
PYRAMID
Issue 3/51 January '13
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by Kenneth Peters
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STEVE JACKSON GAMES
Stock #37-2651

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We never stop investigating. We are never satisfied that we know enough to get by. Every question we answer leads on to another question. This has become the greatest survival trick of our species.

– Desmond Morris

Article Colors

Each article is color-coded to help you find your favorite sections.

Pale Blue: In This Issue
Brown: In Every Issue (letters, humor, editorial, etc.)
Dark Blue: ***GURPS*** Features
Purple: Systemless Features

Cover Art
John Zeleznik

Interior Art
Greg Hyland

In This Issue

In a boundless tomorrow of infinite possibilities, there's one rule that holds fast: You can always use more *stuff*. This month's installment of *Pyramid* returns to the mall of imagination with new marvels (mechanical or otherwise) designed to augment your fantastic futures.

Kenneth Peters, co-author of the ***GURPS*** *Fourth Edition* version of ***GURPS Ultra-Tech,*** brings you more future-perfect goodies in *Ultra-Tech Too*. Discover stats for additional weapons, defenses, and other gear, plus suggestions for updating select rules found in ***Ultra-Tech.*** This feature is tastier than a tube of nanopaste!

Expanding on the information and options in ***Ultra-Tech,*** your favorite dystopian anti-hero can *Live Better With Cybernetics*. Equip your shady black-market surgeons with these optional rules for creating custom cybernetic devices, including appropriate limitations and dozens of sample augmentations.

When the ***GURPS Spaceships*** guidelines for designing giant robots is too detailed, use your exoskeleton to grab *Modular Mecha*. The latest Eidetic Memory offering from ***Ultra-Tech*** co-author David L. Pulver streamlines the process to a quick five steps. Stats for three basic models and several customization features are on the showroom floor, waiting to be walked off.

GURPS Low-Tech contributor Dan Howard brings his expertise in armor systems to the future as he discusses how nanotube technology may revolutionize *Near-Future Combat Uniforms*. Marvel at the utility of nanotubes, and make your own suits (with ***GURPS*** stats) from an array of options, or pick one of the predesigned samples.

Cut the opposition down to size with your mind and *The Psi-Sword*. Presented by ***GURPS Psionic Powers*** author Jason "PK" Levine, this seemingly innocuous object allows psi users to focus their abilities for devastating effects. It includes the damage results for all of the powers in the ***Basic Set*** and ***Psionic Powers.***

Get some ideas of how to tweak existing tech with this month's Random Thought Table, then consider some technological advances you might not have thought of in Odds and Ends. And if all else fails, this month's Murphy's Rules fully supports your efforts to blow up the universe and try again.

Whether you're adding corroded chrome to an imperfect near-tomorrow or outfitting your optimistic explorers in the latest and greatest, this month's *Pyramid* is *geared* to please!

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From the Editor

The Toys Are Back in Town . . .

One of my earliest comic-book memories was of the Supermobile, which was an airplane with fists that Superman flew when he was powerless. It was made of Supermanium. (Look it up online; it's even goofier than I make it sound.) As a child of single-digit age, my mind absolutely devoured that comic . . . and the reason behind it is at the core of why technology is so *cool* – especially for gamers.

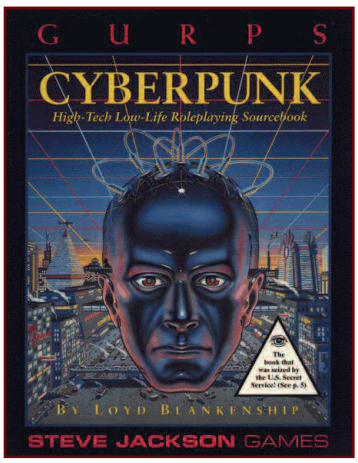
The Supermobile took a hero I already knew and enjoyed (Superman) and gave him new abilities and context to enjoy him in (flying an airplane *with fists*). In the same way, technology allows the addition of new abilities or adventure possibilities to our heroes, without saddling them with an integral part of their being. Admittedly that gets fudged a bit with cybernetics (pp. 12-21), but the principle's the same: Letting the heroes stomp around in ready-made mecha (pp. 23-27) opens up new avenues to excitement . . . and when they tire of it, they can replace or upgrade it to discover new possibilities, without fundamentally altering the heroes inside the tin cans.

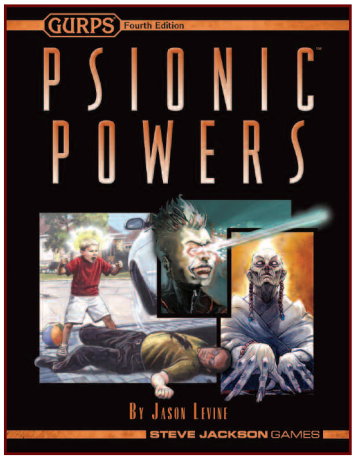
Technological marvels are like passports to adventure, heroic upgrades, and portable plot points – all rolled up into one. We hope this issue of *Pyramid* provides you with many hours of heroic helpers and scenario starters.

> *What an outlandish contraption, Kryptonian!*
>
> *– Amazo, in* ***Action Comics*** *#481*

Write Here, Write Now

Of course, we don't know what effect the unleashing of our technological terrors has upon the world unless you tell us about it! Did our open house of inventive impossibilities rev your engines? Or did any of our ideas blow up on the launch pad? Let us know how were doing privately at **pyramid@sjgames.com**, or join the outspoken super-scientific community at **forums.sjgames.com**.





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Ultra-Tech Too

by Kenneth Peters

The Sandman lived near the garage district, in a decaying crawler with peeling white anti-radiation paint. He was 100 years old (didn't look a day older than 200), stank of Tarrelian Rotgut, and his scraggly beard had more fleas than a tabby lovebot. But he had contacts from Old Terra to New Samarkand, and could peel open a compcore security lockout faster than anyone I knew. I once asked the Sandman where he got his name – it seemed odd for a netrat. Turns out computers were once made from silicon chips instead of collapsed matter.

Fancy that.

– Tisephone Logos, >warangel>heavenweb>solnet

GURPS Ultra-Tech is a catalog of science-fiction technology. It covers a bewildering array of exotic technologies, from hyperspectral sensors to neural interfaces, and includes many devices that blur the line between realistic and fantastic. But it couldn't cover *every* possibility or *every* path that technology could take in only 240 pages!

This article fills in some gaps and expands the wondrous ultra-technology available in ***GURPS Ultra-Tech***. You also should check out ***GURPS Psi-Tech, GURPS Bio-Tech,*** *Pyramid #3/12: Tech and Toys,* and *Pyramid #3/37: Tech and Toys II* for more gadgets and goodies.

The implementation of thermobarics may offer the first major shift in explosives application since the introduction of the shaped charge. If the underlying principles can be understood and consistently controlled, a significant new weapons system or series of weapons systems may become available to the warfighter.

– National Research Council, ***Advanced Energetic Materials***

Core Technologies

Antibiotics. Fission power. Transistors. All technologies that reshaped society. And the future will bring new technologies, new changes to the lives of billions.

Power

Kardashev's calculation of the energy needed to transmit vast quantities of information from more highly developed civilizations to ones less developed led him to postulate the existence of three types of technological civilizations. The amount of energy it controlled determined the type of each civilization.

– George Basalla, ***Civilized Life in the Universe***

Ultra-tech societies are energy-constrained systems. Crafting everyday miracles requires an astounding amount of energy if the society wants to dig ever-deeper into the crusts of planets and asteroids, refine and assemble advanced materials, build titanic artifices to live and travel among the stars, and power the ubiquitous electronics that permeate the very air and bodies of the citizens. See *Civilization and Power* in ***Ultra-Tech*** (p. 21) for examples of power sources that can be tapped at each TL.

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.

Quantum Nucleonic Reactor (TL9^)

Still a promising candidate for a real-world emergent superscience (***Ultra-Tech***, p. 10), 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 (***Ultra-Tech***, p. 20) 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

Briefly, nothing and nobody in the Culture is exploited. It is essentially an automated civilization in its manufacturing processes, with human labor restricted to something indistinguishable from play, or hobby.

No machine is exploited, either; the idea here being that any job can be automated in such a way as to ensure that it can be done by a machine well below the level of potential consciousness; what to us would be a stunningly sophisticated computer running a factory (for example) would be looked on by the Culture's AIs as a glorified calculator, and no more exploited than an insect is exploited when it pollinates a fruit tree a human later eats a fruit from.

– *Iain M. Banks,* ***State of the Art***

In retrotech settings (***Ultra-Tech***, p. 10) 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*.

Hardware

Ultra-Tech never ties specific technologies to higher-TL improvements over modern silicon-based transistor processors. However, for added verisimilitude, here are some possibilities in a conservative or hard-science-fiction setting (***Ultra-Tech***, p. 9):

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).

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.

Storage

Terabytes (1,000 GB) are the standard measure of computer storage for all TL9 ultra-tech computer systems (***Ultra-Tech***, p. 21), with base storage capacity expanding by three orders of magnitude every additional TL. Canny readers may have noticed that this is mostly a cosmetic detail, as only a few entries list storage requirements for their recorded information or databases (e.g., VR environmental databases in ***Ultra-Tech***, pp. 54-55, and the 100-TB requirement for an archived mind emulation noted in ***Ultra-Tech***, p. 220).

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! In other words, experience has shown that people *seek out* novel ways to fill the empty storage capacity in their digital devices and will invent new hobbies, tools, or avenues of research to do so.

Design Switch: Technical Vagueness

Because ***GURPS*** Complexity is only loosely tied to the number of instructions or floating point math operations that can be computed per second – and storage capacity is already set dressing – you may wish to ignore storage requirements entirely. With this design switch, Complexity conflates computational speed and data storage capacity. Complexity 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 often object to role-playing abstractions.

Electromagnetic Hardening

By default, ***Ultra-Tech*** computers have no particular resistance to electromagnetic pulse (EMP) effects produced by nuclear explosions and radiofrequency weapons (see *EMP* in ***GURPS High-Tech***, p. 196, and EMP warheads in ***Ultra-Tech***, p. 157). In some settings, the default assumption is that the use of vacuum tubes, optronics, or nanomechanical systems confers a degree of robustness against electromagnetic interference.

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.

Styling

Replace the *Styling* rules (***Ultra-Tech***, p. 15) with the following, 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.

General Equipment

The equipment in ***Ultra-Tech*** is *personal*. The gadgets are powerful, but they expand the possibilities of character interaction rather than with replacing it with bolts of scientific lightning. However impressive the hardware, it remains a *tool*; built to serve the mind and hand (or tentacle) that wields it.

Foodstuffs

When early versions of Parepin first went into our water supply, the brief outcry was squashed primarily by evoking the horrors of bioterrorism and presenting Parepin as a key defense.

"Would you rather suffer a few mild side effects, or put yourself and all your loved ones at risk of dying a gruesome death?"

I know what my answer was for a long time. I didn't care a bit about being constipated, or twitchy, or losing most of my sex drive, or even risking the occasional "serious" side effect . . . so long as I felt safe.

Combofoods

Advanced technology allows for unusual combinations of tastes that could never be found in nature. These are genetically engineered (TL9) or vat-grown (TL10) foods designed with exotic aromas, flavors, and textures. For example, "alibanas" – tailored bananas with scaly skins that taste like a combination of alligator meat and banana – may be the latest taste sensation that is sweeping the nation!

Fauxfoods

These are foods with no special properties, but are marketed so that many buyers *believe* they do. These are candidates for minor addictions or quirk-level delusions and obsessions. Examples include:

Black Bear Beer: "Taste the bear bile advantage!"
Maas Dreambars: "We imagine for you."
Mars Chocolate: "From authentic Martian spidergoats!"
Orbital Farms Dairy Products: "Low-G means low fat and big taste!"
Technogen Sweetmeats: "Serving up automatic emotion."

Then I met an old friend of mine. He seemed different from everyone else. Sharper. Healthier, even. He told me he'd been off Parepin for four years solid. I didn't believe him at first, but he was very convincing. He said he'd been off Parepin during the northeastern bio-attack in '19 and didn't suffer a thing.

– I Am Trying to Believe, ***Year Zero***

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.

Environment Gear and Suits

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 (***Ultra-Tech***, p. 176). (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.

150 Fathoms Deep

Standard TL9+ diving equipment uses air tanks (***Ultra-Tech***, p. 176) or artificial gill systems that can extract dissolved oxygen from the surrounding water (***Ultra-Tech,*** p. 177). Both of these systems use integrated closed-circuit rebreathers that can function to depths of about 100 yards, using small tanks of mixed-gas diluents to mediate oxygen partial pressure and allow the rebreather lungs to inflate against hydrostatic pressure. They do *not* prevent the bends (p. B435); quick returns to the surface risk death or disablement. Manned exploration of greater depths requires pressurized vehicles or the use of the liquid breathing rig.

For additional information on underwater experiences, see ***GURPS Transhuman Space: Under Pressure*** and the ***GURPS*** *Fathom Five* article in *Pyramid #3/26: Underwater Adventures*.

It's a Feature

For consistency with ***High-Tech***, air tanks and gill systems give Doesn't Breathe (while the air tanks hold out) and No Sense of Smell/Taste. ***Ultra-Tech*** air masks (p. 176) do not suffer from No Peripheral Vision.

Weaponry

I am Light Plasma Projector, model LPP 91, series two, constructed in A/4882.4 at Manufactory Six in the Spanshacht-Trouferre Orbital, Ørvölous Cluster. Serial number 3685706. Brain value point one. AM battery powered, rating: indefinite. Maximum power on single bolt: 3.1 ¥ 8^{10} joules, recycle time 14 seconds. Maximum rate of fire: 260 RPS. Use limited to Culture genofixed individuals only through epidermal gene analysis. To use with gloves or light armor, access "modes" store via command buttons. Unauthorized use is both prohibited and punishable. Skill requirement 12-75%C.

– Iain M. Banks, ***State of the Art***

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.

> *They lowered the handguns reluctantly. Racal IR laser carbines, Greg noted absently, restricted to military sales only.*
>
> *– Peter F. Hamilton,* ***The Nano Flower***

Firearms

Pyramid #3/37: Tech and Toys II contains two articles of particular interest to those with a penchant for ultra-tech ultraviolence: David Pulver's *Blaster and Laser Design* provides a design system for beam weapons, and Mark Gellis' *More Ultra-Tech Guns and Heavy Weapons* adds over two dozen new weapons.

Warheads

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 reaction produces an additional explosion inside the target.

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

Explosives

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 (***Ultra-Tech***, p. 43) for remote triggering. This can be disabled and replaced with a timer (built-in) or optical cable (***Ultra-Tech***, p. 43). $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 (***Ultra-Tech***, p. 89) are standard on all legal explosives. Packaged explosives may also include a homing beacon (***Ultra-Tech***, p. 105) and other failsafe devices.

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 *Standard Explosives Table* (below), 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.

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.

TL	*Type*	*REF*	*Cost/lb.*	*Description*
11	Strained Bond	10	$100	Explosive energy stored in deformed lattice
12	Caged Charge	20	$100	Trapped electron charges

Explosives Tables

Standard Explosives Table

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]

Notes

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

Advanced Explosives Table

TL	*Type*	*REF*	*Cost/lb.*	*Description*	*Notes*
8	CL-20	2.3	$40	Hexanitro hexaazaisowurtzitane	
9	VOMEX	15	$20	Advanced thermobaric compound	[1]
10	Isomers	100	$500	Triggered nuclear isomers	[2]
11	Super Isomer	500	$700	Advanced nuclear isomers	[2]

Notes

[1] 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 4 × distance. Only works in atmosphere.

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

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 explosives listed in the *Advanced Explosives Table* (above) 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.

Explosive Swarms

A one-square-yard collection of swarmbots (***Ultra-Tech***, pp. 35-37) 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).

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. Burning nanoscale thermite 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.

Melee Weapons

Future technology doesn't just lead to deadlier and more efficient ways of killing your enemies at a distance . . . it also gives an edge in down-and-dirty brawls and scrums. Commandos and spies will still carry knives and the like for discrete violence, of course.

Low-Tech Hypertech

To clarify design intent, and bring the ***Ultra-Tech*** physical weapons (***Ultra-Tech***, pp. 163-164) 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).

Additional Melee Weapon Options

The following options can also be applied to ***Ultra-Tech*** melee weapons. Many melee weapons are also styled (p. 6), especially if they are ceremonial (such as the swords carried by modern U.S. Marines) or coveted tools.

Balanced: +1 to skill. Multiply cost by 5.

Nanomaterials: This blade-composition option is available at TL9. A nanomaterial weapon uses advanced composites and metal laminates to create blades that are lighter, stronger, and hold an edge better than steel. Halve weight, and double cost. Use the *original* weight of the weapon when checking for breakage. Most nanomaterial weapons are also very fine or superfine.

Poorly Balanced: -1 to skill. Multiply cost by 0.5. Mutually exclusive with balanced.

Vibrowire Blade: This is a blade-composition option, available at TL10^. It combines vibroblade technology with small monomolecular cutting teeth, with effects similar to a chainsaw – it is *not* an elegant weapon! Vibrowire blades add +2d to cutting damage, with a (5) armor divisor, or (10) if superfine. If it fails to penetrate the DR of the target, immediately check for weapon breakage. A broken blade whips around and strikes the wielder for 2d(5) cutting damage. Vibrowire blades cost 30 times as much as regular melee weapons.

Ultra-Tech Swashbuckling

Those with a taste for swordplay may wish to stack the deck in favor of melee weapons by carefully selecting situations and technologies to encourage their use over firearms in their campaigns.

Law and Custom

I, Mark Phellius of the Independent Republic of New Samarkand, given the insult to my word and honor, demand satisfaction from Phi'kl'ataraph of the N'kan Empire by blood and blade.

Legal codes or social customs, enforced by sophisticated detection systems, make it a felony or *very* bad manners to carry a firearm, but self-defense laws still allow bladed "tools." Strongly hierarchical societies may permit different lengths and type of weapon depending on Social Status. This allows plenty of opportunity for knife or swordplay, especially if honor duels and other flashy displays of martial skill are tolerated.

Environment

Warning! *Assault cannons are prohibited aboard the New Hawai'i station. Defense Force personnel have been dispatched to your position to ensure that you place your weapons in our armory until you depart. Thank you, and have a nice day!*

Campaigns set in environments where a stray shot could prove catastrophic – such as aboard a starship, space station, or domed city – will almost certainly outlaw the classes of ranged weapons preferred by adventurers. However, they may still permit melee weapons for self-defense. Of course, less-than-lethal weapons (such as stunners) might be able do a similar job, but where's the fun in *that*?

Special Protection

Woe! Only a slow moving mass can penetrate the Overlord's Shadowfield! If only there was some way to still injure him through the direct application of kinetic energy. But what weapon could perform such a miraculous task when our hyperdarts, quasar beams, and nucleonic explosives have failed?

Superscience armor materials may protect against ravenous energy beams, hypervelocity projectiles, and crushing explosions . . . but be entirely bypassed by an expertly aimed blow at an almost invisible gap. Alternatively, if force field defenses (***Ultra-Tech***, pp. 190-193) exist, a common science-fiction trope is that they may only be built with the energy or velocity option. If so, relatively slow-moving melee or thrown weapons may ignore them, leading to a return of close-range combat.

Defenses

Bryan's hands kept feeling up and down the coat, hands searching for any sign of the bullet impact, but the fabric felt normal. "What the hell is this made out of?"

"The core is a layer of shear-thickening fluid," Adam said. "It's sandwiched on either side by nanocomposite and fronted by spider-silk protein fiber-matrix."

*"Nanocomposite? **Spider-silk?** What are you, a mad doctor or something?"*

"He's not mad," Alder said. "But he is a doctor. Thrice over. My grandson holds doctorate degrees in physics, metallurgy and medieval history."

*– Scott Sigler, **Nocturnal***

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

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 (***Ultra-Tech***, p.171) 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 now 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 the skin or clothing. Cerablate is a *semi-ablative* material (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 (***Ultra-Tech***, p. 174). LC3.

Technological Buzzwords

Coming up with plausible-sounding technical jargon can be a daunting task, especially in cinematic settings where strict scientific accuracy and consistency are not important. In these cases, the GM can use the following chart to quickly come up with sources for vexing plot-related malfunctions and name exotic new components.

Roll 2d three times, once for each column. Put the results together and you have a new term! The results may not make a lot of sense, but that's never stopped science-fiction authors and television scriptwriters in the past . . .

Result	*Roll 1*	*Roll 2*	*Roll 3*
2	Quantum	Flux	Catalyst
3	Muon	Polarity	Converter
4	Plasma	Induction	Generator
5	Nano	Containment	Grid
6	Energy	Displacement	Field
7	Resonance	Imaging	Device
8	Hyperspectral	Routing	Chamber
9	Digital	Space-Time	Accelerator
10	Antimatter	Subspace	Coil
11	Thermal	Radiation	Crystal
12	Multiphasic	Conversion	Initiator

Multiple Optics (TL9)

Helmets built without a faceplate (***Ultra-Tech***, p. 187) can use distributed optical sensors. This provides the advantages of No Eyes due to multiple redundancies. The extra cameras cost $500.

About the Author

Kenneth Peters is a scholar and a gentleman, with a fine education in both anthropology and spatial analysis. He is the co-author of ***GURPS Ultra-Tech*** and has contributed to a number of other technology-related ***GURPS*** volumes. He is happily employed as a professional student in Idaho, working on novel ways to predict radioisotope concentrations in heterogeneous environments.

Syna exploded through the door and plowed into the soldier, shoulder first. The Tse fell back and tried to bring his autofléchette to bear, but Syna already had her monoblade in hand. She pulled back on the blade's activator and the monomolecular edge of the sword blurred into the life. The soldier blanched at the characteristic shriek of the blade, and she could see him mouth the weapon's feared nickname – ***screamsword.***

– J.C. Hay, ***Heart and Minds***

Live Better With Cybernetics

by Demi Benson

Cyborgs are humans (or other animals!) with machine parts either added to or replacing existing body parts. These machine parts (or cybernetics) can be broadly categorized as *implants* (discussed on pp. 13-15) and *bionics* (described on pp. 15-21). See ***GURPS Ultra-Tech*** (pp. 207-208) for more information about features, repairs, and installation procedures.

Surgery

The surgeries for replacing an organic body part with a bionic replacement are described in ***Ultra-Tech*** (pp. 207-218). The surgery for replacing an existing bionic with another bionic is at least one step easier; replacing a bionic limb with another bionic limb is thus a simple procedure. If both the new and old bionics are detachable, no extra surgery is required. Some entries list the procedure in terms of a basic bionic (e.g., a micromanipulator arm lists "bionic hand procedure"), indicating that to acquire such a bionic, the user must either have an existing bionic and buy a replacement with the upgrade, or get the basic procedure and arrange for the new bionic to include the upgrade.

The surgical techniques for bionic and implanted devices improve at later tech levels. Unless otherwise specified, reduce the difficulty of a surgery by one step every two tech levels after the device's introduction (but no lower than "simple"). Use the best TL of the culture's medical science, biotechnology, or wet nanotech.

Costs may be lower for particularly common procedures (implant radios), or higher for those that are rare ("You want me to put *what* in your chest?!").

Likely Disadvantages

Any abilities improved above the racial baseline, whether bionics or implants, should be bought with some combination of Temporary Disadvantages such as Electrical, Unhealing (Total), or Maintenance (1 person, weekly, *or* monthly). However, advanced cybernetics and bionics might not have any of those! Electrical-system hardening can remove Electrical (or assume a +10 bonus instead of total immunity). Superior energy storage and self-repairing systems might remove Maintenance. Technology based on bioplastic or living metal can remove any of them. See *Mitigators* (p. 16) and *Maintenance* (p. 16) for further discussion these aspects, plus *Variant Equipment* for customization suggestions. Although those section specifically address bionic issues, some ideas are applicable for implants.

Cost Factor

To handle multiple modifications to a single device more effectively, use a "cost factor" (CF), instead of a straight multiplier. For existing modifications, convert the multiplier to a cost factor by subtracting 1. New modifications presented in this article include appropriate cost factors. Next, decide which modifications apply to the implant or bionic and total all relevant CFs. Then, multiply the desired cybernetic device's listed cost by (1 + total CF). If total CF is below -0.8, treat it as -0.8; thus, final cost cannot be below 20% of base cost.

Armoring Cybernetics

As machines of metal, plastic, and ceramic, bionic replacements have inherent DR that can be improved with purpose-built armor. Most implants do not have inherent DR, because of fragility, small size, diffuse nature, or flexibility requirements. Bionic hearts, gill implants, hive implants, and ripsnakes are rigid and compact enough to be armored. Count them as extremities for armoring purposes.

Rigid Armor

All rigid cybernetics can be armored beyond the free DR 2 they get as machinery. The normal maximum DR that can be built-in is equal to the crippling threshold (pp. B420-421) of the replaced part in HP times (TL-8). For each additional level of Unnatural Features (up to 5), add +1 to effective TL. Increased rigid armor supersedes the DR that comes with basic bionic limbs.

Example: A TL9 bionic arm for an average person can be armored to DR 5 without attracting notice, while the TL12 version can have DR 20. The same TL9 arm with Unnatural Features 2 can have DR 15, but *looks* heavily armored.

At TL9, rigid armor costs $80 and weighs 1.6 lbs. per point of DR for whole-body coverage; reduce cost and weight to the fraction covered for that bionic part. At TL10, the armor is $50 and 1 lb. per point; at TL11, $40 and 0.8 lbs; at TL12, $25 and 0.5 lbs.

Flexible Flesh-Like Armor

Realistic flesh biomorphics can be made with tougher material – up to half the maximum DR of equivalent rigid parts (above). Realistic flesh biomorphics have Semi-Ablative and Flexible. Living flesh and synthetic organs can have up to 1/4 DR of equivalent rigid parts; these versions have Ablative and Tough Skin.

Flexible flesh-like armor is a weak form of dermal armor; don't combine them with real dermal armor (see *Pyramid #3/12: Tech and Toys*, p. 11, for the results of more than one layer). This type of armor should be purchased as lightweight partial suits of flexible armor (***Ultra-Tech,*** pp. 172-174) appropriate for that TL.

Bionic limbs *can* have both rigid internal armor and flesh-like external armor. Bionic eyes can only have rigid armor.

Implants

Implants are machines added to living tissue to enhance natural abilities or bestow new ones. Many implants are too complex to be fully manipulated by conscious thought; these are often controlled by an internal computer system with a much simpler interface usable by the cyborg. Implants either perform a function on the user (like an intestinal recycler or psych implant), or perform an action for the user (like an implant radio or computer implant).

Implanted Gadgets

Many external devices can be implanted into living bodies. Tiny implants are powered by the user's motion, body-heat gradient, or nanomachines consuming blood sugar. Any implanted gadget that uses a B cell or larger probably needs real power cells and an access port to change them or the bio-power tap (p. 14). Cybernetics located in the torso can have their power-cell port or charging socket located between two ribs and covered by synthetic flesh.

Tiny cybernetics implants (less than 0.05 lb.) can be placed anywhere in the body. Small ones (0.05-0.25 lb.) should be anchored to bones (ribs, a spinal disk, skull, pelvis) to prevent internal lacerations from hard acceleration like falls, slams, or high-G maneuvers. Medium-sized implants (0.25-1 lb.) should be suspended in the body on shock mounting or distributed into multiple pieces around the body. Larger implants (larger than 1 lb.) almost always should be distributed into smaller pieces. Double all devices' weights to account for the bio-compatible shell and added internal support structures and any access ports for data cables, ammunition, or power cells. Many sensors can be built as distributed arrays in the same manner as ladar smartskin (***Ultra-Tech*** p. 64), taking up negligible internal space, but with added weight.

Most simple implants count as an Accessory perk. However, some may be versatile enough or the user is so familiar with them that they may be better represented as full advantages. See *Perks vs. Powers* (below) for more discussion on these options.

Basic implantation has +2 CF and is a minor procedure that gives the device push-button activation (e.g. pushing on a biomonitor to activate the screen, or tapping on a subdermal printed computer). A device implanted just below or in the skin that doesn't require precise placement is typically -1 CF, and the surgery is one step easier than if it were placed elsewhere. If the device has a reflexive muscle trigger to turn it on and off (like cyber-claws) add +1 CF, or +2 CF if its function can be dialed up and down like a dimmer. If it requires biometric, positional, or physical feedback from the body (like an autoinjector, or the radar skin on p. 14), include +1 CF.

To send to *or* receive from an existing simple sense (like hearing or basic skin pressure) is +4 CF; +8 CF for complex information (like vision or the full sense of touch); or +12 CF for any number of senses. To both send *and* receive via an existing sense, add half again the CF (an extra +2, +4, or +6). To send non-human sensory information via another human sense (e.g., sensing magnetic field density via simulated tactile pressure) is also half again the CF of the target sense. Interfacing with complex senses is a major procedure and probably requires eye or brain surgery.

Perks vs. Powers

Most implanted gadgets can be bought with an Accessory perk – for example, Accessory (Radio) [1]. The perk means the gadget has some plot protection and is almost always available. Since it's only a perk, the item it represents must still be used in the regular manner. Thus, a built-in radio would still need a Ready action before use or when adjusting any controls.

With enough practice or when particularly beneficial, some implants can become or be taken as full-fledged advantages. They're used like inborn abilities, allowing their full use without taking Ready actions, such as an implant radio that provides Telecommunication (Radio) [10]. When taken as an ability, the advantage has total plot protection and is always available, barring its own limitations. Because it's a built-in ability, it doesn't require Ready or Concentrate actions to use unless limitations indicate otherwise, such as a built-in radio that can frequency hop or change bands with a thought. See also *New Limitation: Cybernetic* (p. 17) for a limitation on advantages suitable for implants or bionics.

Most cybernetic devices start off as Accessories, and are bought up to more complex advantages to reflect the cyborg internalizing the ability.

To transmit information from the device to the user via surface thoughts is +8 CF, or +18 CF to include full two-way communication. Both versions need major brain surgery procedures and cannot be performed until TL10.

A device that must use an implant computer or implant radio instead of linking directly to a brain is only +2 CF. However, the implant computer or radio must be acquired separately.

If the cybernetic system requires modifying most of the body (for example, the skin, all nerves, or all blood vessels) rather than a simple implant, increase the surgery difficulty by one step.

Oh, and Marty, be careful around that Griff character. He's got a few short circuits in his bionic implants.

– Dr. Emmett Brown,
Back to the Future II

New Implants

For additional implants, flip through pp. 208-218 of ***Ultra-Tech.*** List costs include the CFs presented in the following descriptions.

Autoinjector Implant (TL9)

A biomonitor autoinjector (***Ultra-Tech*** p. 197) implanted in the torso. This is not under the user's control. Instead, it triggers based on physiological conditions. The refill/interface device is $100, 0.5 lbs. LC4.

Statistics: Accessory (Autoinjector) [1]; Accessory (Biomonitor) [1]. *2 points*.

Availability: Minor procedure (simple at TL11-12). $400. LC4.

Bio-Power Tap (TL10)

An implanted flexible power cell and electric trickle-charger powered by the user's blood sugar using the same technology as gastrobot power supplies (***Ultra-Tech*** p. 36). Unlike the ones for tiny implants, this produces enough energy to charge larger power cells. However, it requires the user to consume significant quantities of food. Higher TL taps are more efficient, but higher TL power cells hold more energy. A bio-power tap can charge a C cell of its own TL in one day at TL10, three days at TL11, and 10 days at TL12.

This device powers bionics or implants, including those that would otherwise require removable power cells, such as the gill implant (***Ultra-Tech*** p. 213).

Statistics: Accessory (C Cell) [1]; Internal Create 1 (Electrical Energy; Temporary Disadvantages, Electrical and Increased Consumption 1, -20%) [4]. *5 points*.

Availability: Minor procedure (simple at TL12). $4,000. LC4.

Deflector Arm (TL11^)

A force shield bracelet (***Ultra-Tech*** p. 192) implanted (+2 CF) in the forearm (replacing the ulna) with a basic muscle trigger (+1 CF). Uses Shield skill, not Shield (Buckler). Represent this as Accessory (Force Shield) [1] if it requires a Ready maneuver and conscious use; otherwise, use the stats below.

Statistics: DR 100 (Hardened 1, +20%; Directional, Front and Shield-side, -10%; Electrical, -20%; Maximum Duration, 30 minutes, -25%; Requires active defense, -40%) [125] + Defense Bonus* 3 (Electrical, -20%; Maximum Duration, 30 minutes, -25%) [50]. *175 points*.

Availability: Minor procedure. $6,000, B/30 min. LC3.

* Combines Enhanced Block, Dodge, and Parry.

Radar Skin (TL10)

An array of subcutaneous radar emitters and receivers distributed throughout the body. Built as three small multi-mode radar arrays (for 360° coverage; ***Ultra-Tech,*** pp. 64-65) implanted (+2 CF) throughout the body with positional feedback (+1 CF and difficult surgery). It also has two-way mental communication (+18 CF) and a one-way full sensory output (+12 CF) which overlays its map in the visual field with hearing and touch as secondary sub-channels. Bearing and range to target comes as subconscious knowledge thanks to the two-way mind interface.

Statistics: Radar (Extended Arc, 360°, +125%; Low-Probability Intercept, +10%; Maximum Duration, 8 hours, -5%; Multi-Mode, +50%; Targeting, +20%; Temporary Disadvantage, Electrical, -20%) [56]. *56 points*.

Availability: Major brain procedure. $102,000, 3B/8 hrs. LC3.

Skin Remote (TL9)

A 3" by 5" surface typically placed in the forearm or thigh, mainly used as an ever-present interface to better computers or as a universal remote. This tiny computer has compact and printed options (***Ultra-Tech,*** pp. 22-23). It is implanted with push-button controls (+2 CF) in the skin (-1 CF, easier surgery). It aso a radio microcomm, with the same implantation (total +1 CF) but only accessible via the computer (+2 CF).

Statistics: Accessory (Printed computer) [1]. *1 point*.

Availability: Simple procedure. $240. LC4.

Sound Projector (TL9)

A small sonic projector (***Ultra-Tech*** p. 52), implanted (+2 CF) in the bridge of the nose with a tunable muscle activation (+2 CF). It beams the user's speech directly ahead of him.

Statistics: Accessory (Sonic Projector) [1]. *1 point*.

Availability: Minor procedure. $250. LC4.

Water Vapor Lungs (TL10)

This vapor collection system is similar to that of a vapor canteen (***Ultra-Tech*** p. 76). Its collection vanes are spliced into the lungs, pulling moisture from both inhaled and exhaled air and feeding it into the bloodstream. An automated shutoff stops collection if the user is already well-hydrated. Adds +2 (quality) to Survival skill where potable water is not abundant. Collection rate and power use are the same as the vapor canteen.

Statistics: Doesn't Eat or Drink (Accessibility, Requires humidity, -10%; Temporary Disadvantage, Electrical, -20%; Water Only, -50%) [2]. *2 points*.

Availability: Major procedure (minor at TL11-12). $2,000. LC4.

Wonder Glands (TL9)

This upgraded version of the encapsulated cell implant (***GURPS Bio-Tech,*** p. 120) includes a specialized, programmable biomonitor that releases a dose when certain conditions are met. Any of the drugs from ***Bio-Tech*** (pp. 148-161) or ***Ultra-Tech*** (p. 205) are appropriate; the usual choice is Ascepaline or Hyperstim, triggered if the subject is badly injured (HP 0 or worse) or unconscious.

Wonder glands typically dispense drugs that must be administered immediately, such as combat enhancers or emergency healing drugs, although some people use them for lifestyle chemicals. This implant can also be used to refill the drug and poison reservoirs of stingers (***Ultra-Tech,*** p. 211) and similar weapons.

Statistics: Any advantages or disadvantages granted, modified to fit the dosage requirements and triggering criteria. Aftermath, Limited Use, Takes Recharge, and Trigger are all appropriate modifiers.

Availability: Minor procedure (simple at TL10-12). $500 plus a microbe culture worth the cost of a single dose at LC4, multiplied by 10 for every LC lower. LC is that of the drug released.

Bionics

Bionics are machine replacements for living tissue, bones, or organs. They may be simple stand-ins that perform the same function, but no better than the original (with any benefits outweighed by the drawbacks). Alternatively, they can be significant improvements on the original, offering high strength, incredible toughness, and superhuman improvements.

Basic Statistics

Bionic replacements are assumed to be about the same size and weight as the body part they replace. By default, they are *sculpted* (see *Biomorphics*, ***Ultra-Tech,*** p. 28); while they have an obviously artificial appearance, it does not fall within the "uncanny valley" and so does not (normally) count as an Unnatural Feature (p. B22). Some replacements might qualify as Distinctive Features.

Bionics are also lightly sealed to keep out everyday dust and water, such as from walking in the rain or swimming. However, unless the ability is added at extra cost, they are not sealed enough to resist driving sand storms, vacuum, or ocean depths.

Certain changes in various features – such as ST that varies from the racial average and unusual SM – include cost modifiers. These price changes are an adjustment to the base cost, not a CF – apply all of them before adding the CF from any modifiers.

Body Parts

Bodies come in all sizes and shapes. General fitness and musculature have a big influence on distribution of body weight. While this is by no means a comprehensive chart, it will serve as a gameable approximation of weight distribution.

Body Section	*Percentage of Body Weight*
Head	6-9%
One Eye	6-8 gr (about 0.0132-0.0176 lbs.)
Torso	39-60%
One Hand	0.6-0.8%
One Arm and One Hand	5-6%
One Foot	1.3-1.6%
One Leg and One Foot	15-20%

Variant ST

Bionic limbs and extremities must be matched to a user's body. The bionic limbs listed in ***Ultra-Tech*** are for an average human (ST 10) – stronger or weaker limbs cost more or less than the base model. For every point of ST above 10, increase the price of the limb by 10%. For every point of ST below 10, decrease the price by 5%. Any ST increase above +2 should take the Unsupported Strength limitation (***Bio-Tech,*** p. 215) unless braced by equally strong bionic legs ***Ultra-Tech*** (pp. 209-210) and spine (p. 21).

How Much Metal?

Bionic replacements take up the whole body part and part of the attaching joint. Fingers include the knuckle leading to the palm. Thumbs include a section of the hand. Hands include the wrist and part of the forearm. Arms include the shoulder. Feet include the ankle and part of the lower leg. Legs include the hip and part of the pelvis. Eyes include at least some of the socket and musculature. Ears can be entirely internal, or might have noticeable external components.

Basic Bionic Arms and Hands

The bionic arms in ***Ultra-Tech*** (p. 209) are listed with +2 ST, and the bionic hand on the same page has +1. Without the extra ST, a single bionic arm for an average human costs $10,000 and is worth 0 points; a basic bionic hand is $7,000 and -2 points.

ST and Distinctive or Unnatural Features

Users can have bionic limbs with different ST than their body's ST. Up to two levels of ST (or +/-20% of racial average, for other races) in either direction falls within normal variance. The bionic arms listed in ***Ultra-Tech*** (p. 209) already include that +2 ST bonus. Any further difference gives Unnatural Features 1 for every 20% difference from racial average. Higher TLs also allow hidden strength augmentation of +1 ST per TL above TL9. Thus, a TL12 bionic arm for an average person can have ST 15 and still look normal, but a TL9 version would give Unnatural Features 2 for being over the +20% threshold.

Obviously artificial limbs don't incur Unnatural Features, but could qualify for Distinctive Features instead.

Biomorphics

External bionics use the biomorphic lenses in ***Ultra-Tech*** (p. 28). Basic ones are simply sculpted. See also *On the Cheap* (p. 17) and *Decorations* (p. 17).

Odd-Sized Limbs

In a human-centered setting, limbs for people of different SM may cost more due to rarity. At TL9, limbs larger than usual are +25% cost per SM larger; limbs smaller than usual are +10% cost per SM smaller.

At higher TLs, odd-sized limbs may be more common or easier to design and build. At TL10, ignore one SM of difference; at TL11, ignore two; at TL12, ignore three. Odd-sized limbs should also buy the base ST up or down to match natural limbs at the usual cost.

Significant size changes affect the amount of concealable armor a limb can have (see *Armoring Cybernetics*, pp. 12-13). Multiply maximum DR by 2/3 per SM smaller than SM 0, and by 1.5 per SM larger. Use a factor of 2 for SM difference of 2.

Integrated Gadgets

Not all of a bionic's volume is taken up with machinery. Small weapons or simple gadgets (those with one or two functions) can be built into replacement parts. These gadgets must be designed into and integrated within the bionic device – they can't be added to an existing bionic, and are nonfunctional if removed. Integrated gadgets add a CF of (12-TL) squared.

The maximum supported size of integrated gadgets is based on the BL of the *original* body part. Cybernetic fingers and thumbs can support BL/300 each, hands can support BL/30, arms can support BL/6, feet can support BL/10, and legs can support BL/2. If the bionic has any modifiers, divide the above value by the weight modifiers listed on the *Cybernetic Modifiers Table* (p. 17). For example, a cheap bionic has less space available, while an expensive one has more space. Although the actual weight of the integrated gadget is lower as it doesn't have any casing, structural members, or interfaces, use the gadget's original weight (modified as per *TL Improvements,* below) to decide whether it can fit in a desired bionic. Assume any gadget with "neg." weight are actually 0.001-0.01 lbs. each.

Complex gadgets or ones bonded onto a bionic still require external controls and a free hand to operate. These types should use the *Combination Gadgets* rules in ***Ultra-Tech*** (p. 16).

Integrated weapons lack sights (but see *Gunsight,* p. 18), and weapons in lower limbs will be very awkward. The maximum Acc for an index finger mount is 6, a middle finger mount is 4, all other digits are 2, a hand or arm is 3, a foot is 1, and a leg is 0. Double the maximum Acc for beam weapons.

Integrated gadgets and weapons *do* cost points. Many gadgets are simply Accessory perks while some are advantages (see *Perks vs. Powers,* p. 13, for a discussion of this distinction). Weapons should be built as Innate Attacks (p. B61).

Unusual Shapes

Most bionics will be designed and made for the dominant species (humans in most settings). Bionics made for other species will cost more depending on their rarity. Bionics for common species (dogs, horses, common aliens on a human-owned space station) or ones similar to humans (chimpanzees) would add +4 CF. Those for a rare species (elephants, dolphins, alien visitors to Earth) would add +19 CF. For exotic species (octopuses, newly discovered aliens), the devices would have to be specially built. Modify for different ST and SM as usual.

Mitigators

Replaced body parts should give the appropriate crippling disadvantage (One Arm, Legless, etc.) with the Mitigator limitation. ***Ultra-Tech*** (p. 207) specifies the -70% version, and states that it includes the effects of Electrical, monthly Maintenance (see below), and Unhealing (Total).

Cyberwear that doesn't need monthly Maintenance, that doesn't have the drawbacks of Electrical, or is capable of self-repair and thus not Unhealing is a Mitigator worth -80%. If it has two of these benefits, it is a Mitigator worth -90% (ignore the usual -80% cap when dealing with disadvantages). If it has all three, it is as good as the thing it replaces, so simply get rid of the disadvantage altogether.

See also *New Limitation: Cybernetic* (p. 17) for a limitation on bionic- or implant-related advantages.

Maintenance

Replacement limbs usually have the Maintenance limitation on advantages, which should be incorporated into the Cybernetic limitation (p. 17), if that option is being used. This maintenance represents the need for regular cleaning, swapping power cells, topping up lubricants, and so on. By default, this requires an hour's worth of *skilled* attention at the stated frequency. The GM may permit exchanging this for *unskilled* labor at a higher frequency or longer duration. Rather than "1 person, weekly," either "1 unskilled person, daily" or "1 unskilled person, 8 hours, weekly" could be used for cyberlimbs that need removing power cells and running it through an automated cleaner, or just a bit of brushing off but longer recharging periods. If the limbs last a long time between cleaning, don't have consumable parts, and have batteries that can be swapped or charged quickly and easily, then replace Temporary Disadvantage (Maintenance) in all cyberlimbs with a single quirk, "Cybernetics require occasional maintenance," and reduce the effect of the Mitigator limitation as described in *Mitigators* (above).

TL Improvements

Better materials and cheaper fabrication means all bionics improve with TL. Each TL after introduction reduces the cost of a bionic by 20% and the weight by 10%. The weight savings can be used directly for hidden compartments (***Ultra-Tech,*** p. 211) or integrated gadgets (see above).

Variant Equipment

Cybernetics can come in a variety of qualities, toughness, and styling. Some of these features modify the device's HT rolls (when hit with surge attacks, rolling vs. crippling, and so on). Some affect the weight and DR of those devices that have non-negligible weight, such as bionic limbs. Treat weight changes as a 0-point feature, but enough heavy ones might justify Cannot Float [-1].

The *Cybernetic Modifiers Tables* (below) lists common alterations made to equipment along with their CF and their effect on the device's HT, weight, and DR. Some of these modifiers require further explanation. For additional information on cheap, expensive, rugged, and styling modifiers, see *Ultra-Tech* (p. 15).

On the Cheap

Cheap bionics may have poor-quality interfaces, which would give Numb (Partial). Cheap manufacturing makes the bionic larger and heavier; such shoddy design is also ugly, removing one level of Appearance (p. B21) in the same way as One Eye (p. B147), at the GM's option. See also *Cheap Hands* (p. 19) for more notes on low-quality equipment.

Downgraded optics may be available. Cheap-quality ones are larger and heavier, and might be so much bigger that they need more space than an eye socket has. Such bionic can be ugly or disturbing (bulging out of the socket) or designed with a modicum of aesthetics.

Durability

Fragile bionics reduce the device's HT, while tough and rugged devices improve HT. A surge-protected item is immune to electrical disruptions.

Decorations

Use decorations (***Low-Tech,*** p. 38) only for *obvious* cybernetics. Sculpted biomorphics can be highly decorated. These count as styling (***Low-Tech,*** p. 14) for purposes of reaction rolls (p. B494) and Influence rolls (p. B359) in certain circumstances. Whether the bonus comes from diamond-studding and gold-plating, or the sleek ultra-minimalist look of top fashion designers is up to the players and the GM.

Cybernetics with Unnatural Features might be unstylish. Mannequin and semi-sculpted sit right in the middle of the uncanny valley. When noticed, they reduce Appearance by one level (mannequin) or two levels (semi-sculpted) for whole-body biomorphics, or half that if the face and torso are still living flesh.

Detachable

Bionic limbs and eyes can be designed for easy removal from the body, leaving only a modular socket with the cybernetic interface. This is useful for easy repair and maintenance, and it also allows the creation of a modular cyborg whose parts have many different options which he exchanges depending on the situation. Only pay for the highest point-value bionic part that can fit in a particular socket. There are two levels of detachability:

Detachable without tools: The bionic simply snaps into or out of its housing. It can be removed in five seconds and attached just as easily. +0.1 CF.

Detachable with tools: The bionic requires electronics tools or a mini-tool kit to remove, but is still relatively simple. Removal takes 10 minutes and requires an Electronics Operation+3 (cybernetics or medical) skill roll. Failure means another try and more time. Critical failure disables the device, requiring repairs before it can function. +0.05 CF.

Cybernetic Modifiers Table

Quality	***CF***	***HT***	***Weight***	***DR***	***Notes***
Cheap	-0.5	+0	x1.5	x1	[1]
Cheap (Numb)	-0.5	+0	x1	x1	[2]
Basic	+0	+0	x1	x1	
Expensive	+1	+0	x2/3	x1	
Durability	***CF***	***HT***	***Weight***	***DR***	***Notes***
Fragile	-0.25	-2	x1	x0.5	
Tough	+0.5	+1	x1.1	x1.5	[3]
Rugged	+1	+2	x1.2	x2	[4]
Surge-Protected	+1	+0	x1	x1	[5]
Styling	***CF***	***HT***	***Weight***	***DR***	***Notes***
Stylish 1-9	+1-+9	+0	x1	x1	[6]
Other Modifiers	***CF***	***HT***	***Weight***	***DR***	***Notes***
Detachable without tools	+0.1	+0	x1	x1	
Detachable with tools	+0.05	+0	x1	x1	

Notes

[1] Ugly; may remove one level of Appearance (see *On the Cheap,* above).

[2] Limb has Temporary Disadvantage (Numb).

[3] Gives the limb Pressure Support 1.

[4] Gives the limb Pressure Support 2 and Vacuum Support.

[5] Remove Temporary Disadvantage (Electrical)

[6] May modify reaction rolls.

New Limitation: Cybernetic

Variable

Your ability is due to an artificial construct such as a bionic limb or implanted cybernetic device. The default version is equivalent to the limitation Temporary Disadvantage (Electrical). -20%.

If your ability is from an external bionic or a significant surface implant (and therefore targetable in combat), it may also have Temporary Disadvantage (Unhealing, Total), which adds -30%, and it may have the enhancement Injury Tolerance (Unliving), which adds +20%. Bioplastic (***Ultra-Tech,*** pp. 170-171) constructs should not have either of these; living metal should have Injury Tolerance, but not Unhealing.

If the limitation also includes Temporary Disadvantage (Maintenance, 1 person, monthly), add -2%. For Temporary Disadvantage (Maintenance, 1 person, weekly), add -5%.

When including this meta-limitation with advantages, make a note of which limitations it includes.

Damage to Bionics

Bionic replacements of living organs have Injury Tolerance (Unliving). They reduce damage modifiers from piercing and impaling attacks. They have twice the HP of the original part. Moreover, damage does not affect the user's HP total.

Total cyborg (***Ultra-Tech,*** p. 27) bodies are entirely made of constructed machinery, which gives them the Machine meta-trait (p. B263). They *are* affected by damage to replaced parts since their entire body is replaced parts.

Damage to Bionic Organs

Partial cyborgs whose internal organs have been replaced probably have Injury Tolerance (No Vitals) [5] along with Terminally Ill with a Mitigator. Their organ replacements can be targeted at the usual penalties. For hits to the vitals, roll 1d: On 1, this is a heart hit; on 2-3, this is the lungs; on 4-6, this is the other internal organs.

If an artificial heart is disabled, the victim immediately suffers the heart attack mortal condition (p. B429) unless a functioning secondary heart is present. A disabled breathing system causes the choking incapacitating condition (p. B428) as soon as the cyborg's air is used up; Breath-Holding and Doesn't Breathe (Oxygen Storage) may greatly increase this time! For other organ replacements failing, these trigger Terminally Ill with deadline and effects based on which organs have failed.

Treat a bionic heart as having the same crippling threshold as a hand; artificial lungs, the same as an arm; and the other internal organs (liver, stomach, intestines, etc.) together as the same as an arm.

New Bionics

For a wide selection of bionics, review pp. 208-218 of ***Ultra-Tech,*** plus check out the cybernetic skins in *Pyramid #3/12: Tech and Toys*. List costs include the CFs mentioned in the following descriptions.

Bionic Digits

Basic bionic digits are tougher than the original, but not much stronger.

Bionic Finger (TL9)

A replacement for a whole finger.

Statistics: DR 2 (One Finger, -140%) [2]; Missing Finger (Mitigator, -70%) [0]. *2 points*.

Availability: Minor procedure. $600. LC4.

Bionic Thumb (TL9)

A replacement for a whole thumb. Not much larger than a finger, but considerably more complex.

Statistics: DR 2 (One Thumb, -140%) [2]; Missing Thumb (Mitigator, -70%) [-1]. *1 point*.

Availability: Minor procedure. $1,500. LC4.

Integrated Digit Gadgets

Many gadgets and weapons can be added to bionic fingers and thumbs before they are installed in the user; apply the rules under *Integrated Gadgets* (p. 16). See also *Integrated Bionic Weapons* (p. 19) for other options to add to digits.

Combat Wire (TL9)

Removing a fingertip reveals a miniature spool containing 6' of thin, strong wire, with one end connected to the tip. The wire spool can reel in or out on mental command, with the fingertip serving as a weight at the end. The wire can be used two-handed as a garrote (use Garrote skill), or one-handed as a one- to two-yard-long whip (use Whip skill). Cutting Attack 1 point (Melee Attack, Reach 1-2, Cannot Parry, ST-Based, +70%; No Knockback, -10%; Temporary Disadvantage, Electrical, -20%) [3]. $100, 0.25 lbs. LC3. *3 points*.

Cutters (TL9)

A set of *two* digits on the same hand (either the thumb and index finger, or index and middle fingers) can have sharp inner edges mounted so that they function exactly like wire cutters or scissors. Used as a weapon, they can snip for 1d-2(2) cutting damage. This is a mostly external modification, taking up half the usual internal volume. Cutters may be upgraded with the improved blade types in ***Ultra-Tech*** (pp. 163-164). Since this device has an obviously bionic look to it, the GM may allow it to qualify for certain appearance-related disadvantages. Cutting Attack 1d-2 (Armor Divisor 2, +50%; Melee Attack, Reach C, Cannot Parry, -35%) [4]. $60, 0.25 lbs. LC4. *4 points*.

Finger Printer (TL9)

This is the fingerprint-only portion of an electronic thumb (***Ultra-Tech,*** pp. 96). It can be added to any bionic digit, taking up only half the usual internal volume as its mechanism is largely external. Elastic Skin (Fingers Only, -95%; Temporary Disadvantage, Electrical, -20%) [4]. $3,000, 0.125 lbs., A/200 hrs. LC3. *4 points*.

Gunsight (TL9)

This periscope (p. 19) or micro-light finger (below) – chosen before installation – has high precision motors that lock it into place to function as a HUD gunsight or laser sight (respectively) for weapons integrated into a bionic hand or arm. The gunsight adds +2 CF to the digit. The hand or arm also has +1 CF because of the locking motors. It must be installed at the same time as the weapon it's associated with.

Heater (TL9)

The fingertip contains a small electric heating coil that glows white hot within a second. It can be used like a lighter, and will ignite flammable material or boil a cup of water in a minute. If touched against bare skin, it does 1 point of burning damage per turn. Burning Attack 1 point (Melee Attack, Reach C, Cannot Parry, -35%; Temporary Disadvantage, Electrical, -20%) [1]. $500, 0.08 lbs., 5A/1 min. LC4. *1 points*.

Micro-Light (TL9)

The digit contains a penlight (***Ultra-Tech*** p. 74) with the expensive option and multi-spectral laser sight (***Ultra-Tech,*** p. 149). Accessory (Illumination) [1]; Accessory (Laser Sight) [1]. $20, 0.07 lbs., 2A/24 hrs. LC4. *2 points*.

Monowire (TL9^)

The fingertip is removable and is connected to a miniature spool containing 12' of monowire. The monowire spool can reel in or out on mental command, with the fingertip serving as a weight at the end. It can be used two-handed as a garrote (use Garrote skill), or one-handed as a one- to four-yard-long whip (use Whip skill). Cutting Attack 1d-2 (Armor Divisor 10, +200%; Low Signature, +10%; Melee Attack, Reach 1-4, Cannot Parry, ST-Based, +80%; No Knockback, -10%; Temporary Disadvantage, Electrical, -20%) [11]. $500, 0.25 lbs. LC3. *11 points*.

Periscope (TL9)

This puts a camera on the tip of a finger. It overlays its image over one bionic eye's visual field. By default it has the same stats as an expensive flatcam (***Ultra-Tech,*** p. 51), but can be upgraded like a bionic eye. This also requires a minor eye procedure if the chosen eye is already bionic, or no extra procedure if installed at the same time as a bionic eye. Enhanced Tracking (Temporary Disadvantages, Electrical and Tunnel Vision, -45%) [3]. $100, 0.065 lbs., A/10 hrs. LC4. *3 points*.

Zapper (TL9)

This digit functions a low-power zap glove (***Ultra-Tech*** p. 165). It has no "kill" setting, and only stuns on a HT-3 roll. Affliction 4 (HT-3; Armor Divisor 0.5, -30%; Melee Attack, Reach C, Cannot Parry, -35%; Temporary Disadvantage, Electrical, -20%) [8]. $300, 0.15 lbs., B/30 shots. LC3. *8 points*.

Integrated Limb Gadgets

Most gadgets can be added to bionic limbs before they are installed by using the rules under *Integrated Gadgets* (p. 16).

Tool-Kit Hands (TL9)

Mini-toolkits (***Ultra-Tech,*** p. 82) and multi-tools (***High-Tech,*** p. 26) can be built into a bionic hand. If the toolkit is constructed upon the exterior of an obviously cybernetic hand instead of internal in a realistic hand, it takes up half the usual space.

Integrated Bionic Weapons

Most weapons can be built into bionic digits, hands, arms, and legs before they are installed applying the rules under *Integrated Gadgets* (p. 16). A few options warrant special mention. For weapons that replace limbs, see *Heavy Weapon Arm* (***Ultra-Tech,*** p. 212) and the weapons in *Other Bionic Limb Options* (below).

Built-in Glove Weapon (TL9)

Include glove weapons like the zap glove and neuroglove (***Ultra-Tech,*** p. 165) normally as per *Integrated Gadgets* (p. 16). However, they take up only half the usual internal volume as their mechanisms can be integrated into a bionic hand's outer surface. Subtract the cost and weight of the protective glove to find the gadget's base stats.

Cyber-Blades (TL9)

Knives, swords, and other long, thin blades can be built to pop out of bionic digits, hands, arms, and feet. To account for guide rails and the ejector mechanism, the effective maximum length of the blade is half the length of the body part it's stored in. Thus, for average humans, this is 1" to 2" in the palm of a bionic hand, 3" to 6" in a forearm or foot, or 6" to 9" for a downward heel spike stored behind a shin. Higher TLs have better mechanisms or telescoping blades. At TL10, increase the lengths by 20%; at TL11, by 40%; at TL12, by 100%.

The releasing mechanism comes in three strengths.

Unpowered: Costs $50/lb. of the blade's weight, and adds 10% to weight. Unsheathing the blade takes a Ready action and a flick of the limb to make the blade slide free. Sheathing it takes another Ready action and a hand or other firm surface to push the blade back in.

Weak: Costs $250/lb. of the blade's weight, and adds 20% to weight. This gives it an ejection ST of 1/2 the bionic limb's ST. It can be deployed and retracted with a Fast-Draw (Cyber-Blade) roll or a Ready action.

Strong: Costs $500/lb. of the blade's weight, and adds 30% to weight. This gives it an ejection ST equal to the bionic limb's ST. It can be deployed and retracted with a Fast-Draw (Cyber-blade) roll or a Ready action.

Powered mechanisms can unsheathe through regular clothing, and might push their way out through armor, environment suits, and so on. Check maximum thrust damage vs. the covering's or target's DR to see if it penetrates. An exit port can be built into gloves and footwear for $20 ($200 for a sealed suit).

To buy the pop-out blade, add the cost and weight of the blade and mechanism, then adjust as per *Integrated Gadgets* (p. 16).

Cheap Hands

A simple mechanical gripper or crude grasper can be installed instead of a fully articulated bionic hand. The simplified nerve connections and motors greatly reduce the cost of the hand. Minor hand surgery (instead of the usual major surgery) results in nerve connections that are such low quality that every hand in that socket has at least Ham-Fisted 1 regardless of the quality of the bionic hand.

One Gripper Hand (TL9)

When including integrated gadgets (p. 16), multiply the gripper hand's available space by 1.5.

Statistics: Ham-Fisted 1 (One Hand, -80%) [-1]; One Hand (Mitigator, -70%) [-4]. *-5 points*.

Availability: Bionic hand procedure. $4,000. LC4.

One Grasper Hand (TL9)

When including integrated gadgets, multiply the grasper hand's available space by 5.

Statistics: Ham-Fisted 2 (One Hand, -80%) [-2]; One Hand (Mitigator, -70%) [-4]. *-6 points*.

Availability: Bionic hand procedure. $1,000. LC4.

Other Bionic Limb Options

Many other possibilities exist for personalizing bionic limbs.

Gun Hand (TL9)

A ranged weapon instead of a bionic hand. The weapon is undroppable and may give a bonus to Intimidation (see *One Hand,* p. B147).

Statistics: One Hand [-15] and an Innate Attack (p. B61).

Availability: Bionic hand procedure. $1,000 plus $100/lb. of weapon weight. LC of the weapon.

Hand Slammer (TL9)

This bionic hand has ruggedized joints, and hardened, reinforced knuckles and edges. It is designed for punching, stabbing, and chopping (using Exotic Hand Strike technique, ***GURPS Martial Arts***, p. 71). The knuckles are formed into stubby spikes and the hand's edges taper to an obvious curved ridge. This modification gives +2 damage for both regular punches and exotic hand strikes. The hand counts as very fine for the purposes of parrying.

The hand must have DR 3 or higher to include this option. Installing this bionic gives the user a Distinctive Feature.

Statistics: Perk (Striking Surface) [1] + Crushing Attack 1 point (Melee Attack, Reach C, ST-Based, +70%) [4]. *5 points*.

Availability: Bionic hand procedure. Include +0.2 CF to the hand, and +0.1 CF to any additional hand armor. LC3.

Micromanipulator Arm (TL9)

A bionic arm can be equipped with precision motors to allow super-fine movement. Allows up to TL/2 levels of High Manual Dexterity. If combined with a Mechanics (Micromachines *or* Nanomachines) mini-tool hand (see *Tool-Kit Hands,* p. 19), and enough microscopic vision (either external or bionic), this is equivalent to a micro-manipulator tool bench (***Ultra-Tech,*** p. 82).

Statistics: High Manual Dexterity (Temporary Disadvantages, Electrical and Maintenance, 1 person, weekly, -25%) [3.75/level]. *3.75 points per level, rounded up*.

Availability: Bionic hand procedure. $5,000 per level. LC4.

Sensitive Touch (TL9)

The bionic hand's fingertips are modified with enhanced tactile receptors, making them extremely sensitive.

Statistics: Sensitive Touch (Temporary Disadvantage, Electrical, -20%") [8]. *8 points*.

Availability: Bionic hand procedure. $15,000. LC4.

Sword Hand (TL9)

A melee weapon instead of a bionic hand. The weapon is undroppable and may give a bonus to Intimidation (see *One Hand,* p. B147).

Statistics: One Arm [-20] and a Striker (p. B88).

Availability: Bionic hand procedure. $1,000 plus $20/lb. of weapon weight. LC of the weapon.

Tentacle Arm (TL9)

A bionic arm can be built as an extra-flexible tentacle. In addition to the usual benefits of a flexible arm (p. B53), the user gets +1 to grapple or strangle.

Statistics: Add Extra Flexible (+50%) to existing arm. *5 points*.

Availability: Bionic hand procedure. $12,000. LC3.

Bionic Eye Upgrades

Bionic eyes can include better visual capabilities such as hypervision and telescopic zoom, or combat modifications like armor and micro-weapons. All of these upgrades must be designed and built into a bionic eye prior to installation.

Bionic eyes are very small and don't have much room for improvements. A realistic-looking basic bionic eye can hold 0.004 lbs. of integrated gadgets at the usual gadget density. At TL10, it can hold 0.008 lbs. At TL11, it holds 0.01 lbs. At TL12, it can have 0.012 lbs. An obviously artificial eye doesn't need to stay within an eye socket, so can be much larger to accommodate extra gadgets.

Telescopic Zoom (below) and Microscopic Zoom (p. 20): These improvements require not just better sensors, but actual internal machinery. The first additional level of zoom is $250 and 0.002 lbs., halved at each higher TL. Each subsequent level of the same type doubles the cost and weight. There are no restrictions on the number of levels, barring available space. An improved zoom that can function as either telescopic or microscopic is double cost.

Deadeye Weapon (TL9)

This is a larger implant that fully replaces an eye with a weapon mount, making the user One-Eyed (or blind, with two of them).

Statistics, One Eye: Buy it as an Innate Attack (p. B61); One Eye [-15].

Statistics, Two Eyes: Buy it as an Innate Attack (p. B61); Blindness [-50].

Availability, Each Eye: Bionic eye procedure. $500 × (13 - TL). The lower of LC2 or the LC of the implanted weapon.

Eyebite Weapon (TL9)

A tiny weapon can be built into a bionic eye. The best candidates are beam weapons and drugged darts. This cannot be built into an eye covered by an eyeshield (below).

Statistics: Buy it as an Innate Attack (p. B61).

Availability: Bionic eye procedure. $2,000 × (13 - TL). The lower of LC2 or the LC of the implanted weapon.

Eyeshields (TL9)

Armored shades (***Ultra-Tech,*** p. 176), implanted into the eye sockets. Since the eyeshield completely covers the eye, the shield can completely hide additional eye cybernetics. This feature allows double the internal capacity for integrated gadgets (p. 16). If both eyes are covered, this gives the perk Hard to Read, which gives -1 to anyone trying to read the cyborg in any of the situations covered by Easy to Read (p. B134). A covered eye is also sealed and vacuum-proof. At higher TLs, the shields offer additional DR.

Statistics, One Eye: Nictitating Membrane 8 (One Eye, -50%) [4]. *4 points*.

Statistics, Two Eyes: Hard to Read [1]; Nictitating Membrane 8 [8]. *9 points*.

Availability, Each Eye: Minor eye procedure. $200. LC3.

Improved Night Vision (TL9)

All basic bionic eyes have Night Vision 2. Higher quality sensors allow higher levels. At TL9, five extra levels can be bought, and another level at each of TL10-11.

Statistics, One Eye: Night Vision (Temporary Disadvantages, Electrical and No Depth Perception, -35%) [0.65/level].

Statistics, Two Eyes: Night Vision (Temporary Disadvantage, Electrical, -20%) [0.8/level].

Availability, Each Eye: Bionic eye procedure. $200 per level, halved at each higher TL. LC4.

Improved Telescopic Zoom (TL9)

All basic bionic eyes have Telescopic Vision 1. Only a total of TL-6 levels of Telescopic Vision can give a bonus to aiming due to the limits of image stabilization. Higher levels are still useful for noncombat purposes. This bionic can be combined with the microscopic zoom feature (p. 20). See the note above for additional information about levels and multifunction capabilites.

Statistics, One Eye: Telescopic Vision +1 (Temporary Disadvantages, Electrical and No Depth Perception, -35%) [3.25/level].

Statistics, Two Eyes: Telescopic Vision +1 (Temporary Disadvantage, Electrical, -20%) [4/level].

Availability, Each Eye: Bionic eye procedure. See above for cost. LC4.

Microscopic Zoom (TL9)

Microscopic zoom uses similar equipment to improved telescopic zoom, but is optimized for targets within one yard. (If the eye is not multifunctional, and thus does not use the same equipment, it takes a Ready maneuver to switch between lenses.) This device can be combined with the improved telescopic zoom feature (p. 20). See the note on p. 20 for additional information about levels and multifunction capabilites.

Statistics, One Eye: Microscopic Vision (Temporary Disadvantages, Electrical and No Depth Perception, -35%) [3.25/level]. *3.25 points per level, rounded up.*

Statistics, Two Eyes: Microscopic Vision (Temporary Disadvantage, Electrical, -20%) [4/level]. *4 points per level.*

Availability, Each Eye: Bionic eye procedure. See above for cost. LC4.

Ultravision (TL9)

This adds a sensor to detect ultraviolet light. The eye can project UV light in a narrow cone from emitters in a ring around the iris. The emitters are 0.002 lbs.

Statistics, One Eye: Accessory (UV Flashlight) [1]; Ultravision (Temporary Disadvantages, Electrical and No Depth Perception, -35%) [7]. *8 points*.

Statistics, Two Eyes: Accessory (UV Flashlight) [1]; Ultravision (Temporary Disadvantage, Electrical, -20%) [8]. *9 points*.

Availability, Each Eye: Bionic eye procedure. $1,000 × (13 - TL). LC4.

Body Systems

Other parts of the body can receive mechanical modifications.

Bionic Jaw (TL9)

An artificial jaw, tongue, and lips. A bionic voicebox (***Ultra-Tech,*** p. 210) can be added at the same time – just add the cost of the voicebox.

Statistics: Cannot Speak (Mitigator, -70%) [-3]; DR 2 (Jaw, -60%) [4]. *1 point*.

Availability: Major procedure (minor at TL11-12). $7,000. LC4.

Cheap Bionic Jaw (TL9)

The lips and tongue have much less articulation that normal, and may be noticeably artificial.

Statistics: Cannot Speak (Mitigator, -70%) [-3]; DR 2 (Jaw, -60%) [4]; Disturbing Voice [-10]; Unnatural Features 1 [-1]. *-10 points*.

Availability: Major procedure (minor at TL11-12). $4,000. LC4.

Bionic Organ Reconstruction (TL9)

Installs the full suite of bionic organ transplants (***Ultra-Tech,*** p. 210) and any needed encapsulated cell implants (***Bio-Tech,*** p. 120), shock-mounting and ruggedizing as many systems as possible, reinforcing intestines and major blood vessels, and armoring the primary and secondary artificial hearts. The user also gains weight – typically about 10% of torso weight.

Statistics: HP +5 (Torso, -10%) [9]; DR 4 (Tough Skin, -40%; Vitals Only, -30%) [6]; Hard to Kill 3 (Temporary Disadvantage, Electrical, -20%) [5]; Improved G-Tolerance (0.3G) [5]; No Vitals (Only to prevent first heart attack, -40%) [3]; Resistant to Metabolic Hazards +3 [10]; Terminally Ill (Up to one month; Mitigator, -70%) [-30]. *8 points*.

Availability: Radical procedure (major at TL11-12), or 10 major procedures over time. $80,000. LC3.

Bionic Spine (TL9)

This artificial spine and pelvic anchor is tougher than the original, and allows bionic limbs to perform beyond the limits of mere bone and muscle. The user may buy higher Lifting ST by increasing the ST of the bionic arms, legs, and spine. Any increased ST also counts as neck ST for resisting Neck Snaps (***Martial Arts,*** p. 77), Wrench Spine, and Backbreaker (both ***Martial Arts,*** p. 82). The built-in DR also protects against the later two techniques. The spine is heavier than a natural one – the user gains 5% of torso weight.

Statistics: DR 3 (Spine, -80%) [3]; HP+2 [4]; Quadriplegic (Mitigator, -70%) [-24]. *-17 points*.

Availability: Radical procedure (major at TL10-12). $25,000. LC3.

Independent Focus (TL10)

This is just the neural modifications to allow the eyes to move and focus independently. This doesn't require bionic eyes.

Statistics: Enhanced Tracking 1 (Temporary Disadvantage, No Depth Perception, -15%) [5]. *5 points*.

Availability: Major brain procedure. $10,000. LC4.

Skeletal Hardening (TL9)

The largest bones are hardened with metallic strips along likely impact angles. This makes bones less likely to break and more resistant to crushing attacks. The added metal clearly shows up on diagnostic scanners, but metal detectors are at -4 since the metal is covered in flesh.

Statistics: HP+2 [4]; DR 5 (Skull Only, -70%; Tough Skin, -40%) [5]; DR 3 (Limited, Crushing, -40%; Tough Skin, -40%) [3]. *12 points*.

Availability: Radical procedure (major at TL10, minor at TL11-12). $10,000. LC3.

Enhance or acquire abilities!

About the Author

Demi Benson lives in Boston, the hub of the universe. After trying her hand at rocket science and computer security, she's now automating the coming of the Robopocalypse, teaching hooligans to ride motorcycles, and occasionally writing for gaming companies.

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Eidetic Memory

Modular Mecha

by David L. Pulver

Giant human-piloted robots – call them mecha – are huge multi-ton fighting machines resembling a giant in powered armor. Cybernetically controlled by the pilot who rides inside it, protected by advanced super-dense armor, powered by a nuclear reactor and armed with an array of the most lethal weapons known to man, the mecha is the ultimate fusion of armor and infantry, combining the agility of the individual soldier with the firepower and protection of the main battle tank. They can do (nearly) anything a human soldier can: run, jump, take cover, pick up and carry an object – but on a mammoth scale.

One of my players was an anime fan who wanted to build his own mecha, but he wasn't into using a complex design system like the ***GURPS Spaceships*** rules, or juggling the points needed when using the character creation system. To keep him interested I came up with a basic system to build "game balanced" TL10 mecha whose offensive and defensive capabilities were closely matched with each other. A fairly narrow range of armament and gear is included, along with a simple price system.

Standard Mecha

Start by selecting a mecha class from the *Standard Mecha Table* and recording its statistic block. They are available in three weight classes.

Light Mecha: Approximately the same weight as a light tank or infantry fighting vehicle, designed for easy air or space transport and often used for armored reconnaissance missions. It stands about 17-23' tall.

Medium Mecha: The mass of a medium main battle tank, this is a standard battlefield machine. It stands about 24-27' tall.

Heavy Mecha: Approximately the same weight as a heavy main battle tank, this is a powerful fighting machine. It stands 28-33' tall. Even the largest conventional aircraft have difficulty transporting more than one of these machines.

All standard mecha are assumed to have the following characteristics:

The mecha is humanoid with two legs, two arms, a torso, and a head (independent turret). It has a metallic skeleton covered with exotic composite armor. The exact composition can vary from setting to setting, but a typical material might be titanium metal matrix nanocomposite (titanium alloy reinforced by carbon nanotubes), ceramics, and exotic synthetics. This counts as laminate armor with its DR doubled against shaped charges and plasma bolts.

The lower body houses the power plant, a well-shielded nuclear fusion reactor (***GURPS Ultra-Tech,*** p. 20) capable of 20 years operation. It supplies power to electric motors in the arms, legs, torso, and head-turret, all of which are capable of independent movement. The mecha also has an energy bank providing 10 minutes of auxiliary power in the event of generator failure.

Mecha Design Checklist

1. Pick the standard mecha's *class*: light, medium, or heavy. Record stat block.
2. Select the *quality* of the mecha (from a super model to piece of junk) and modify the cost shown in the stat block. Note the Design Point Total.
3. Pick and record *design features* whose total DP value exactly equals the mecha's Total Design Point Total. Modify stat block based on chosen features.
4. Select what weapons are carried, and optionally any handheld weapons.
5. Name the mecha.

This also sustains the plasma containment field long enough to power down in the event of a catastrophic breach. A fire-suppression system puts out fires aboard the mecha on a 3d roll of 14 or less (roll each second).

The mecha is controlled by a single driver (often called a pilot). He uses Driving (Mecha) skill to maneuver it and Electronics Operation (Communications and Sensors) to operate its onboard systems. Most mecha pilots also have Artillery and/or Gunner skills for whatever weapons they're armed with.

The pilot's one-man cockpit is located in the torso. It has limited life support (see ***Ultra-Tech,*** p. 224) providing 50 hours of air, food, and water. The cockpit has no windows, relying on video cameras spaced about the vehicle to give an effective 360° arc of vision. Access is via a hatch in the torso. The mecha will often be parked in a kneeling position to allow entry; it also has a retractable ladder or winch. The pilot has a well-padded seat with a computerized crew station and a head-up display (see ***Ultra-Tech,*** p. 24; +1 to Driving (Mecha) skill). Provision is made for direct neural interface control if the pilot has an appropriate implant or a neural interface helmet (see ***Ultra-Tech,*** p. 48). Built into the cockpit is a personal computer (Complexity 7; Hardened; stores 100 petabytes data). Other instruments include a tactical ESM detector that detects radar and laser signals (***Ultra-Tech,*** p. 62), plus GPS and inertial navigation system (+5 to Navigation skill; see ***Ultra-Tech,*** p. 74).

The standard sensor and targeting system is a pair of tactical sensor turrets (20× Hyperspectral Vision, +3 Acc when aiming; see ***Ultra-Tech,*** p. 66) mounted atop the mecha's own turret and on its shoulder. A trio of laser rangefinders (10,000-yard range) are in the turret and each arm to paint targets, giving +3 to Acc for aimed shots when in use (though this warns a target with laser sensors). The mecha's computer runs targeting programs (+2 to all Artillery and Gunner skills) and a tacnet program (+2 to Tactics skill). Thus, usually the mecha pilot will get a +5 targeting system bonus.

The mecha's head-turret can rotate at 180° per second and is typically used as a sensor and communications mount, and sometimes a weapon mount. Built into the head is a large radio (1,000-mile range) with a medium laser communicator (500-mile range; see ***Ultra-Tech,*** pp. 43-44, for both), and searchlight (***Ultra-Tech,*** p. 74). The head counts as an independent stabilized turret. The turret also has a pair of smoke dischargers (***High-Tech,*** p. 229). These can fire up to four times to create a 50×25-yard smoke screen up to 50 yards away. Usually radiant prism smoke is used, which obscures radar, imaging laser, radar, infrared, and visible light.

Each of the two arm and legs have motors that give the mecha a transitory Striking Strength four times that of its ST/HP score. The arms end in a reasonably dextrous hand, but the mecha still counts as Ham-Fisted (p. B138). Standard mecha arms incorporate the same auto-stabilization systems as a stabilized turret, allowing weapons to be fired on the move. Each leg has large feet to reduce ground pressure; they are also capable of kicking or stomping opponents. A mecha can climb or jump the same way that a human can, but it is too heavy to swim unless equipped with the submersible design feature (p. 26).

Standard Mecha Statistics

DRIVING (MECHA)/TL10

TL	*Type*	*ST/HP*	*Hnd/SR*	*HT*	*Move*	*LWt.*	*Load*	*SM*	*Occ.*	*DR**	*Cost*	*Loc.*
10	Light	145	+4/3	12	15/15	25	0.4	+3	1	900/600	$3M	2A2Lt
10	Medium	170	+3/3	12	15/15	40	0.5	+4	1	1,050/750	$5M	2A2Lt
10	Heavy	200	+2/3	12	15/15	65	0.6	+5	1	1,200/900	$7M	2A2Lt

* The higher DR applies across a 120° front arc and top for the body and the turret. Lower DR applies to the body and turret from other angles and to arms and legs. All armor is laminate (with doubled DR vs. shaped charges and plasma bolts.)

DR values are divisible by 2, 3, or 5 to make armor divisor calculations simpler.

Mecha Quality

After deciding on the base features, select the quality of mecha. If PCs are buying their own mecha the quality will modify the mecha's cost. In a campaign where mecha are issued to the protagonists – for example, if they're military pilots – the GM decides what quality of machine they will start with. He might reward victorious ace pilots with higher-quality designs.

The table below shows the various grades and modification to cost and the Total Design Points (DP) that must be used to buy design features (see pp. 25-26).

Mecha Quality Table

Description	*Total DP*	*Cost*	*Example*
Super Model	5	×100	A prototype super weapon
Elite Model	4	×20	A high-tech new prototype
Advanced Model	3	×4	A state-of-the-art design
Enhanced Model	2	×2	An expensive or upgraded model
General Model	1	×1	A good-quality, mass-produced design
Basic Model	0	×0.75	No-frills "grunt" mecha
Cheap Model	-1	×0.5	Mass-produced downgrade or "export" design
Piece of Junk	-2	×0.3	Inferior or obsolete design

Design Features

Most mecha differ in some way from the baseline standard design. A variety of mecha design features are available. Each has a cost in Design Points (DP). Much as with advantages and disadvantages, these can be positive or negative. The GM may allow PCs to customize their own mecha (especially if they are paying for it), or he may decide on the features if the robots are provided by a Patron or job.

Select design features from the *Mecha Design Feature Table* shown below. The total DP cost of all features must equal the mecha's Total DP, as shown on the *Mecha Quality Table*. A given design feature can only be taken once unless marked with an asterisk; if so marked it can be taken twice. Modifications that are exact opposites (e.g., +1 Health and -1 Health) are incompatible. After choosing the desired features, adjust the mecha's vehicular stat block accordingly and go on to select weaponry (p. 26-27).

Mecha Design Feature Table

Description	*DP*	*Description*	*DP*
Active Defense System	1	Move -5	1*
Airborne	1	Jump Jets	1
Canopy	-1	Jump Jet Extra Fuel	1*
Cargo	1*	Multispectral Chameleon	1
Cockpit in Head	-1		
Combustion Engine	-1	No Hands	-2
DR +150 (front torso)	1*	No Laminate	-1
DR +150 (rest of torso)	1*	Occupancy +1	1
DR +150 (head)	1*	One Hand	-1
DR +150 (both arms)	1*	Psi-Amplifier	1
DR +150 (both legs)	1*	Radar Jammer	1
DR +30 (entire mecha)	1*	Sensor Periscope	1
DR -30 (entire mecha)	1*	Stealth	1
Ejection Seat	1	ST/HP +50	1
Foot Rollers	1	ST/HP -50	-1
Full Life Support	1	Submersible	1
Handling +1	1*	Surveillance Array	1
Handling -1	-1	Tactical AESA	1
Health +1	1	Volatile	-1
Health -1	-1	Weapon +1	1
High Maintenance	-1	Weapon -1	-1
Move +5	1*		

* This feature can be taken twice (if desired).

Feature Descriptions

Active Defense System: This missile defense system automatically tries to intercept incoming grenade launcher, rocket, missile, or indirect fire artillery projectiles fired from at least 100 yards away. Check after an attack hits but before Dodging. It works on 13 or less on 3d; if multiple hits in one turn, apply a cumulative -1 per projectile after the first.

Airborne: The mecha's joints are reinforced giving it the equivalent of Catfall advantage. It is also equipped with a parachute that allows it to be air dropped into action even if it lacks jump jets (see below).

Canopy: Instead of the pilot relying on sophisticated internal holographic displays for situational awareness, the mecha employs a transparent bubble canopy like a fighter aircraft. Add the small glass windows location (g) to the mecha's Location stat block.

Cargo: The mecha adds 0.5 tons of cargo space to its Load. Cargo is in a leg or torso.

Cockpit in Head: A mecha pilot is normally seated in the well-armored torso, for safety. A simpler alternative is to place the cockpit in the head – this simplifies the design (as there's more room for the power plant), but the head (as an independent turret) is easier to disable.

Combustion Engine: The mecha uses an air-breathing internal combustion or gas turbine instead of the more common nuclear reactor. The mecha can operate for 10 hours with Range 400 miles, and is also somewhat noisy (+2 to detect via Hearing). If in vacuum, underwater, or atmospheres lacking oxygen, or trying to be quiet, it must switch to its auxiliary battery power and can only operate for 30 minutes (Range 20 miles).

Ejection Seat: The mecha is fitted with an ejection seat and parachute that can blast its crew free in only one second if the mecha is disabled and about to crash, explode, etc. The system can be set to work even if the crew are unconscious. (If the mecha location containing the cockpit is disabled, roll against the mecha's HT to see if it works.)

Foot Rollers: Legs can be fitted with small semi-retractable rollers in their feet, allowing the mecha to skate across smooth ground. It takes a Ready action to switch to them. On a completely flat, hard-surfaced ground like a road or building interior, using foot rollers doubles the mecha's Top Speed (but not its Acceleration). However, the mecha is considered to be Road Bound when using them. It is also at -1 to Handling and SR.

Full Life Support: Instead of limited life support, the mecha can provide unlimited water and air (see ***Ultra-Tech,*** p. 224). It still only has a two-day food supply; extra meals should be carried as cargo.

High Maintenance: Complex, jury-rigged, or advanced systems impose -2 on rolls to repair or maintain it. Usually, the vehicle spends a lot of time in the workshop.

Jump Jets: A compact nuclear rocket engine allows free flight with aerial Move 20/60 using Piloting (Vertol) skill; Hnd/SR is unchanged. Heavy fuel consumption limits it to 30 seconds of thrust unless extra fuel is added (see below). It's for quick "jumps" rather than sustained free flight. In space, it has 1.5G acceleration and delta-V 600; use Piloting (High-Performance Spacecraft). The plasma wash does 6d×2 burning damage to anything directly under it within a 10-yard long, 60° cone. The jet makes the mecha easy to spot on infrared; it is detected at +3 and visual or infrared stealth is useless.

Jump Jet Extra Fuel: An extra reaction mass tank – usually ordinary water is used – that adds a further 60 seconds of thrust (delta-V 1,200) to jump jet capability.

Multispectral Chameleon Surface: A sensor-controlled active camouflage system (see ***Ultra-Tech,*** p. 98) adds +8 to Stealth vs. ordinary and IR vision, +4 vs. hyperspectral vision, and +2 vs. extended high- or low-band hyperspectral. Halve this if moving.

Vehicles With Legs

On the *Vehicle Hit Location Table* (p. B554), legs are hit on a 6-7 (right leg or legs) and 13-14 (left leg or legs) with the same effects as leg hits to humans and humanoids (see p. B552, note 5).

No Hands: The mecha has arms (acting as strikers and possibly weapon mounts) but has No Manipulators and cannot grapple, carry handheld weapons, etc.

No Laminate: The armor's DR is not doubled against shaped charge warheads, etc.

Occupancy +1: The mecha has a seat for a gunner/sensor operator. The gunner operates turret weapons and independent comm systems, surveillance sensors, or sensor turrets, while the pilot drives the mecha, controls arms, and uses arm and torso-mounted weapons.

One Hand: The mecha effectively has the One Hand disadvantage. Not compatible with No Hands.

Psi-Amplifier: Some mecha pilots are psis, and their mecha can amplify their power! A large psi-amplifier built into the mecha's cockpit adds +4 to one psi talent.

Radar Jammer: Jams radar signals, giving -6 to radar and -4 to imaging radar to detect the mecha. This also applies to attack rolls made with any type of radar-homing missiles. It can spoof radar signals as detailed in ***Ultra-Tech*** (p. 99).

Sensor Periscope: The mecha's tactical sensor turret and laser rangefinder can extend on a telescoping mast up to 21' to see over hills, while submerged, etc. (see ***Ultra-Tech,*** p. 66).

Stealth: A combination of radar stealth and infrared cloaking. It gives the vehicle -6 to be detected via infrared sensors and radar

Submersible: The mecha is designed for underwater operations in up to a mile of water. It has a torso-mounted pump jet propulsion system giving it 1/5 its ground acceleration but full top speed underwater. Use Submarine (Minisub)/TL10 skill to maneuver. Sensors are augmented with a large tactical sonar (40,000-yard range, ***Ultra-Tech,*** p. 65) and large hydrophone (+14 detection; ***Ultra-Tech,*** p. 63, p. 65).

Surveillance Array: An array of indirect sensors: a TL10 tactical sound detector, tactical chemsniffer, and medium radscanner (see ***Ultra-Tech,*** pp. 61-63).

Tactical AESA: The mecha skin incorporates a distributed tactical AESA (200-mile-range multi-mode radar; see ***Ultra-Tech,*** p. 65). If using the radar for active targeting, it gives +9 (instead of +3 for laser rangefinder and +2 for Targeting program.)

Volatile: The mecha's power plant, fuel, ammo, or energy bank can explode when damaged. It has the Fragile (Explosive) (see p. B136) disadvantage. If it has an ejection seat (p. 25), roll vs. HT; on a successful roll the pilot ejects before it blows.

Weapon +1/-1: The mecha has one extra or one less weapon than usual (see *Weaponry,* below).

Weaponry

A light mecha normally has two weapons, a medium has three weapons, and a heavy mecha has four weapons (as modified by design features). Pick the weapons the mecha has from the *Ranged Weapon Table* (p. 27). When a weapon is chosen, decide where it is located. One weapon can be mounted on or carried in each arm (in an arm mount). Up to two weapons can be mounted in the head (in the same turret mount). Up to two weapons can be mounted in the torso (in a fixed mount). It's usually a good idea to mount weapons in the head or arms if possible, for the best field of fire, but since the torso is normally better armored, a fixed weapon there can be more survivable.

A mecha operator can fire one weapon at a time, or two different weapons with an All-Out Attack.

Remember that laminate armor gets double DR vs. a plasma lance or a missile's shape-charged warhead.

Light Missile Pod: Launches guided missiles that can be set for either Homing (Hyperspectral) or Homing (Imaging Radar). The typical warhead is a high-explosive multi-purpose shaped charge inflicting crushing incendiary damage and a linked crushing explosion. Alternatively, it can use any 100mm warhead from ***Ultra-Tech*** usable with missiles (except APEP or APDS. Damage is 6d×10 pi++ with a solid warhead.

Heavy Missile Pod: As above, but launches a missile that is more accurate and longer ranged, with a heavy high-explosive anti-tank shaped charge warhead. Damage is 6d×12 pi++ with a solid warhead.

Particle Beam: A high-energy charged particle beam weapon similar to that of a blaster cannon, but built for enhanced damage at the expense of much shorter range.

Ranged Weapon Table

This abbreviated weapon table covers mecha weapons described on pp. 26-27. All are TL10 and LC1 weapons, and all are mounted (M) with Bulk -10 if dismounted.

Weapon	*Damage*	*Acc*	*Range*	*RoF*	*Shots*	*ST*	*Rcl*
ARTILLERY (GUIDED MISSILE) (IQ-5 or other Artillery-4)							
Light Missile Pod linked	6d×12(10) cr inc 8d×2 cr ex	5	1,000/6,000	7	21(20i)	40	1
Heavy Missile Pod linked	6d×15(10) cr inc 6d×3 cr ex	6	1,500/20,000	3	6(20i)	40	1
GUNNER (BEAMS) (DX-4 or other Gunner-4)							
Particle Beam	5d×20(5) burn sur	15	6,000/18,000	1	*	100	1
Plasma Lance	6d×20(10) burn exp	8	20/200	1	*	100	2
Rainbow Laser	6d×25(3) burn	18	10,000/30,000	1	*	100	1
GUNNER (CANNON) (DX-4 or other Gunner-4)							
Railgun, 40mm	6d×25(3) pi+	8	8,000/29,000	5	200(5)	150	2
Railgun, 64mm	6d×30(3) pi+	8	12,000/40,000	1	60(5)	150	2

* Relies on mecha's internal energy bank; the number of Shots depends on the type of mecha: 15 for light, 30 for medium, 60 for heavy. The power plant can recharge 1/30 its total shots every second if neither moving nor firing a beam weapon or railgun.

Plasma Lance: A very high-energy short range plasma beam weapon, a hybrid of flamer and fusion gun. Note that laminate armor gets doubled DR against it.

Rainbow Laser: A heavy multi-frequency laser weapon, similar to the laser cannons in ***Ultra-Tech*** but with a higher-energy focal array optimized for battlefield lethality rather than extreme range.

Railguns: These fire electromagnetically accelerate projectiles. The 40mm weapon is similar to the railgun in ***Ultra-Tech*** but with a lower rate of fire to better fit in a mecha; the 64mm is a larger-caliber but slower-firing weapon.

> *The pilot chamber rang like a bell, and Matt grunted with the shock of a physical blow. Through the interface suit, he felt the chill touch of long, bladelike talons.*
>
> *– Brett Patton,* ***Mecha Corps***

Handheld Weapons

If a mecha with hands wants to use additional weapons but lacks the space to install them, it may carry them externally. Handheld versions of all beam weapons and railguns have a loaded weight of 1,200 lbs. and cost $500,000 each. Spare magazines for the railguns are 150 lbs. and cost $1,500 each. Handheld missile pods are 500 lbs. and $25,000 each (but much more bulky). All handheld weapons are lightly armored with DR 50 and are SM +1. Handheld beam and gun weapons are less accurate; multiply their Acc by 2/3 and treat them as Bulk -4 for purposes of firing when moving (due to stabilization).

Vehicles with arms (such as giant robots and Japanese-style mecha) often carry oversized swords, axes, and similar weapons. Rules for giant-sized melee weapons can be found in ***GURPS Low-Tech Companion 2: Weapons and Warriors*** (pp. 20-21), which scales weapons based on Size Modifier. To get through armor, they'll need to be either superfine vibroblades or monomolecular blades (***Ultra-Tech,*** p. 164).

Mecha Shields

Mecha often carry large shields reinforced with ultra-tech materials. These aren't built in and so count against encumbrance. A mecha can only carry a single shield.

Mecha Shield Table

Type	*DB*	*Cost*	*Weight*	*DR/HP*
Light Shield	1	$10,000	80	320/120
Small Shield	1	$16,000	320	360/180
Medium Shield	2	$24,000	600	400/240
Large Shield	3	$36,000	1,000	480/360

All shields are laminated. Light, small, or medium are also available as a buckler (see p. B287). All can be used to shield bash; including a spike adds $400 and 100 lbs. to weight.

About the Columnist

David L. Pulver is a Canadian freelance author. An avid SF fan, he began roleplaying in junior high with the newly released ***Basic Dungeons & Dragons.*** Upon graduating from university, he decided to become a game designer. Since then, David has written over 70 roleplaying game books, and he has worked as a staff writer, editor, and line developer for Steve Jackson Games and Guardians of Order. He is best known for creating ***Transhuman Space,*** co-authoring the ***Big Eyes, Small Mouth*** anime RPG, and writing countless ***GURPS*** books.

Near-Future Combat Uniforms

by Dan Howard

Advanced combat uniforms have been part of science fiction for decades – from the powered armor worn by Heinlein's *Starship Troopers* to the Colonial Marines in *Aliens*, who were kitted out in integrated armor, sensors, communications, and cameras. It seems that every year or so, the Pentagon or one of its contractors announces a new vision or innovation for the army of the future. They are heralded with much fanfare, but few concepts ever make it to the battlefield.

History

In the late 1980s, General Electric investigated integrated combat systems for ground soldiers, but it was determined to be unfeasible with the available technology of the time. In 1994, the *Land Warrior System* was announced, and a development contract was awarded to Raytheon Systems. It was envisioned that Land Warrior would give the soldier "enhanced tactical awareness, lethality and survivability." This project centered on an advanced fighting load vest with integrated gadgets and computing power. It included GPS and navigation, digital and voice communications, body armor and helmet, and a weapons-targeting system. The aim was to link soldiers, vehicles, and sensors into a global military intranet where a commander in a remote operations base could monitor and coordinate every individual, and every soldier in the field could instantly know everyone else's position and current status – to improve communications and situational awareness, thus minimizing the so-called fog of war.

Land Warrior

Raytheon developed and tested various prototypes of Land Warrior, and it was quickly discovered that weight was a primary concern. It was extremely difficult to produce a system that was robust enough to survive field operations while being light enough for the soldier to endure. Power was another problem – the weight of the batteries in early prototypes exceeded the weight of the actual equipment. Moreover, there were logistical problems keeping troops supplied with new batteries or recharging existing ones.

Despite many hurdles, in the year 2000, around 100 Land Warrior "proof-of-concept" units were successfully demonstrated in a war-game exercise at Fort Polk. Cost blowouts saw the contract taken away from Raytheon, and an attempt was made to replace military-spec technology with parts bought off the shelf from commercial electronics suppliers. This brought the price down dramatically, but the result was too fragile to survive field operations. In 2003, a contract was awarded to General Dynamics to create a more rugged version of the system.

By 2005, units started to be delivered for field trials. These were still considered to be too heavy and unreliable for use in the combat arena, so further enhancements were made that managed to reduce the weight further. In early 2007, the 4th Stryker Brigade Combat Team (SBCT) performed the first operational assessment of Land Warrior, and its sister program, *Mounted Warrior* (for vehicle crewman), at Fort Lewis. With their experiences and suggestions, improvements were made. Additionally, the weight was pared down even more – partly by storing some batteries in vehicles rather than on the soldiers. Even then, many soldiers were not impressed. They complained about the software being too slow and having to spend too much time fixing problems. They didn't see how the alleged improvement in tactical effectiveness was worth the additional weight. Many soldiers believed that they could get the same results with traditional maps, GPS units, and radios. It took eight months of training and improvements for the skeptics to admit that Land Warrior might be worth using (by now the weight was down to around 10 lbs.).

Doubts

During this time the entire Land Warrior concept was being questioned. Did every soldier need to be "wired up" and "plugged in"? How much of the equipment was superfluous to day-to-day operations? Was the Army focused too much on what might be desired in the future instead of giving soldiers what they needed right now? In addition, other, more advanced projects were under various stages of development such as *Ground Soldier Ensemble* (p. 29) and *Objective Force Warrior* (p. 29) – all of which were competing for limited funding.

In February of 2007, the Department of Defense announced the proposed termination of the Land Warrior program. The 4th SBCT was sorely disappointed at this news.

Despite the cut, their commander decided to take it to Iraq in June anyway, since all of the systems and support had already been funded. It proved to be successful – improving effectiveness and saving lives. Congress made some appropriations for the program so that the 5th Stryker Brigade Combat Team could take it to Afghanistan in 2009.

After many setbacks, the program is finally being successfully used in the field, but Land Warrior is unlikely to ever be widely distributed. Despite having a system that is proven in battle, the Army is already looking for something new.

Ground Soldier Ensemble

Touted as the next generation of Land Warrior, the functionality of the Ground Soldier Ensemble is very similar, just with more advanced technology. In 2009, the program was renamed *Ground Soldier System* (GSS) and given the nickname "Nett Warrior" after Robert B. Nett, a WWII Medal of Honor recipient. In October of the same year, the three contractors, General Dynamics, Raytheon, and Rockwell Collins all delivered prototypes for assessment.

However, technology has been changing too fast for developers to keep up; in the last few years, consumer electronics have overtaken the military prototypes. The contractors were working on a hand-held device that consisted of a computer with viewing monitor attached to an eyepiece, plus control unit, navigation system, radio, microphone and headphones. In 2011, Natick Soldier Center was ordered to transfer all of the above functions into a smart phone, which was smaller and lighter than any of the prototypes in development. This project has been nicknamed "Droid Warrior" after the open-source Android operating system. Connecting Nett Warrior with smartphone technology has already been successfully demonstrated, but the system needs to be "military-hardened" to survive field operations and the 3G communications needs to be changed to a more secure protocol.

Future

The Natick Soldier Centre has a project called the *Future Soldier Initiative*. Its vision is to equip every future soldier "physically, cognitively, socially and with the appropriate materiel to conduct Full Spectrum Operations." According to Natick, in order to achieve this, the soldiers will require "agility, adaptability, mobility and the ability to act efficiently and effectively to simultaneously perform operations in many traditional and non-traditional roles including but not limited to warfighting in complex, rapidly changing environments around the world."

Future Force Warrior

This is a U.S. military advanced technology demonstration project exploring the various capabilities that a soldier might take into combat in the future. It investigates the use of radical technologies to see how they may be used in the field. The *Objective Force Warrior* system is one aspect of the Future Force Warrior project.

Objective Force Warrior

The goal of this program is to create "wearable technology." All of the electronics are to be integrated into the soldier's combat uniform. Thermal and low-light imaging, CCD-TV sensors, laser targeting, and head-up display will be integrated into the helmet. The clothing will combine ballistic armor with chem-bio and physiological sensors, in addition to microclimate conditioning. The power sources are all to be worn by the soldier and are envisioned to be a combination of solar cell, fuel cell, and micro gas-turbine technologies.

Some of the technologies are available today, while others still need to be developed. It is proposed that the program be implemented in stages with each subsystem being introduced as it is made ready. This means that each new piece of equipment needs to be backwards compatible with existing technology, but the soldiers will be using some of the advanced hardware much sooner than if the whole system were kept for one large rollout.

> *Our intent is to stir imaginations, and start a dialogue about how best to equip the soldier.*
>
> *– Natick Soldier Centre,* ***Future Soldier 2030 Initiative***

Nanotubes: a New Building Block

Arguably one of the most exciting innovations in materials science in recent decades is the *nanotube*. Discovered in 1991 by electron microscopist Sumio Iijima at NEC in Japan, his finding has sparked a whole new era of scientific research. As more breakthroughs in nanotube research are made, scientists and engineers are speculating that nanotubes, alone and combined with other materials, will form the basis of many technological advances for decades to come.

Structure and Properties

A nanotube can be thought of as a sheet of *benzene rings*, a "hex-grid" of carbon atoms, that has been rolled up to make a seamless cylinder – similar in appearance to rolled-up chicken wire – and capped by a hemisphere of the same structure (called a *fullerene*). Just a nanometer across, the cylinder can be tens of microns long, although technologies are emerging to enable the creation of longer ones. These structures exhibit an amazing array of properties such as the ones described below, and more are being discovered constantly.

Coherence: Nanotubes demonstrate very large coherence lengths and do not contain magnetic impurities. This means that they would be useful in "spintronics," where the spin of electrons is used for various applications. Nanotubes could also be used for magnetic-sensing or switching applications. They would be the ideal choice for ultra-fast switches – perfect for digital computation.

Containers: Being hollow in the center, a nanotube can act as a container for other molecules. A good candidate is hydrogen. By storing hydrogen inside these tubes, it should make it a much safer material with which to work, and could possibly lead to the widespread use of pure hydrogen in fuel cells.

Electrokinetic: The application of electricity to a sheet of nanotubes causes it to flex in a similar manner to muscle tissue. This could provide the principal material needed to build artificial muscles for bionic limbs and tiny robotic devices. The opposite effect is also possible. When nanotube sheets are bent, their electrical resistance changes, making it possible to convert mechanical energy to electricity. This property could be used in power plants, utilizing wind or wave energy to generate electricity. A suit made from nanotube fabric would generate power every time the wearer moved. This could be used to recharge batteries, which in turn, could be used to power various electronic gadgets.

Field Emission: Nanotubes emit electrons out of their ends, which can be used to produce nanoscopic writing with molecular "ink," or to stimulate light-emitting substances. Recently, carbon nanotubes have been integrated into organic light-emitting transistors (OLET). This combination was then incorporated into a layer of organic light emitting diodes (OLED). The technology will lead to thin, flexible, extremely high-resolution display screens. An extension of this technology could be used to produce fabric with the same attributes. The fashion industry will have clothing able to be programmed to display any conceivable combination of colors and patterns.

Machinery: Micro machinery at its finest – adding a few benzene rings perpendicular to the tube produces nanogears.

Metallic: The properties of nanotubes can change simply by varying the way the sheets are rolled. If the sheet is rolled so that its hexagons line up straight along the tube's axis, the nanotube acts as an electrical conductor that is better than copper, and whose resistance does not vary according to its length. This means it should be possible to create extremely long, but very thin wires. With copper-wire diameter starting to limit the size of computer chips, this could dramatically alter the computer and electronics industry.

Resistance Variability: Upon exposure to various molecules, the electrical resistance of nanotubes dramatically changes. This response is faster and more sensitive than current solid-state sensors. Nanotube sensors have been, and continue to be, developed to detect a wide range of substances.

Semiconductor: If the sheet is rolled on the diagonal, so that the hexagons spiral along the axis like a barber's pole, the nanotube becomes a semiconductor – the type of material used to make transistors, diodes, and many other electronic components.

Strength: Nanotubes are over 100 times stronger than steel and have a high strain to failure rating. Fabric woven from strands of nanotubes has the potential to create extremely tough body armor and cord that is virtually unbreakable.

Supercapacitors: Capacitors store energy in the form of an electric field of charged particles created by two electrodes. They can be charged and drained many more times and more quickly than a chemical battery. However, storage potential is limited by the surface area of the electrodes. Covering the electrodes with nanotubes greatly increases the surface area and thus the amount of energy that the capacitor can store. A suspension of nanotubes can also be sprayed onto a surface, which can act as an electrode. When an electrolyte gel is sandwiched between two of these nanotube electrodes, a thin, flexible supercapacitor is created.

Thermal: Nanotubes have a thermal conductivity at least as good as the world's current best heat conductor – diamond – and it is resistant to flame damage. In addition to acting as a fire shield, nanotubes would be perfect as the basis of a temperature-regulation system for combat uniforms, keeping the soldier comfortable despite extreme climate conditions. This would also reduce the chance of detection by thermal imaging devices.

Combined Applications

Consider a jacket for a soldier fashioned from fabric made of multiple layers of nanotube composites. This jacket will have three-dimensional circuitry with phenomenal computing power and a built-in antenna for communication. It will also be a flame-resistant ballistic shield able to stop bullets with a capacity to generate and store its own power – all in one fabric! Add to this a microclimate control system that will regulate the suit's temperature, keeping the soldier comfortable while simultaneously helping him evade infrared detection. Field-emitting nanotubes will create adaptable camouflage patterns. A molecular filtration layer will protect the soldier from biochemical weapons. It may even have a limited capacity to self-repair.

Nanotech Combat Uniform (TL9)

Many of the technologies discussed in the Future Force Warrior program are described in ***GURPS Ultra-Tech***. They are combined here to create a modular combat uniform for the soldier of the near-future (TL9). This work speculates that woven sheets of nanotubes and other nano-materials could be manufactured with different properties. Each nanofiber "layer" (or gadget) could be combined with others to form a multi-purpose fabric – each incorporating a different technology utilizing one or more of the above-mentioned properties of nanotubes. This fabric could be manufactured into a combat uniform weighing little more than a standard ballistic vest, and able to be tailored with different technologies to suit the various types of action a particular unit might see.

The following rules give a modular system for tailor-designing combat uniforms by adding layers onto a basic foundation to create a suit similar to the flexible, sealed tac-suit in ***Ultra-Tech*** (p. 178), but more customizable. Most features cannot be retro-fitted; they must all be specified at the time of manufacture.

Basic Combat Uniform

The *Nanotech Basic Combat Uniform* (NBCU) incorporates two layers: *NanoShield* and *NanoComp* (see below). Other layers may be added for additional cost and weight. It is possible to have more than one layer of some technologies. For example, a particularly complex suit may consist of multiple layers of NanoGen (p. 31) or NanoCaps (p. 31) to avoid power shortages. Weight savings are made by combining multiple technologies in one housing (see *Combination Gadgets*, ***Ultra-Tech***, p. 15).

NanoShield

A more primitive (TL9) version of nanoweave (***Ultra-Tech,*** p. 172). NanoShield's main function is as ballistic armor.

It can resist high-velocity projectile attacks as well as cutting blows. NanoShield is flexible with a split DR. t provides full DR against piercing and cutting attacks, and uses its reduced DR against all other types of damage. It comes in three grades.

Concealable NanoShield: DR 14/5*, $500, 2 lbs. Don 20 sec. Holdout +0.

Tactical NanoShield: DR 20/10*, $800, 6 lbs. Don 30 sec. Holdout -3.

Assault NanoShield: DR 36/16*, $2,000, 12 lbs. Don 45 sec. Holdout -8.

The above figures are for a vest that only covers the torso (areas 9-11). Use the *Hit Location Table* in ***GURPS Low-Tech*** (p. 100) for armor that covers other parts of the body. For example, long sleeves would add 50% to the cost and weight for a total of $750, 3 lbs. for concealable NanoShield.

NanoComp

A computer with three-dimensional circuitry and fast processing speeds, built into a layer of nanofibers. This is the "brain" of the NBCU and forms an integral part of any combat uniform. It has multiple CPUs for parallel processing, including redundant systems in case part of the suit is damaged. However, its data storage capacity is limited. It also has interfaces for external devices, including connectivity to the soldier's combat helmet and weapons systems, which contain their own electronic devices. The software that comes in a standard NanoComp includes applications for navigation, communications, IFF ("Identify Friend or Foe"), media playback, targeting, and helmet interface, which use up almost all of its internal data storage. $400, 1.2 lbs., Complexity 3, 0.01 TB, B/1 day. LC4.

Only one NanoComp is needed for each NBCU, but it will require additional storage to accommodate applications for additional layers in the suit. Each 0.1 TB of hardened data storage costs $20 and adds 0.02 lbs. to the weight. Additional data storage is one of the few modifications that can be added after the NBCU has been manufactured. This data storage comes in flexible modules that are installed in interfaces on the suit. Power comes from external power cells (***Ultra-Tech***, pp. 18-19) or a flexible power cell that is integrated into its own layer in the NBCU (see *NanoCaps,* below).

Additional Functionality

All of the following layers require an entire *suit* of NanoShield, covering the torso, arms, and legs. The base cost and weight for this is 250% of a torso-only vest. For example, a suit of tactical NanoShield (above) costs $2,000 (2.5 × $800) and weigh 15 lbs. (2.5 × 6). Don time is 75 seconds (2.5 × 30). The layers also require a sealed helmet such as the infantry combat helmet in ***Ultra-Tech*** (p. 180), ideally with integrated communicator (***Ultra-Tech,*** p. 43) and camcorder (***Ultra-Tech,*** p. 52). Each layer of added functionality increases the amount of data storage needed. The cost and weight of the 0.1 TB module is included in the stats of each layer. An additional 0.1 TB of data storage ($20, 0.02 lbs.) is also required for each installed application (see *NanoComp Applications*, pp. 32-33). NBC Suit skill (p. B192) is needed to get in or out of the combat uniform quickly or to gauge its state of repair, but there is no DX penalty.

NanoCaps: Nanotube electrodes combined with an electrolyte create a capacitor to store power. This can then be used to power other devices just like a power cell. Each layer that covers the entire body (torso, arms, legs) can hold the equivalent of a C cell. NanoCaps can be drained and recharged indefinitely. They can be charged at a maximum rate of one A cell per second (100 seconds to fully charge it). In addition to integrated gadgets, external devices (e.g., combat helmets and energy weapons) can be plugged into the suit enabling the NanoCaps to provide power directly to the device. Multiple NanoCaps may be required for more complex NBCUs. Treat as a flexible (***Ultra-Tech,*** p. 19), rugged (***Ultra-Tech,*** p. 15) C cell; $80, 0.6 lbs. LC4.

NanoFilter: Works in conjunction with SensorWeave (p. 32) to protect the body from contaminants. It stops chemical, biological, and radiation threats. It only uses power when a threat is detected and NanoFilter is activated. $1,000, 1 lb., A/1 day LC4.

NanoGen: This generates power any time the wearer moves. The greater the physical activity, the more power that is produced. A layer of NanoGen produces enough power to recharge one A cell for every hour of normal activity (e.g., walking). Power generation is *doubled* during periods of physical exertion (e.g., running or fighting). NanoGen stops making power during prolonged periods of reduced movement (e.g., sleeping or sniping). Multiple layers of NanoGen may be purchased for additional cost to increase power output (e.g., three layers are equivalent to three A cells per hour). $5,000, 8 lbs.

NanoMuscles: Simulates human muscle tissue, effectively giving the wearer a temporary exoskeleton. NanoMuscles can give a slight boost (up to +2) to the wearer's ST or DX for physical skills (except for skills that require manual dexterity, such as Lockpick). The wearer can choose either ST or DX but not both at the same time; two layers must be installed for both ST and DX to function simultaneously. Each second of use requires the capacity of an entire B cell for +1 and a C cell for +2, so it can't be used for long. $5,000, 8 lbs., LC3.

NanoRes: Generates high-resolution images on its surface, similar to the varicloth technology in ***Ultra-Tech*** (p. 39). This can be used for a variety of purposes such as programmable camouflage (***Ultra-Tech,*** p. 99) or a video display. It can also create a basic reflec armor (***Ultra-Tech***, p. 173), and it has a "distress pattern" (a bright color to assist search and rescue). NanoRes must be the outermost layer of the NBCU for it to be useful, so it cannot be used in conjunction with SolarWeave (below). $2,000, 1 lb. A/1 day. LC4.

NBCU Computing Power

The computers in ***Ultra-Tech*** are more advanced than today's computers. A small computer (***Ultra-Tech,*** p. 22) costs $100, weighs 0.5 lbs., has Complexity 4, and stores 10 TB. It requires 2 × A power cells to operate it for 20 hrs. However, the computer in the NBCU has been integrated into a thin layer of fabric and can be treated as a printed small computer (***Ultra-Tech,*** p. 23). It has also been hardened (***Ultra-Tech,*** p. 23) to survive electromagnetic attacks, and ruggedized (***Ultra-Tech,*** p. 15) to survive field operations. A printed small computer is the same weight (0.5 lb.) and cost ($100) but only has Complexity 3 and 0.01 TB storage. Hardening takes it up to 1 lb. and $200. Rugged increases it to 1.2 lbs and $400.

SensorWeave: Not a discrete layer like many others, SensorWeave is incorporated through all the other layers from the outside of the suit to the inside. The network of sensors – including electromagnetic detectors, pressure sensors, chem-sniffers (***Ultra-Tech,*** pp. 61-62), biomedical sensors (***Ultra-Tech,*** p. 187), and input from external sources (e.g. helmet cameras and microphones) – constantly feed data to the NanoComp. The information includes everything from details about the environment to the wearer's physiological condition. Without SensorWeave, many other functions could not operate. $3,000, 2 lbs. A/1 day. LC4.

SolarWeave: A layer of thin, flexible solar panels over the surface of the NBCU convert light into electricity. On a sunny day it generates enough power to recharge one A cell per hour. Overcast skies produce energy for one A cell every four hours. A well-lit room generates enough for one A cell every six hours. SolarWeave cannot be worn in conjunction with NanoRes (p. 31) since it needs to be the outermost layer to function. It is the cheapest way to generate power for the NBCU. $1,000, 1 lb. LC4.

ThermoWeave: A "thermal layer" of nanotube fiber, with components including thermocouples and thermal diodes, regulates the temperature of the suit and converts the heat generated from the wearer and the environment into electrical energy. ThermoWeave can be used for two main functions, *microclimate control* (MC) and *infra-red shielding* (IR). It has to be purchased twice for a suit to have both functions.

ThermoWeave (MC): Regulates the *inside* temperature of the suit, creating a microclimate system. If the soldier needs to be cooled down, surplus heat is converted to electricity. If the soldier needs to be warmed up, stored power can be used to produce heat. In temperate climates, enough power to recharge two A cells per day is generated. In hot climates, power generation is *doubled*. In cool climates, there is negligible power generation. In Arctic conditions, the microclimate system requires one A cell per hour to keep the wearer warm. $3,000, 2 lbs., LC4.

ThermoWeave (IR): Regulates the *outside* temperature of the suit, creating infra-red shielding. If the surface of the suit is kept at the same temperature as the surrounding environment, thermal imaging devices will not be able to detect it. When used by itself, it gives +4 to Stealth against infrared detection. This is *halved* (round down) if moving. When used in conjunction with NanoRes (p. 31) it provides a thermo-optic chameleon surface (***Ultra-Tech***, p. 98). For more details, see *Dynamic Camouflage* (below). $3,000, 2 lbs., A/1 hr. LC3.

WRWRS (Waste Reclamation and Water Recycling System): Nicknamed "whir-whirs," it combines the waste-relief system (***Ultra-Tech,*** p. 187) with the desert environmental suit (***Ultra-Tech,*** p. 187) and the vapor canteen (***Ultra-Tech,*** p. 76). Whir-whirs collects and packages the wearer's waste products in a hygienic manner, and recycles about 90% of his body fluids for reuse. The recycled water is stored in a reservoir for drinking, which is topped up by the vapor canteen technology. In all but the driest of climates, the wearer should never run out of water. $5,000, 12 lbs., B/1 day. LC4. Weight includes around a quart of water (2 lbs.) in the drinking reservoir.

Power Consumption

Many of the technologies of the NBCU require power in order to operate and ***Ultra-Tech*** uses *power cells* for this (pp. 18-19). Just like in ***Ultra-Tech***, each layer (or gadget) incorporated into the NBCU is listed with the type of cell it uses and the length of time it can operate. Flexible power cells (see *NanoCaps*, p. 31) can be incorporated into the NBCU and are rechargeable. If additional power is required, then regular power cells can be inserted in ancillary battery packs – usually on the soldier's belt or load-bearing harness.

Each layer can use a different size or number of power cells. To make all of the integrated gadgets run off the same size of power cell, adjust endurance based on relative cell size. Since a D cell is 10 times the power of a C cell, a gadget that switched from using one D cell to using C cells will need 10 of them to operate for the same length of time (i.e. one C cell will operate for 1/10 as long). Don't forget that changing the types of power cells will modify the weight of the suit – subtract the weight of the old power cell(s), and add the weight of the new one(s).

If a suit doesn't have enough power to run all of its functions then they start to shut down. Noncritical systems are affected first, such as NanoMuscles and NanoRes. The last two to shut down are SensorWeave and finally NanoComp. When there is no power at all, the NBCU becomes a regular NanoShield ballistic armor with a lot of superfluous weight. A suit should be fitted with at least one power-generating layer such as NanoGen (p. 31) or SolarWeave (see above) to keep the critical systems functioning at all times.

Miscellaneous Systems

All of the items in *Miscellaneous Accessories* in ***Ultra-Tech*** (p. 187) can be applied to the NBCU and may be retrofitted. For example, if the suit was not initially fitted with a WRWRS (above), then a waste-relief system could be retrofitted later on.

NanoComp Applications

These aren't separate layers in the suit but specialized applications ("apps") that enable existing layers to perform additional functions. Since apps are just software, they can be installed at any time. However, each application requires an additional 0.1 TB of data storage ($20, 0.02 lbs.) for the NanoComp. The cost of this is included in the package when it is purchased, but the total weight of the suit needs to be increased by 0.02 lbs. per app.

Dynamic Camouflage: Requires SensorWeave and NanoRes. The *Deluxe* version (below) requires ThermoWeave. SensorWeave constantly receives data about the color and texture of the local terrain and allows NanoRes camouflage to adapt to the surroundings (see *Chameleon Surface*, ***Ultra-Tech***, p. 98).

The *Basic* version automatically selects from an extensive database of preset camouflage patterns, and changes the pattern whenever it deems it necessary. This is superior to programmable camouflage (***Ultra-Tech,*** p. 99) because it takes the operation out of the user's hands, and it has a much greater variety of camouflage patterns from which to choose. +3 to Stealth against ordinary vision (only +1 when moving). $500, 0.02 lbs. A/1hr. LC4.

The goal of our Army is to continue the transformational process of building a campaign quality expeditionary Army that can support our combatant commanders in the challenges of the 21st century across the full spectrum of conflict.

– Gen. George Casey

The *Deluxe* version generates patterns "on the fly," creating an almost infinite number of variations to more closely emulate the immediate surroundings. It gives +4 to Stealth skill against ordinary vision. When used in conjunction with ThermoWeave, it becomes a thermo-optic chameleon surface (***Ultra-Tech,*** p. 98), giving +4 against infrared detection, +2 against hyperspectral or ultraviolet vision, and +1 against extended high- or low-band hyperspectral vision. All bonuses are *halved* (round down) if moving. $5,000, 0.02 lbs. 2A/1hr. LC3.

Heat Shield: An advanced application that requires both versions of ThermoWeave (MC *and* IR) to help protect the wearer from heat and flame damage. It attempts to disperse as much heat as possible in as short a time as possible to prevent the wearer being injured. The NanoShield armor can normally absorb up to the second value of its split DR of heat damage (e.g., tactical NanoShield armor can absorb up to 10 points). Additional heat is either converted into electricity or is distributed over the rest of the suit, which acts as a heat sink. It gives the armor an effective +10 DR vs. heat damage. Any more than this, and the wearer starts to burn. Some of the converted heat is fed into NanoCaps (if available) at a rate of one A cell per second until they are all full. Heat could also be *deliberately* applied to the suit (e.g., by standing in a camp fire) to help recharge NanoCaps. The source would need to deliver the right amount of heat damage per turn – if it were less than the NanoShield's DR, no power would be generated, and if it were more than DR+10, the excess heat would burn the wearer. $5,000, 0.02 lbs. LC4.

NanoFlex: Requires both SensorWeave and NanoMuscles. NanoFlex detects and tracks low-velocity attacks (i.e., muscle-powered weapons) and makes the suit rigid for an instant, localized at the point of impact, providing enhanced protection. This means that the armor's full DR can be applied to impaling and crushing damage, and the wearer does not suffer from blunt trauma. Every attack it attempts to stop uses up one B cell. $2,000, 0.02 lbs. LC4.

NanoMed: Requires SensorWeave and NanoMuscles to function. NanoMed keeps track of the body's medical condition. If it notices any abnormalities, it can act to rectify them. NanoMuscles constrict around a wound, preventing further blood loss or act as a splint for broken limbs. Drugs can be delivered into the body in a similar fashion to how nicotine patches work today, allowing a more controlled release into the bloodstream. Once activated, it uses one A cell per hour. The NanoMed package includes the trauma maintenance system (***Ultra-Tech,*** p. 189), which is retrofitted to the suit. $3,000, 0.02 lbs. LC4.

NanoRepair: Requires SensorWeave and NanoCaps. This app can be handy if armor damage rules are being used. NanoRepair makes use of some of the electrolytic fluid in a NanoCap to help repair the suit. If the suit is damaged, some of the fluid is released into the damaged area. The NanoComp can then manipulate a localized electric field to enable the nanocrystals in the damaged layers to regrow, thus allowing the NBCU to self-repair. The rate of repair is fairly slow, about 10 minutes per HP per layer (e.g., NanoShield + NanoComp + SensorWeave + two NanoCaps takes 50 minutes to heal 1 HP). NanoRepair only uses power when it is in active repair mode at a rate of A/10 minutes. $500, 0.02 lbs. LC4.

ScentMask: Requires NanoFilter. It reverses the NanoFilter so that it stops chemicals from *leaving* the suit. See *Scent Masking* (***Ultra-Tech***, p. 100). $500, 0.02 lbs. A/1 day. LC4.

SensorWeave Detectors: Requires SensorWeave. Many of the detectors in ***Ultra-Tech*** can be simulated by special apps designed to interpret specific types of data being processed through SensorWeave. Examples include computer monitoring mini scanner (***Ultra-Tech,*** p. 100), ESM detector (***Ultra-Tech,*** p. 62), and RF bug detector (***Ultra-Tech,*** p. 106). Each of these apps costs $500 and the 0.1 TB storage module weighs 0.02 lbs. A/12 hr. Requisite skills and the LC are described in ***Ultra-Tech***.

Miscellaneous Applications

The above apps are specifically designed to be used in military contexts, but there are plenty of other uses to which the equipment can be put. The GM should allow the players to be creative so long as their ideas won't upset game-balance. Here are some suggestions.

Focused Light: Requires NanoRes. This application manipulates the NanoRes layer so that it can emit a beam of light, just like a flashlight, from any single point on the suit (see *Flashlights and Searchlights*, ***Ultra-Tech***, p. 74). The effect of a penlight requires one A cell every six hours; a mini flashlight, one B every six hours, and a heavy flashlight, one B every three hours. $500, 0.02 lbs.

Media Recording: Requires the cameras, microphones, and HUD display on the combat helmet. The NanoComp is perfectly capable of using its interface with the combat helmet to record audio and video, but it doesn't have the data storage capacity. This is a simple app that enhances the media recording and playback function of the NanoComp and gives enough storage to hold around 100 hours of compressed, but high-definition audio-video recordings on its 0.1 TB module. It also includes the ability to transmit recordings between NBCUs or to remote data storage. $100, 0.02 lbs.

Resistance Training: Requires Nanomuscles. This application manipulates the NanoMuscles to provide the wearer with a regimen of isotonic and isometric exercises without the need for weights and machines. It requires the power of one C cell every minute, so it is only really practical when the suit is plugged into an external power supply. $100, 0.02 lbs.

Designing a Combat Uniform

First decide which functions you want to have in the NBCU. You will need to look at the different "layers" that are available as well as any applications that you may want to install.

Power requirements need to be calculated. Some functions, such as the NanoComp and SensorWeave, are constantly draining power while others, such as NanoFilter and NanoMuscles, only use power when they are activated. The constant-drain layers should be totaled first to get an idea of the minimum amount of power that is required for the suit. This will help determine whether you need integrated power generation or storage, or whether an external power cell would suffice. Start by converting all power requirements to A cells per day. For example, a NanoComp needs a B cell per day, which is 10 A cells per day.

The discount for combining multiple gadgets together (see *Combination Gadgets*, ***Ultra-Tech***, p. 16) has already been determined so all you need to do is add all the costs and weights together. Every 5 lbs of extra weight gives an additional -1 to Holdout. For example, 11 lbs. of gadgets gives -3 Holdout.

For variations other than the versions described below, you will need to start with a complete suit (torso, arms, legs) of NanoShield, which is 250% of the cost and weight listed in the descriptions of that layer (see *Basic Combat Uniform*, pp. 30-31). Some example NBCUs are described below.

> *Our suits give us better eyes, better ears, stronger backs (to carry heavier weapons and more ammo), better legs, more intelligence (in the military meaning . . .), more firepower, greater endurance, less vulnerability.*
>
> *– Robert Heinlein,* ***Starship Troopers***

Standard Issue NBCU

"Standard issue" consists of a simple Tactical NanoShield vest (torso only) with an integrated NanoComp to interface with the weapons and helmet systems. Simply add the NanoComp stats to the tactical NanoShield.

This combat vest has no power generation or storage capacity, so a power cell would need to be installed in an external battery pack on the soldier's belt to keep the NanoComp functioning. A standard B cell costs $3 and weighs 0.05 lbs and will need to be replaced or recharged once per day to keep the NanoComp functioning. A standard C cell costs $10 and weighs 0.5 lbs, but will only need replacing or recharging once every 10 days. Assuming a C cell is used, total cost is $1,210 and weight is 7.7 lbs.

Standard Issue NBCU: DR 20/10*; $1,200, 7.2 lbs. Don 30 sec. Holdout -4. B/1 day (external). LC3.

Recon NBCU

This combat uniform is designed for reconnaissance missions. Its foundation is a tactical NanoShield suit (torso, arms, legs; stats: DR 20/10*, $2,000, 15 lbs., don 75 sec., Holdout -4). Other functions are as follows.

NanoComp: $400, 1.2 lbs. Complexity 3. 0.01 TB. B/1 day. LC4.
NanoFilter: $1,000, 1 lb., A/1 hr. LC4.
NanoRes: $2,000, 1 lb., A/1 day. LC4.
SensorWeave: $3,000, 2 lbs., A/1 day. LC4.
ThermoWeave (MC): $3,000, 2 lbs., -2A/1 day. LC4.
ThermoWeave (IR): $3,000, 2 lbs., A/1 hr. LC3.

Installed apps include: ESM Detector ($500, 0.02 lbs., A/12 hr.), ScentMask ($500, 0.02 lbs., A/1 day), and Dynamic Camouflage (Deluxe) ($5,000, 0.02 lbs., 2A/1 hr), which total $6,000, 0.06 lbs.

If all functions were running all day, then total power requirements would be 131 A cells per day. Since the NanoFilter only activates when a threat is detected, it would be powered down most of the time. The Dynamic Camouflage and ThermoWeave (IR) also could be deactivated until needed. This reduces the daily power requirements to 12A per day, so a single layer of NanoCaps (100 A cells) could power the basic functions for over eight days. An additional layer of NanoCaps could power the NanoFilter, ThermoWeave (IR), and Dynamic Camouflage (total 96 A cells) for a little over one day. So a total of four NanoCaps ($320, 2.4 lbs) would be needed to power all functions for three days. After that time, the basic functions would continue to operate for a further five days.

Recon NBCU: DR 20/10*, $20,720, 26.66 lbs., Don 75 sec., Holdout -7. 4C/3 days (internal).

Assault NBCU

This is a heavy-duty combat uniform designed for high-threat environments. Its foundation is an assault NanoShield suit (torso, arms, legs; stats: DR 36/16*, $5,000, 30 lbs., don 113 sec., Holdout -8). Other functions are as follows.

NanoComp: $400, 1.2 lbs. Complexity 3. 0.01 TB. B/1 day. LC4.
NanoFilter: $1,000, 1 lb. A/1 day. LC4.
NanoGen: $5,000, 8 lbs., -A/1 hr. LC4.
NanoMuscles: $5,000, 8 lbs., B/1 sec. (+1) or C/1 sec. (+2). LC3.
NanoRes: $2,000, 1 lb., A/1 day. LC4.
SensorWeave: $3,000, 2 lbs,. A/1 day. LC4.
ThermoWeave (MC): $3,000, 2 lbs., -2A/1 day. LC4
ThermoWeave (IR): $3,000, 2 lbs., A/1 hr. LC3.
WRWRS: $5,000, 12 lbs., B/1 day. LC4.

Installed apps include: Dynamic Camouflage (Deluxe) ($5,000, 0.02 lbs., 2A/1 hr.), Heat Shield ($5,000, 0.02 lbs., -1A/1 sec.), NanoMed ($3,000, 0.02, A/1 hr.), NanoFlex ($2,000, 0.02 lbs., B/1 attack), which total $15,000, 0.08 lbs.

NanoMed would only be required if the solder was wounded, but it would be safer to include this power requirement as part of the base load. If all functions including Dynamic Camouflage were running all day, then total power requirements would be 105 A cells per day, plus one-off uses such as NanoFlex (B per attack) and NanoMuscles (B or C per second).

This value assumes that the NanoGen generated an average of 12 A cells per day. A week's operations (735 A cells) with no recharging would require 800 A cells or eight NanoCaps. A couple more would be needed to get some use from NanoFlex and NanoMuscles. Ten NanoCaps (1,000 A cells) cost $800 and weigh 6 lbs.

There is enough power to run most functions for seven days and have 26 B cells left for NanoFlex and NanoMuscles. If these are expected to be used often, then the soldier will install external B cells on his belt ,which can be used up first and discarded.

Assault NBCU: DR 36/16*, $48,200, 73.28 lbs. Don 113 sec. Holdout -15. 10C/7 days (internal). LC3.

The BodyGuard

This is a civilian version of the NBCU. It has been tailored in two parts to resemble a tight-fitting jacket and pants but it is light enough to be concealed under other clothing if required. Its foundation is a concealable NanoShield suit (torso, arms, legs; stats: DR 14/5*, $1,250, 5 lbs., don 50 sec., Holdout +0). Other functions are as follows.

NanoComp: Complexity 3, 0.01 TB. $400, 1.2 lbs., B/1 day. LC4.
NanoFilter: $1,000, 1 lb., A/1 hr. LC4.
SensorWeave: $3,000, 2 lbs., A/1 day. LC4.
SolarWeave: $1,000, 1 lb. LC4.

It also has a trauma maintenance system installed (***Ultra-Tech,*** p. 189): $2,000, A/1 year, LC4, which is linked to the SensorWeave. There is a flexible filter mask (***Ultra-Tech***, p. 177) built into the collar of the jacket using NanoFilter technology. In an emergency, it can be pulled over the entire head and fastened around the throat to protect the wearer from chem-bio-rad threats. $800, 0.2 lbs. AA/1 hr.

Even with interior lighting, SolarWeave can generate enough power to run the SensorWeave indefinitely and keep a flexible A cell charged for the NanoFilters to run for an hour or so. The flexible B cell required to run the NanoComp will need charging or replacing once per day. If this armor is concealed under other clothing, then the SolarWeave will not function, so an additional power cell will be required.

The BodyGuard: DR 14/5*, $9,450, 10.4 lbs. Don 50 sec., Holdout -2, B/1 day (external), LC4.

Higher Tech Levels

The described NBCUs become a viable option at TL9, but a TL10 version would be more advanced. The base armor would be the TL10 nanoweave in ***Ultra-Tech*** (p. 173) instead of the TL9 NanoShield described above. The NanoComp would remain effectively unchanged because, as computer technology becomes more powerful and complex, so too do the software packages it is expected to run. NanoMuscles could boost attributes by more than 2 points or use less power. NanoRes might be able to generate "refraction matching" camouflage, rendering the wearer virtually invisible. Many of the layers would be so thin that they could be incorporated directly into the structure of the nanoweave, which would effectively make them weightless. The entire suit, with all of its additional functionality would weigh the same as the nanoweave armor by itself!

About the Author

Dan Howard has an arts degree in history and classical studies. He is co-author of ***GURPS Low-Tech*** and author of many articles and supplements for Steve Jackson Games. Dan has written a book titled *Bronze Age Military Equipment,* for Pen and Sword Books Ltd. and has published an ebook called ***Compact Castles,*** available on e23. He holds a second dan black belt in Oh Do Kwan Tae Kwon Do and has competed internationally. Other interests include military history, ancient armor research, permaculture gardening, and renewable energy. He lives in Maitland, Australia, with his wife and three children.

Random Thought Table

Better, Faster, Stronger

by Steven Marsh, *Pyramid* Editor

When it comes to devising new technologically based toys for the future, it can be worthwhile to take a step back and see what technology generally *does*. This can enable us to fabricate new fictional technological possibilities and modify existing ones to bold new frontiers of coolness.

Here, then, is a list of the most common ways that technological advances manifest, based on what they do . . . in an abstract sense.

> *We have the capability to build the world's first bionic man.*
>
> *– Oscar Goldman,* ***The Six Million Dollar Man*** *series*

Do It Faster

The ability of technological advances to enable folks to do stuff faster is one of the quintessential hallmarks of technology; indeed, it's common shorthand to speak of technology using lingo like, "The Fubar 2000 does the work of 40 workers in half the time!" Whether you're talking about the cotton gin, the crop-harvesting combine, or DSL online connection, "do it faster" is usually easy to conceptualize. For example, modern high-speed Internet connections certainly open up many more possibilities than their old dial-up brethren, but they're still recognizable as being related to foregone tech.

In some cases, "faster" doesn't adequately describe the societal effects of the improvement. While the printing press *does* produce copied material faster than monks scribing by candlelight, the speed advances were so amazing that it resulted in a radical – even *disruptive* – leap forward for civilization.

In Game

For any existing technology, look at the speed or duration of the output, and tinker with it. For example, it's certainly possible to envision advances in technology that enable slidewalks (see ***GURPS Ultra-Tech,*** p. 222) to have a top speed of 60 mph instead of 30 (perhaps aided by personal force fields to keep air friction and discomfort to a minimum). Of course, with good-enough impossible science, a slidewalk could have a top speed of 600 mph; being able to "walk" from Washington, D.C. to New York City in half an hour could certainly a good example of "disruptive technology"!

Do It Better

Sometimes technological advances are significant because they enable something to be done *better* than before. For example, advances in document-reproduction technology haven't gotten appreciably faster – modern photocopiers and computer printers aren't an amazing leap forward in speed compared to older mimeograph machines – but the output is vastly superior . . . even if stupid kids can no longer get high by sniffing fresh prints.

The ability of technological advances to do things *better* but not *faster* has caused consternation among some. For example, typing and distributing a printed office memo is not appreciably faster as a result of the computer revolution, but the output is vastly superior-looking (how much time is spent fussing with fonts?), the documents can be saved and recalled digitally, etc. Similarly it can be difficult for most people to tell that (say) windshield technology has improved dramatically over the past 100 years, since we aren't usually in the habit of testing the durability of windshields!

In Game

"Better" is a sometimes-ephemeral quality, but it does have a certain quality of "I'll know it when I see it." For game effects, the rules for Styling (***GURPS Social Engineering,*** p. 19) are one good way to model this. In the same way that a modern-day office worker who produced business reports and proposals via inkjet printer (or even dot matrix!) would signify a lower "status" than one who used high-quality laser printing, so too can advances in making things appear "better" be represented by a reaction bonus tied to an increased cost.

Alternatively, a modest skill bonus can model slight improvements (similar to *Equipment Modifiers,* p. B345), as can more unusual effects: reroll one failure per week/month/whatever attributable to the item's presentation, provide a slight bonus to self-control checks when using the item in stressful situations, etc.

However, in the world of weapons and defense, even a modest element of being "better" can provide a large advantage on the battlefield! Be careful before adding too many offense or defense bonuses to gear that heroes can easily get a hold of . . .

As a final note, coming up with a timeline of "better" (or even mentioning the possibility in an ultra-tech campaign) can serve as a useful tool when crafting adventures that focus on investigation or observation: "As you explore this abandoned vehicle, you know it was made more than 20 years ago because the seat's memory foam isn't temperature-neutral."

Do It Cheaper

In many cases, "cheaper" is another word for "faster" or "better," but it's certainly possible to envision advances in technology that have enabled something to be done less expensively without an appreciable increase in speed or quality. As one example, discounting the limitations of recording technology, the creation of audio content itself rivals the golden age of radio, with a commonplace desktop computer and free or low-cost software replacing a studio full of cutting-edge – and expensive – equipment. (Really, the existence of the podcast industry would likely flabbergast any engineers of 1938 . . . and the quality of the best podcast broadcasters who work for free or nearly free would terrify the best-paid radio performers of the same era.)

In Game

Simply take the cost of any of the gear in ***Ultra-Tech*** (or elsewhere) and lower the price! If the technology has plausible ties to other technology that you don't want to adjust the price of, you may need to do some hand-waving game-world chicanery to explain why the cheapness is limited to just that one example or subclass. For example, if you wanted to reduce the price of 1/8"-diameter TL9 rope (***Ultra-Tech,*** p. 81) to $0.20/10 yards (instead of $2/10 yards) but keep the cost of thicker-diameter ropes the same, then you might say the technological advance that allows for the cheapening of thinner rope doesn't scale up; even if the cheaper rope is braided together, its individual strands still respond aversely to heavier loads (necessitating older, more-expensive technologies for the thicker stuff).

Make It Smaller

Sometimes an advance in technology simply means items can do the same thing as they were able to do before with less space or weight. For example, the MacBook Air wasn't revolutionary for its speed or abilities when it was introduced in 2008, but it did lay claim to being the world's thinnest notebook.

In Game

Simply reduce the weight or size of the technology. Keep in mind that most technology is hampered by the limitations of the human body; for example, screens need to be large enough to read, keyboards need to be big enough to type on, etc. Of course, it's entirely possible to handwave these away, with sufficient innovation: "screens" projected directly onto eyeballs, virtual laser keyboards that enable the user to "type" on tabletops, etc.

Do Something That Hasn't Been Done

In some instances, technology has enabled something that wasn't possible previously. The entire space program is one example; getting to the moon is not merely a matter of improving your horse technology enough so you can ride there.

In Game

Of course, "something that hasn't been done" encompasses a *lot* of material! This is a good explanation for jumps in tech level (many TL9 goodies are things that aren't really possible at all yet in our modern-day world). Alternatively, opening up new branches of "science" or gear certainly fits this bill . . . say, if the world figures out how to unleash psionics – and starts developing the gizmos from ***GURPS Psi-Tech*** as a result.

Don't Do Something

In some cases, technological improvements are noteworthy because of what they let us not do. As some examples:

- Puncture-proof tires obviate the need to worry about most standard flat-inducing situations.
- Vaccines reduce or eliminate the possibility of infectious diseases.
- Advances in metal technology have ensured that our cutlery doesn't tarnish, our cars don't rust, and our miniatures don't poison children who've mistaken a handful of Skavens for Skittles.

In Game

To simulate this, look for any limitations or drawbacks in the item in question, then lessen or remove them. For example, a Forensics roll can determine the exact brand of standard nanocleanser (***Ultra-Tech,*** pp. 69 and 83) used; perhaps a new brand of nanocleanser doesn't have this detectability limitation, because it introduces enough environmental "chaff" to make it difficult or impossible to tell that nanocleanser was used at all!

Alternatively, it's trivially easy to add some ailment into a game world that technology can fix. If you declare that the space-jump mechanism (the only FTL travel means available) afflicts those who use it with space nausea for a week, then a helmet that reduces the illness to a day would be *very* desirable.

About the Editor

Steven Marsh is a freelance writer and editor. He has contributed to roleplaying game releases from Green Ronin, West End Games, White Wolf, Hogshead Publishing, and others. He has been editing *Pyramid* for over 10 years; during that time, he has won four Origins awards. He lives in Indiana with his wife, Nikola Vrtis, and their son.

Odds and Ends

The Technology of Ideas

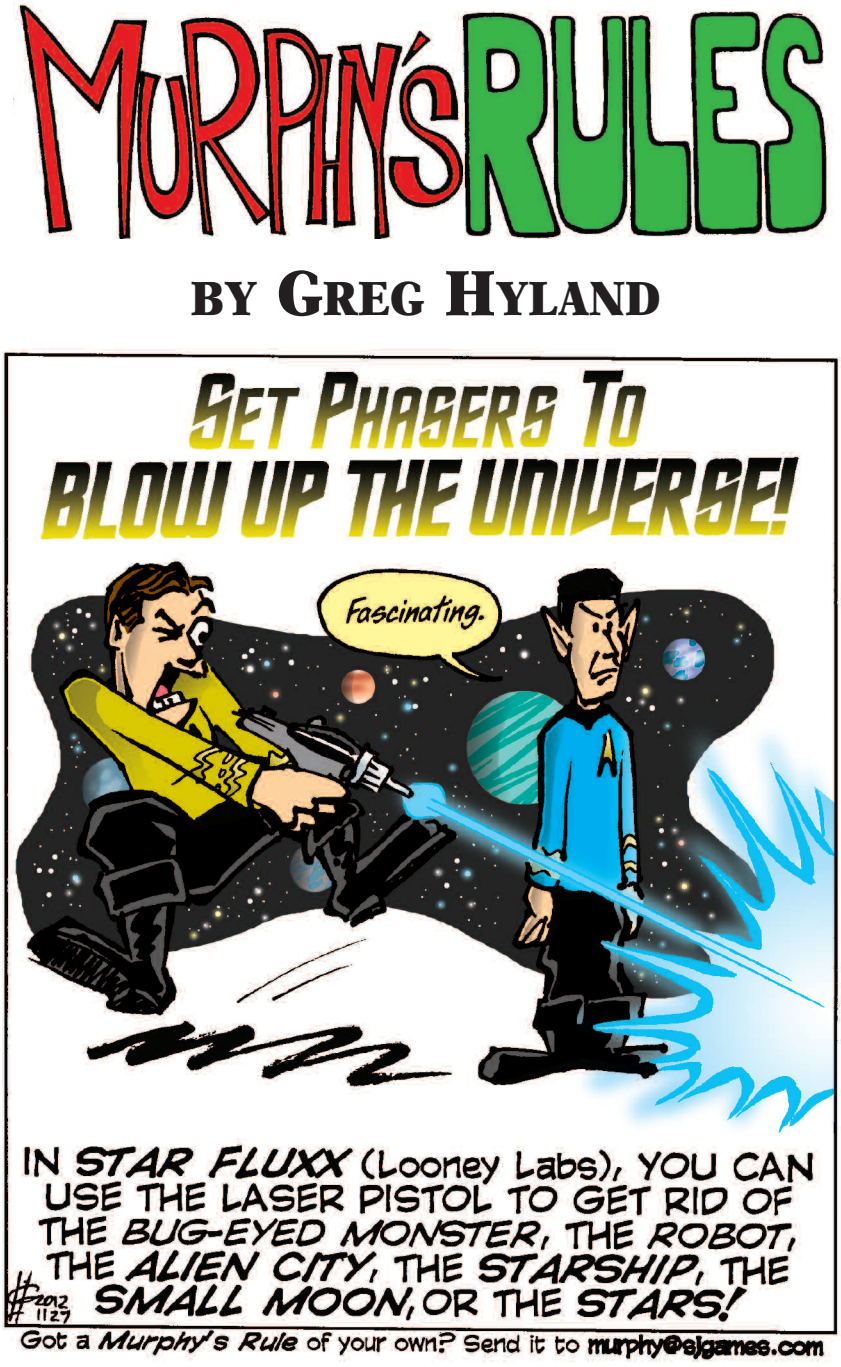
One aspect of "technology" that's often forgotten is the fact that *ideas themselves* are a form of "technology." For example, "money" is so commonplace that we forget it's fairly high-minded: "I give you this worthless piece of paper, and you give me stuff. Then, you give that piece of paper to someone else who gives you stuff!"

The adaptation of ideas in a society is frequently bolstered by technology. Money is bolstered by the concept of counterfeit-resistant currency, Kickstarter (an idea at its core) is only possible because of the technological underpinnings that allow its computer-heavy conceit, and so on.

One way to introduce new "tech" to society is to come up with an unusual or futuristic-feeling *idea,* and hand-wave away the technology that allows it exist. Here are a few ideas.

- *AItruism:* Unlike outdated models of altruism, the omnipresent microchips in all living beings allows for AItruism – a "currency" based on doing good deeds for others, tracked by the faceless cloud computing that underpins the whole thing. Thus, rather than relying on old-fashioned models of "I did a favor for you, so you owe me one," people accumulate AIts by helping others – which can then be redeemed to extract help from other participants (regardless of whether they had been directly helped by the askee).
- *Wholenet:* In a repressive or low-bandwidth universe with huge data-storage and fast-copy options, it may be possible for people to carry around their own private (static) "Internet." Those with Wholenet boxes can interface them as they interact with long-lost friends or associates, each side updating their contents to the latest iterations of the data stored.
- *Data Blinders:* In a setting where social embarrassments or other blurring between "private" and "public" might occur (which is to say, any world post-social-media), society may well come up with elaborate ideas of what is private or public information. The use of AIs, in particular, should permit the rapid determination of whether a piece of data was intended for the public at large. If it isn't, society pretends it doesn't exist (unless they're in a position to know the person's private info); revealing or attempting to exploit it is a big faux pas.

Keep in mind that ideas can be hard to wrap your mind around – in the same way cavemen would find credit cards baffling. However, all that's required to make them work is to presume that the *inhabitants of the world* accept and abide by them.



Appendix Z
The Psi-Sword

by Jason "PK" Levine

The psi-sword appears to be just a hilt, but through it, psis can focus energy into a potent melee weapon. It's perfect for anyone who could benefit from a light, easily concealed weapon *or* who could make use of its special damage effects. As with all psychotronics, this can be "realistically" introduced into *any* setting with psi, regardless of the tech level. In a fantasy game, it might be a specially tuned crystal hilt that acts as a focus for psionic energy, while in a 20th-century game, it could be a flux capacitor wrapped in an orgone shield.

Statistics

For all purposes except Damage, Notes, and *possibly* Cost (only because the GM may wish to adjust the price to fit the campaign), treat the psi-sword as a force sword (p. B272). Wield it with Force Sword skill; psionic Talent does not improve skill.

Damage depends on the psionic power being used to "energize" the sword. Only a psi can cause a blade to form (requires a Concentrate maneuver); in the hands of a non-psi, this is a paperweight at best. The sword can only accept energy from a *single* psionic power at a time, regardless of how many powers the user has. Wielding the sword does not preclude using psi; *all* of the user's abilities are still available, not tied up in the sword.

The sword does swing+(Talent) damage, but *not* based on the wielder's actual ST. Instead, his effective ST equals the total number of character points he has in psionic abilities (for that one power), divided by 3, rounded to the nearest whole number. Only count the points in *abilities* – ignore points spent on Talent, perks, or skills.

Example: Liz has Ergokinetic Talent 3 [15], EK Shield 5 [20], Lightning 4 [48], Interface [1], and the skills EK Shield-15 [8] and Lightning-16 [12]. Her effective ST is (20+48)/3=23, for swing 4d+1. Her Talent adds directly to this, for a net 4d+4 damage.

The damage type and notes vary based on the power being used; see below.

Psionic Powers

The armor divisor, damage type, and special effects related to the psi-sword depend on the psionic power being used. This list includes all of the powers on pp. B254-257, as well as the new ones from ***GURPS Psionic Powers.*** (For the "additional powers" from that book, treat Animal Telepathy *or* Dream Control as Telepathy, and Biokinesis *or* Psychometabolism as Psychic Healing.)

Even a blade that does fatigue or toxic damage is still *solid* energy that can be used to parry incoming weapons – it just can't *damage* them. The blade cannot break and does not require a source of power apart from the psi.

Anti-Psi: Toxic damage. Ignores *all* armor except that provided via anti-psi or psi. Psis take 2× injury, or 3× if they have two powers, 4× if they have three, etc. (Only count powers for which they have actual *abilities,* not just Talent and/or perks.)

Astral Projection: As for Astral Sword (***Psionic Powers,*** p. 28). Character points in the Astral Sword ability count *triple* when calculating effective ST.

Ergokinesis: Burning surge damage with armor divisor (2) – *except* vs. metal armor, which is treated as DR 1. Those injured must roll HT (at -1 per 2 points of injury) or be stunned.

ESP: Fatigue damage. Ignores *all* armor except that provided via anti-psi or psi. Parry becomes +2F, but with no penalties for encumbrance.

Probability Alteration: Cutting damage with armor divisor (2). Raise the critical success target number by 2 (so 3-6 normally, 3-7 with skill 15, or 3-8 with skill 16). If you roll a critical failure vs. Force Sword, roll against it again; if this verification roll succeeds, it's just a normal failure.

Psychic Healing: Toxic damage with armor divisor (2). This necrotic damage *cannot* be healed prematurely via surgery, Psychic Healing, potions, Regeneration, etc. – only natural healing. (Very Rapid Healing *does* apply.)

Psychic Vampirism: Toxic damage with armor divisor (2). Every 5 full HP of injury inflicted in one blow restores 1 FP to the wielder.

Psychokinesis: Cutting damage with armor divisor (10). Does an extra +1 damage per die and has Reach C-3.

Telepathy: Wielder can switch between fatigue or toxic damage as a free action. Ignores *all* armor except that provided via anti-psi or psi. Treats Mind Shield as DR.

Teleportation: Corrosive damage with armor divisor (10). As a special effect, those injured have bits of blood and flesh teleported 1d yards away in a random direction.

The power is all in your mind!

About the Author

Jason "PK" Levine is the Assistant ***GURPS*** Line Editor and author of ***GURPS Psionic Campaigns, GURPS Psionic Powers,*** and ***GURPS Psis.*** He obviously likes this kind of stuff.

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