL10/11): A blaster fires a bolt of ionized charged particles at relativistic velocities. It inflicts tight-beam burning damage with a (5) armor divisor and the surge damage modifier. In vacuum, the charged particles repel each other, so Acc is halved and it has only 20% range. At TL10, only large (20d+ damage) blasters are available. For extra rules, see *Charged Particle Beams ("Blasters")* on p. UT123.

Neutral Particle Beam (TL10/11): Similar to a blaster (see above), this is a neutral beam composed of both positively charged ions and electrons. It inflicts tight-beam burning damage with surge and radiation modifiers, but won't work in atmosphere. However, at the flip of a switch, it can reconfigure to fire a blaster beam with identical stats except using half the power (giving it twice as many shots in this mode).

Rainbow Laser (TL11): This type of laser fires a nanosecond pulse that is focused through interaction with the atmosphere into a needle-thin beam of polychromatic light. It inflicts tight-beam burning damage with a (3) armor divisor. The beam only focuses properly in a very thin to superdense atmosphere; in vacuum or trace conditions, it has 10% range and no armor divisor. See also *Rainbow Lasers* on pp. UT116-117.

X-Ray Laser (TL11): An advanced laser firing coherent X-rays, an X-ray laser inflicts tight-beam burning damage with a (5) armor divisor and the surge damage modifier. In air, range is limited to 7/20 yards divided by the pressure in Earth atmospheres. See *X-Ray Lasers* on pp. UT117-118.

Graviton Beam (TL11^): These weapons project oscillating hypergravity fields that crush or vibrate internal organs. Gravity beams inflict crushing damage with the no-knockback damage modifier. Although their damage is low, they have a cosmic armor divisor (∞) that ignores all normal DR. Force screens can protect against them, but do so at 1/100 of their normal DR. For extra rules, see *Graviton Beams* on p. UT129.

Pulsar (TL11^/12^): A pulsar is an anti-particle beam; it fires antiparticles, usually positrons or anti-hydrogen atoms. It inflicts crushing damage with a (3) armor divisor and the explosive, radiation, and surge damage modifiers. In air, range is limited to 1,000 yards divided by the pressure in Earth atmospheres. At TL11^, only large (40d+ damage) pulsars are available. See *Antiparticle Beams ("Pulsars")* on p. UT124.

Graser (TL12): An advanced laser firing coherent gamma rays, a graser does tight-beam burning damage with a (10) armor divisor and the surge damage modifier. In air, range is limited to 70/200 yards divided by the pressure in Earth atmospheres. See *Gamma-Ray Lasers (Grasers)* on p. UT118.

Example: The Vega Machine Pistol is a pulsar.

Focal Array

This is the weapon's focusing system, which helps determine range. Decide if the weapon has a tiny (×0.1), very small (×0.25), small (×0.5), medium (×1), large (×1.5), very large (×2), or extremely large (×4) focal array relative to typical weapons of its class. The parenthetical number is the effect on range. Most weapons use a medium array, but a smaller array means reduced range with some saving in weight, while a larger array is heavier but longer-ranged.

Example: This is envisioned as a snub-nosed weapon, so the Vega Machine Pistol will have a very small focal array, reducing its weight somewhat at the expense of a shorter range.

Generator

Decide on the beam generator, which determines rate of fire.

Single Shot: The generator can only fire one shot per second, but is lightweight.

Semi-Auto: The generator can be built to fire at up to RoF 3.

Light Automatic: The generator can be built to fire at RoF 4 to RoF 10.

Heavy Automatic: The generator can be built to fire at up to RoF 20.

If using the *Hotshots and Overheating* rule from p. UT133, a weapon with a light or heavy automatic generator may optionally be designated a Gatling. A Gatling can never overheat but may not fire hotshots.

Example: As the weapon was named a "machine pistol," it seems logical to make it capable of rapid fire! It will have a light automatic generator.

Damage Dice

Choose the dice of damage the weapon inflicts. The greater the damage, the heavier and more power-hungry the weapon will be. Partial dice of damage can be specified as a decimal value, e.g., 2.5d. This will be converted to dice plus adds as detailed in *Rounding Damage* (p. 28), but the decimal value is used for all other design calculations.

To create man-portable weapons, give a beam pistol 2d to 5d, a beam rifle 4d to 8d, and heavier weapons even more damage. Pulsars and "super" versions of ordinary non-superscience beams (that is, not graviton or force) are more energy-efficient and so can usually be built to do twice that amount of damage. Graviton beams are less efficient at doing damage, so will usually be about half as lethal (e.g., the average graviton pistol is usually 1d to 2.5d damage).

After the damage dice are assigned, determine the basic empty weight of the weapon (see below). That will give an idea if the weapon is practical. If not, choose a lower or higher damage and recalculate weight again!

Example: The Vega Machine Pistol will inflict 7d damage, high for a normal pistol but about average for a more efficient pulsar.

Empty Weight

Calculate the weight in pounds based on the design decisions and this formula:

Empty Weight = $(D \times S / E)^3 \times F \times G$.

D is the dice of damage.

S is 1 for most beams, or 0.5 for "super" versions of non-superscience beams (i.e., superscience weapons that aren't force, graviton, or pulsar beams).

E is 6 for a pulsar, 4 for force, 1.5 for graviton, or 3 for any other beam type.

F for the focal-array value: 0.25 for tiny, 0.5 for very small, 0.8 for small, 1 for medium, 1.25 for large, 1.6 for very large, or 2 for extremely large.

G for the beam-generator value: 1 for single-shot, 1.25 for semi-auto or light automatic, 2 for heavy automatic or Gatling.

Round the weight off to the nearest 0.1 lbs. if the weight is less than 10 lbs., or to two figures if it weighs 10 lbs. or more.

If the weight seems wrong for the desired weapon, adjust the dice of damage and try again!

Example: The Vega Machine Pistol is a pulsar that inflicts 7d damage. It has a very small focal array and light automatic beam generator. Empty weight is $(7 \times 1/6)^3 \times 0.5 \times 1.25 = 0.992$ lbs., rounded to 1 lb. That seems fine for a handgun.

Configuration

Decide on the weapon format. This is independent of weight, e.g. one can build a massive pistol (for a huge robot) or a tiny rifle (for a miniature alien). However, if built for human-sized users, most beamers are well under a pound, most pistols are 0.5 to 4 lbs., and most rifles are 5-15 lbs., with cannons anywhere from a little bit to a lot heavier.

Beamer: The weapon is handheld but has no stock or handgrip and no special aiming systems. These include small holdout or "flashlight" weapons, laboratory devices, and cutting tools. This reduces Accuracy but lowers Bulk.

Pistol: The weapon uses a pistol grip.

Rifle: The weapon is a carbine or rifle format with a shoulder stock and grip.

Cannon: The weapon is heavy weapon designed to be mounted on a tripod or installed in a turret or other weapon mount.

Example: The Vega Machine Pistol is, unsurprisingly, a pistol.

Weapon Statistics

Determine the weapon's full combat statistic block.

Damage

Record the dice of damage chosen for the weapon.

Indicate the armor divisor, if any, in parenthesis: (2) for laser, (3) for rainbow laser or pulsar, (5) for blaster or X-ray laser, (10) for graser, or infinite for a graviton beam.

Record the damage type: burn for laser, rainbow laser, blaster, neutral particle, X-ray laser or graser; cr for graviton, force, or pulsar.

Record any damage modifiers: dbk for force, sur for blaster; ex, rad, and sur for pulsar; rad and sur for neutral particle beam.

Example: As the Vega Machine Pistol is a pulsar with 7d damage, the damage is recorded as 7d(2) cr ex rad sur.

Accuracy

Use the Accuracy Table (below) to determine Acc based on beam type and configuration.

Rounding Damage

When recording partial damage, convert it to dice plus adds as detailed below:

Damage Under 1d: 0.01-0.32 = 1d-5; 0.33-0.42 = 1d-4; 0.43-0.56 = 1d-3; 0.57-0.75 = 1d-2; 0.76-0.95 = 1d-1; 0.96+ = 1d.

Damage 1d-12d: 0.14- = no modifier, 0.15-0.42 = +1 damage, 0.43-0.64 = +2 or +1d-2, 0.65-0.85 = +1d-1, 0.85+ = +1d.

Damage 12d+ (Optional): Record damage as 6d × Nd, where Nd is number of dice / 6, rounded to nearest whole number. Ignore adds.

Accuracy Table

Beam	*Beamer*	*Pistol*	*Rifle*	*Cannon*
Blaster	3	5	10	15
Force	3	6	12	18
Graser	3	6	12	18
Graviton	3	6	12	18
Laser	3	6	12	18
Neutral Particle	3	5	10	15
Pulsar	3	5	10	15
Rainbow Laser	3	6	12	18
X-Ray Laser	3	6	12	18

Example: The Vega Machine Pistol is a pulsar with pistol configuration, so it is Acc 5.

Range

The weapon's half-damage and maximum ranges depend on the focal array and dice of damage. Use the formula below. Round range to two figures, e.g., 175 becomes 180.

1/2D Range (yards) = D × D × Rb × Rf.
Max Range (yards) = 1/2D × 3.

D is the dice of damage.

Rb is 8 for pulsar, 11 for force, 32 for blaster or neutral particle beam, 40 for laser, 56 for rainbow laser, 100 for graviton, 2,000 for X-ray laser, or 6,000 for graser.

Rf is based on the focal array: 0.1 for tiny, 0.3 for very small, 0.5 for small, 1 for medium, 2 for large, 4 for very large, or 8 for extremely large.

Example: The Vega Machine Pistol's 1/2D range is based on its 7d damage, pulsar beam, and very small focal array: $7 \times 7 \times 8 \times 0.3 = 117.6$ yards, rounded to 120 yards. Max range is $120 \times 3 = 360$ yards.

Rate of Fire

Choose a RoF based on the weapon's beam generator and record it.

Single shot must have RoF 1.
Semi-auto may have either RoF 2 or 3.
Light auto may be given any RoF from 4 to 10.
Heavy auto may be given any RoF from 11 to 20.

Example: The Vega Machine Pistol is light auto, so we can choose RoF 4 to 10. We choose RoF 10.

Shots

Weapons are powered by power cells, as listed on p. UT19. Decide how many cells the gun will use and their class and TL (usually the same as the weapon's TL).

The *Shots Table* shows the number of shots that a weapon with 1d damage gets from a single rechargeable C cell of the specified TL; modify this based on the cell type, multiply by the number of cells, and then divide by the cube of the dice of damage. Columns refer to the TL of the *cell* (if that is different from the TL of the weapon). Round the quotient down and record this as Shots.

Superscience cells (p. UT133) are available in some settings; they store five times as many shots. Non-rechargeable cells store twice as many shots.

Shots Table

Weapon	*TL9*	*TL10*	*TL11*	*TL12*
TL9 Laser	225	900	3,600	7,200
TL10-12 Laser	450	1,800	7,200	14,400
TL11 Rainbow Laser	112	450	1,800	3,600
TL12 Rainbow Laser	225	900	3,600	7,200
TL11 X-Ray Laser	112	450	1,800	3,600
TL12 X-Ray Laser	225	900	3,600	7,200
TL10 Blaster	34	135	540	1,080
TL11-12 Blaster	68	270	1,080	2,160
TL10 Force	270	1,080	4,320	8,640
TL11-12 Force	540	2,160	8,640	17,280
TL10 Neutral Particle Beam*	17	68	270	540
TL11-12 Neutral Particle Beam*	67.5	270	1,080	2,160
TL11 Pulsar	135	540	2,160	4,320
TL12 Pulsar	270	1,080	4,320	8,640
TL11 Graviton	14	56	225	450
TL12 Graviton	28	112	450	900
TL12 Graser	28	112	450	900

Cell Type

Type	*Shots*	*Type*	*Shots*	*Type*	*Shots*
A cell	×0.01	C cell	×1	E cell	×100
B cell	×0.1	D cell	×10	F cell	×1,000

* When a neutral particle beam operates in charged particle ("blaster") mode it drains only one-half of a shot.

Example: The Vega Machine Pistol is a TL12 pulsar powered by a TL12 C cell. It would have 25 shots: 8,640 (TL12 pulsar) × 1 (C cell) / 343 (the cube of its 7d damage).

Reloading Time

The reloading time depends on the weight of the heaviest power cell. It is noted in parenthesis after the number of shots.

The reloading time is (3) for A, B, or C cells, or (5) for D or larger cells. However, each cell must be reloaded individually, so a weapon with 10 A cells would actually require 30 seconds to reload all of them.

Example: The Vega Machine Pistol has a C cell, so reloading time is (3). Its Shots are therefore recorded as Shots 20(3).

Weight

A weapon's weight is its empty weight modified by the weight of its power cells. Decide if the weapon's power cells are built into the weapon or stored in an external power pack, vehicle, etc. External power packs don't count toward loaded weight, but do require removing the pack first before the weapon can be reloaded. Use the already-calculated empty weight and the choice of power cells to determine the weapon's loaded weight:

Weight = Empty Weight + PB.

PB is the weight of all power cells built into the weapon, excluding cells stored in a power pack, vehicle, etc. Weight per power cell is 0.005 for A, 0.05 for B, 0.5 for C, 5 for D, 20 for E, 200 for F.

Record the type of power cell after weight; if more than one cell is used, also record the number, e.g., 2C. If the cells are in a power pack append p after cell type.

Example: The Vega Machine Pistol's empty weight was 1 lb. Its C cell (0.5 lbs.) is loaded into the weapon itself, so it weighs 1.5 lbs. Its weight is recorded as 1.5/C. If the C cell had been in an external power pack, it wouldn't count; the weight would be recorded as 1/Cp.

Strength Requirement

Calculate the weapon's ST requirement using the formula below with loaded weight.

Beamer or Pistol ST = (square root of weight) × 3.3.
Cannon ST = (square root of weight) × 2.4.
Rifle ST = (square root of weight) × 2.2.

Round to the nearest whole number.

If weapon is a rifle, append a dagger after ST to indicate two hands are used. If the weapon is a cannon, append M after ST (e.g., ST 20M).

Example: The Vega Machine Pistol is a pistol that weighs 1.5 lbs., so its ST requirement is the square root of 1.5 ×3.3. This is 4.04, rounded to ST 4.

Bulk

Calculate Bulk using the formula below, and express it as a negative number (e.g., 3 becomes -3).

Bulk = (square root of weight) × SB.

SB is determined from the configuration: 1.5 if rifle or cannon, 1.25 if pistol, 1 if beamer.

Round Bulk to the nearest whole number, and tack on a minus sign. However, the minimum Bulk is -6 for a cannon, -3 for a rifle, -1 for a pistol, or 0 for a beamer; the maximum bulk is -10.

Example: The Vega Machine Pistol is pistol configuration. The square root of its weight of 1.5 lbs. is 1.095 × 1.25 = 1.53, rounded to Bulk -2.

Recoil

All beam and laser weapons have Rcl 1.

Cost

Cost depends on beam type, configuration, and weight using this formula.

Cost = Empty Weight × Bc × Gc.

Bc is based on the beam type: $500 for force, laser, or rainbow laser, $1,000 for X-ray laser, $1,500 for graser, $2,000 for blaster or graviton, or $3,000 for pulsar or neutral particle beam.

Gc is 2 for light automatic or heavy automatic beam generators, or 1 for single-shot or semi-auto beam generators.

Example: The Vega Machine Pistol cost is based on its 1 lb. empty weight, generator, and beam type. This is 1 × $3,000 × 2 = $6,000.

As is usual for ammunition, the cost of power cells are not included in the specified Cost of the weapon but must be bought separately.

Legality Class

Calculate the weapon's LC. The basic LC is 4 for force beams, 3 for blasters, graviton, neutral particle beams, lasers, rainbow lasers, X-ray lasers, and grasers, or 2 for pulsars.

Reduce LC by 1 if the weapon weighs 5 lbs. or more (loaded) or by 2 (with a minimum LC of 1) if it weighs over 15 lbs. (loaded).

Ultra-Tech Beam Weapon Options

Laser Options: An ordinary laser built using this system may have the blue-green, blinding-mode, or ultraviolet options added as detailed in ***Ultra-Tech***. Lasers, X-ray lasers and grasers, but not rainbow lasers, may have the pulse laser option (p. UT118). Apply any modifiers for these options after the weapon is fully designed.

Blaster Options: A superscience blaster or neutral particle beam may incorporate the omni-blaster option (p. UT124) at +100% to cost.

Other Superscience Options: Any beam weapon designed using this system may have the field-jacketed, superscience power cell, gravitic focus or FTL options (p. UT133) if desired. Again, apply these modifiers after the weapon is fully designed.

Example: The Vega Machine Pistol is LC2 for being a pulsar. Its weight does not modify this.

Accessories

Every TL9+ weapon has smartgun electronics (p. B278 or p. UT149) at no extra cost. Other accessories from pp. UT151-152 can be added.

Skill Required

Cannon and other mounted beam weapons use Gunner (Beams) skill.

Pistols and beamers use Beam Weapons (Pistol). Rifle-configuration weapons use Beam Weapons (Rifle).

Example: A Vega Machine Pistol requires Beam Weapons (Pistol) skill.

Statistics

Record the standard statistics for the weapon in the usual format, including skill required and defaults. See the table below for stats for the Vega Machine Pistol.

Vega Machine Pistol Table

BEAM WEAPONS (PISTOL) (DX-4, other Beam Weapons-4, or Guns (Pistol)-4)

TL	*Weapon*	*Damage*	*Acc*	*Range*	*Weight*	*RoF*	*Shots*	*ST*	*Bulk*	*Rcl*	*Cost*	*LC*
12^	Vega Machine Pistol	7d(3) cr ex rad sur	5	120/360	1.5/C	10	20(3)	4	-2	1	$6,000	2