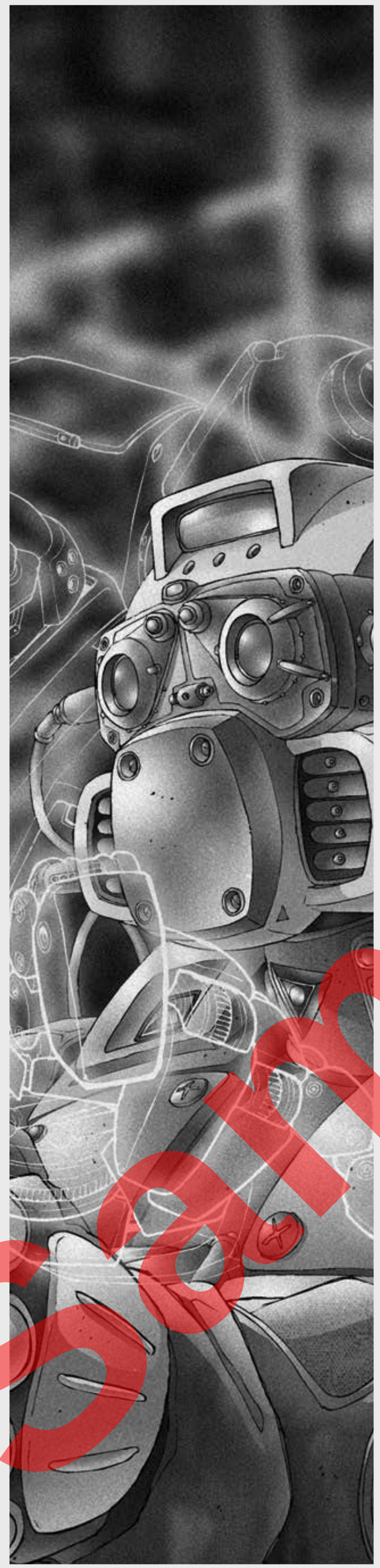
HEAVY GEAR

TERRANOVAN TECHNOLOGY



Heavy Gear Technical Manual — Behind The Scenes

The book you are holding in your hands is the end result of a long, strange project. Strange because it seemed to evolve on its own, rather than being developed like the rest of the Heavy Gear products.

The Tech Manual began as a chapter in the early draft of the Heavy Gear Rulebook. Its main purpose was to give the reader some insight into the technology of the Heavy Gear universe, and as such concentrated mostly on the Gears themselves. Because of the growing amount of material that had to be included in the rulebook, it was decided to cut out this chapter and expand it into a separate technology book.

This new project proved somewhat arduous to plan and write: the technology we were to talk about was meant more for look than accuracy — after all, Heavy Gear isn't an engineering course, it is a game. So, with our apologies to the purists out there, we crunched down on formulas and explanations until we were left with something that can be used on the corner of a game table, without bothering too much about details like engine efficiency or beam energies in joules. It is still possible to get some accurate numbers by checking out a few of the more reality-based vehicle design systems out there: once the "real" stats are generated, it is usually a matter of seconds to convert them to Silhouette. If you prefer not to bother (after all, this is science fiction — might as well make them up), we've included a detailed primer on chosing vehicle statistics.

What started as a short book soon grew, and grew... Then our readers started asking for clarifications and new rules about certain "real world" ammunition types, some fuel-related rules, hints and tips on scratchbuilding vehicles in the field, and more. Well, what else could we do? We complied, and we hope that everyone will find the material within these pages useful to their games, whether roleplaying or tactical.

Now, grab your favorite datapad and your lucky wrench, and let's take a look at what makes these Gears tick...

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Dedicated to the memory of Gene Roddenberry, for challenging the boundaries of what we think of as reality.

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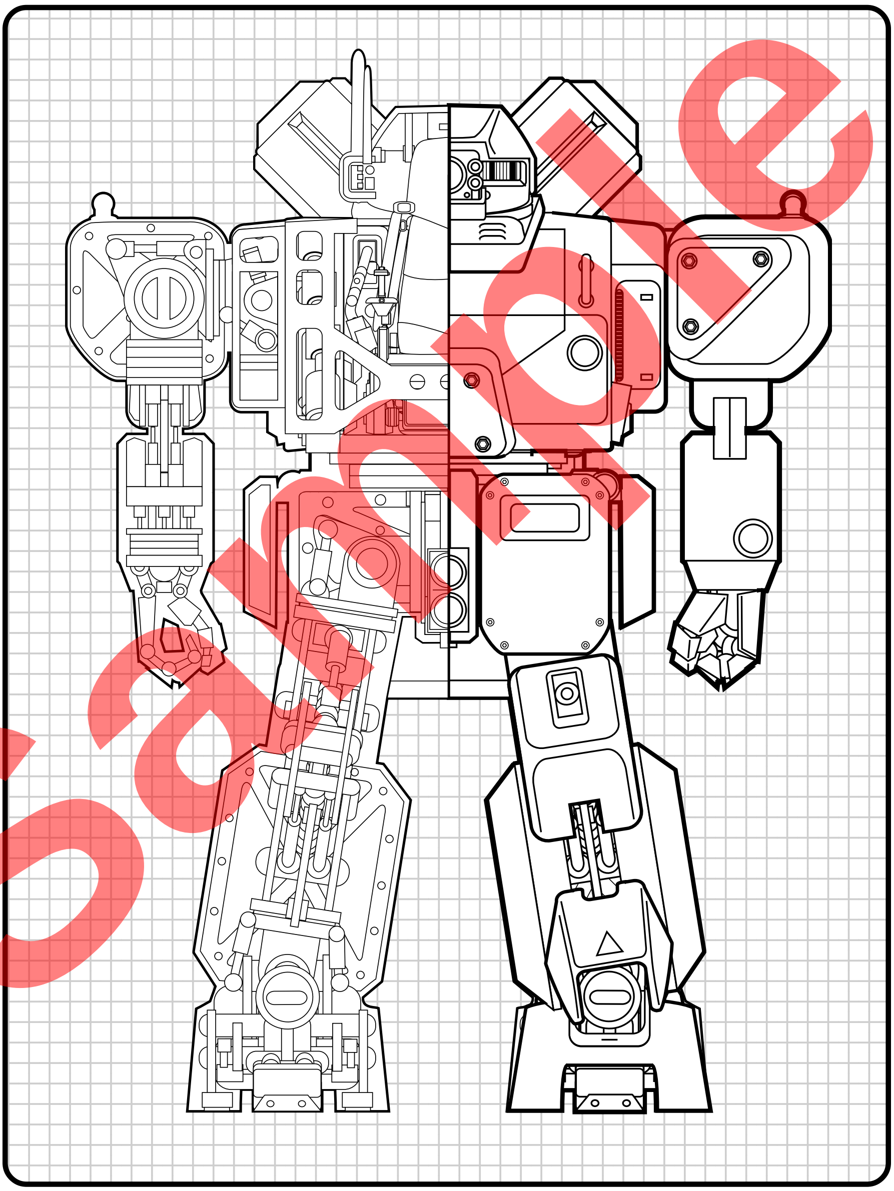

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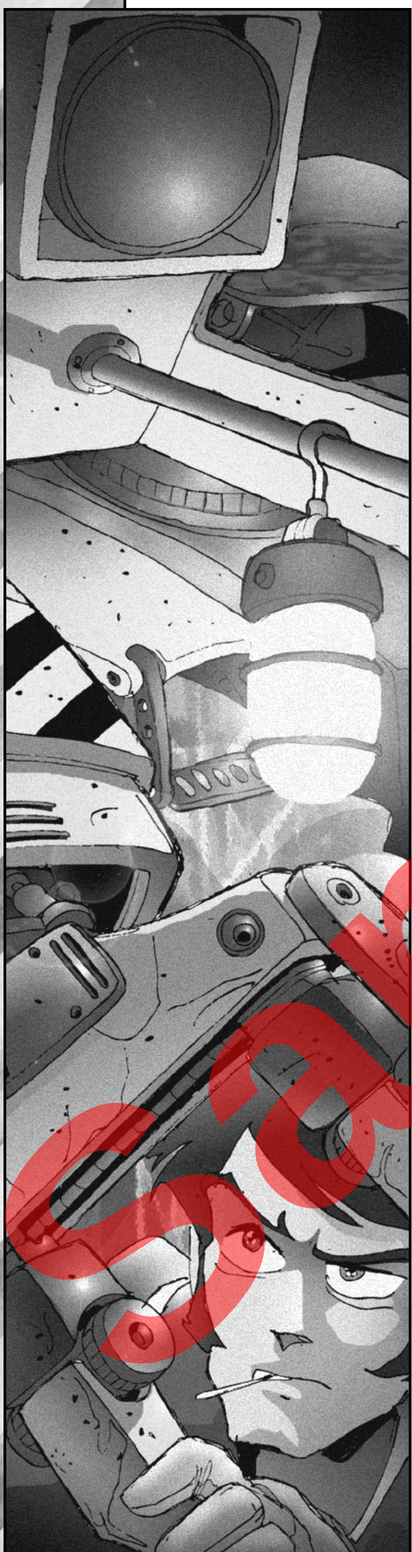
BITS AND PIECES



Jak whispered a quick prayer and pushed the ignition. For a few glorious seconds the V-engine purred and roared as it should. It all went downhill from there.

First came a vague gurgling, the engine seeming to choke on too much fuel. Jak hoped against hope that the purr would come back. Next, the gurgling changed pitch, becoming a wheezing and soon a screech. Before Jak could reach for the switch, the constant high pitched wail turned into a staccato pulse of metal on metal sounds, until both drive shafts halted with a resounding klunk. Then smoke started billowing out of the engine.

Jak doused the fire with his extinguisher, trying his best not to curse — at least, not too loudly. Once the flames were out, he took a moment to look around his shop. The chassis of the *Groundhog* he was working on was mounted on the winch in the center of the garage. Several desert bikes, water filtration processors, even a few home appliances, stood about in various stages of disassembly. Doing his best to forget that the engine parts he had just heard tear apart would not be replaced before the next caravan came through the area, Jak looked over the rest of the Gear.

"Let's see," he took out a notepad computer and started taking notes. "One shot engine, one jammed pincer, one dead laser torch. All in all, one sorry looking machine."

The pincer looked like it was clogged with sand; a common and frustrating problem, but one he could solve in an hour or two. The laser torch, on the other hand, was a more serious issue. Peering into the forearm casing, he saw that the main focusing array had been fractured. He winced — more valuable parts to order.

Accessing the caravan schedule menu, Jak tried to figure out how long it would take to get all the components he needed. The Oxford caravan was coming through at the beginning of the next season and they always had a good selection of machine parts. But a season was an awfully long time to wait without a Gear. Juggling the schedules, he found that the Zeras caravan would be in Hopespring in three weeks. He could probably take a trip out there to get some parts. Still fumbling with the notepad, he went over to the local-band radio in the other room.

"Echo Seven, this is Zulu Niner. Come back." The radio crackled to life a second or two later.

"Echo Seven here." Echo Seven was the call-sign for the Garnet homestead. Gil Garnet had brought in the Work Gear two days earlier when he came to town. Jak knew he must have been anxious to get his machine back, for the harvesting season was getting nearer. "What's the word, Jak?"

"Not good, Gil. The engine's a write-off and it'll take me three weeks to get the parts. I can machine the pistons myself, but I'll need a new combustion chamber." Jak heard his friend groan. "But you still got a *Prairie Dog* don't you? Can't you make due for a few weeks?"

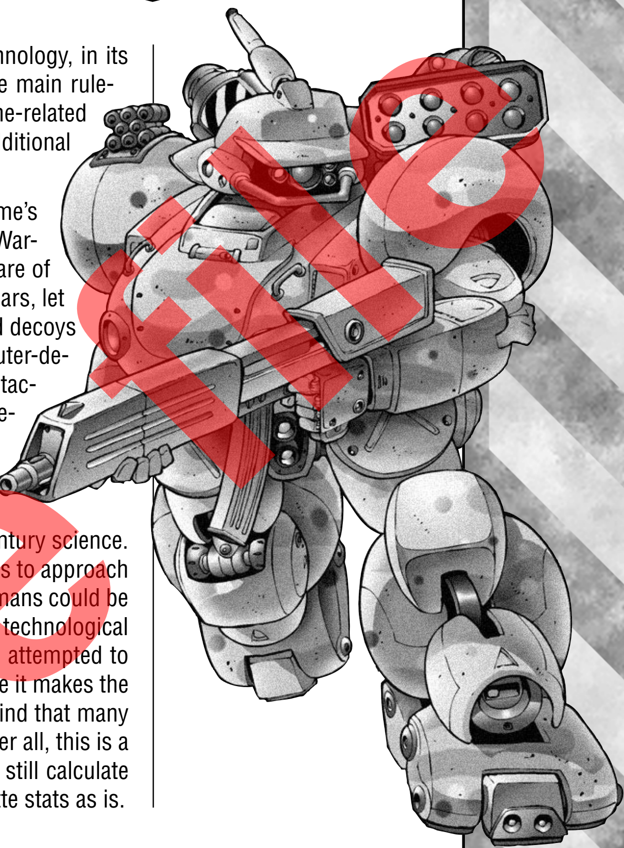
"I could if the damn *Dog*'s NNet hadn't shorted out last night. The cursed thing is totally frozen up. Can you come and take a look?"

Jak closed his eyes and took a deep breath. It was going to be a long three weeks, he could feel it.

1.1 THE TECHNOLOGY OF HEAVY GEAR

Heavy Gear is a science fiction game universe, so it is only normal that technology, in its many forms, is omnipresent. This technical manual was originally part of the main rulebook, but it grew so large it became a book of its own. While there is game-related information throughout the book, this manual's main function is to provide additional atmosphere and flavor to **Heavy Gear**.

One of the limiting factors that became readily apparent when designing the game's background was the fact that it is impossible to accurately predict the future. Warfare in the early part of the twentieth century was very different from the warfare of today. We can barely predict what equipment we will be fighting with in fifty years, let alone in four thousand! Future wars may well be boring affairs with robots and decoys flying and crawling all over the place in an electronic fog, operating on computer-defined strategies. The human factor will probably be reduced to intuition, some tactics, and cannon-fodder. Not a very exciting environment for roleplaying. Consequently, some of today's latest technological developments were simply disregarded or reduced in importance, and a few new ones were theorized instead to create a unique, more playable technology base for **Heavy Gear**.



The technology presented in this manual is obviously inspired by twentieth century science. The descendants of today's scientists will probably find some entirely new ways to approach technical problems that haven't even been considered yet. For all we know, humans could be using flying saucers in a few decades. Despite this, many of the **Heavy Gear** technological assumptions are based on scientific postulation/theory, and the authors have attempted to remain accurate whenever possible. This approach was chosen simply because it makes the game feel more true to life, and thus easier to relate to. It should be kept in mind that many subjects had to be simplified in order to keep the rules fast and playable — after all, this is a game, not an engineering course. Players wishing for scientific accuracy can still calculate exact values with other, more accurate manuals and transfert them to Silhouette stats as is.

1.2 TECHNOLOGY LEVELS

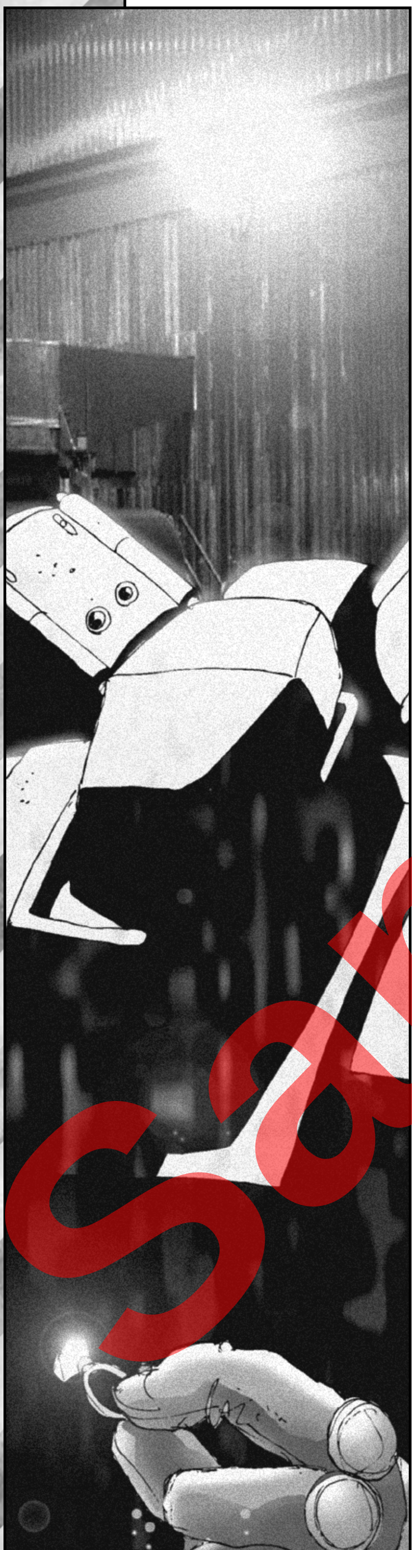
In the course of their adventures, the players are as likely to see an advanced, miniaturized computer terminal on the wrist of a lizard-riding peasant as they are to see two military officers fight out an old-fashioned honor duel with computer-designed composite/ceramic swords. They will be given the opportunity to pilot a 5-meter tall humanoid machine that emulates the human body — and runs on ordinary gasoline.

The presence of many coexisting technological levels in every walk of life is one of the main features of **Heavy Gear**. While this concept is nothing new in science fiction, it does take some getting used to from players expecting to have high technology at their beck and call. Just because the technology exists for a given task does not mean it will automatically be available. Terra Nova is still mostly a frontier planet and the basic necessities of survival will override any other concerns. Sometimes, it is no use knowing how a tractor works when you do not have the tools to build one, or the fuel to operate it. People use what works for them.

In general, the level of technological sophistication is at its highest in the city-states. With the proper connections and contacts, almost any item that is known to the Terranovans of the 62nd century is available (some more than others, obviously). Technology is also more visible within the cities: personal electric cars, holographic advertisement, simple robots, etc.

As we move into the surrounding countryside, the technology becomes more rugged, adapted to the rigors of everyday use. Surfaces are not shiny and neat anymore: items show the marks of constant use. There are fewer luxury objects and repair facilities for the more advanced items become harder to find. In some of the most remote or poor areas, people may hand-manufacture most of what they own, trading only for the things they absolutely cannot build by themselves. The Koreshi Sand Riders are one example of such people.

DIAMONDS AND STEEL



The diamond looked dull now, trapped between Lamar's stubby and grease-laden forefinger and thumb. The stainless steel band appeared almost mundane until the single stone caught the light, glinting with blue fire. Maybe not the romantic ideal for an engagement ring, but he had thought Mara would like it. Emphasis on the "had."

A horn-blast from a *Camel* truck snapped him out of his reverie and he put the ring back on top of Mara's letter. Walking out of his small office and into the massive repair hangar, he tapped on the remote attached to his tool belt to open the main door.

"Okay, bring her in!" Lamar gestured the driver toward one of the hangar's empty work stations. Heavy Gears and other vehicles in various states of disrepair were scattered about the room. The truck driver swore several times as he tried to navigate through the maze of metal carcasses. Lamar barely noticed.

"Too much, too soon," her letter said. Lamar felt a stabbing sensation somewhere in his chest at the memory. They had met two cycles ago and had been living together almost three seasons. They had been happy. He loved her so much it hurt; she supposedly loved him. What was wrong with marriage, for Mamoud's sake?

He barely stepped out of the way as the *Camel* backed into the designated spot. Strapped to its rear deck was the massive hulk of a damaged *Hunter*-class Heavy Gear. It was difficult to tell what was wrong with the war machine since it was half covered by a heavy green tarp, but from the smell of burnt metal, Lamar was sure it would not be pretty.

The driver stopped the truck just under the ten-ton autoloader. Lamar grabbed the remote hanging on a nearby support pillar and directed the robot arm to lay the Gear on the work platform. Heavy clamps secured it against the frame with a dull clank. Overhead, powerful lamps came on, bathing the wounded machine in bright white light. Lamar signaled the driver with a dull shrug and turned to his work, hoping to become lost in a world of simple technical problems.

He shook his head. The Gear had holes the size of a human fist in its lower body. Enemy fire had destroyed part of the machine's movement system. Pieces of the ceramic and composite layers showed underneath the broken and shattered outer covering. Repairing the *Hunter* would mean long hours of grueling work. Just what he needed.

Grabbing a power drill from a nearby rack, Lamar unfastened the damaged leg cover. Using a lever, he attempted to pull back the armored panel, only to discover it was half fused with the neighboring sections. A short blast from his plasma torch cut loose the last of the melted material and the heavy plate fell to one side with a loud "thud," exposing the damaged inner mechanisms. Part of the leg's alloy skeleton had been shredded by a shell, metal fragments lodged in every nearby internal surface. Lamar took down a hand held electromagnet and passed it over the machine-works, picking up the loose fragments. He watched as they caught the light, glittering like little diamonds at the end of the magnetized rod.

Lamar hated diamonds.

2.1 MATERIALS AND STRUCTURES

Research constantly develops new and useful materials. Most of the work is centered on finding new ways to improve the qualities of the existing alloys and composites while simplifying the manufacturing processes involved in their creation, for the demand is great. Few Terranovan items and vehicles use unmodified natural materials in their design.

Construction materials are generally divided into four broad categories: metals, ceramics, polymers and composites; and three main physical states: solid, liquid and gaseous. However, with the advancement of metallurgy and other material technologies throughout the centuries, the distinction between these categories has blurred somewhat. For convenience and ease of reference, they will be retained for this text.

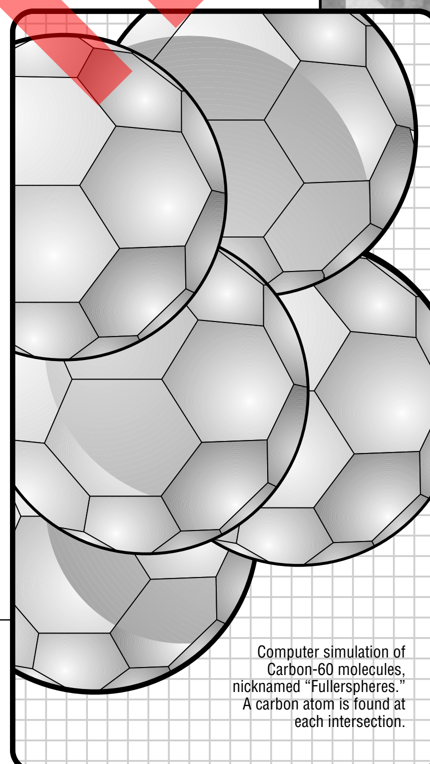
2.1.1 METAL ALLOYS

For simplicity, any metallic material composed of a mix of two or more different elements is now called a metal alloy, regardless of its contents. Alloys have the remarkable property of being more than the sum of their constituent parts; for example, iron and carbon are brittle, but steel is fairly ductile. Each element brings different properties to the alloy.

Iron was one of the greatest discoveries of all times, but it was not until the iron/carbon alloy commonly known as steel appeared that this metal became vital to Man's industrial society. Since then, steel — the generic name for an alloy whose main component is iron — has been one of the most widely used construction materials. 62nd-century steels are composed of a multitude of metals, each mix tailored for maximum performance for a specific use. The internal frame of many Heavy Gears is made out of Flexite, a steel alloy that is both tough and flexible (see text below).

The twentieth and twenty-first centuries were the first to see the advent of new kinds of metal alloys made possible by the zero-g conditions of the space stations. Metals that would not normally mix well suddenly seemed more cooperative, creating materials of incredible strength. Further research in the centuries that followed showed that proper manufacturing techniques could yield similar results without the expense of sending the material into space and bringing it back. New molecular-level shaping techniques, using a combination of heat treatments, magnetic field generators and particle beams, can force completely new crystal structures into existence.

Metal alloys are commonly used in the 62nd century for all sorts of engineering functions. They are known for their high tensile strength, electrical conductivity, ductility and isotropic properties. Rare metals are used in alloys for specific purposes. Iridium, vanadium, beryllium and other such metals are often found in the resilient alloys required by military technology.



Computer simulation of Carbon-60 molecules, nicknamed "Fullerspheres." A carbon atom is found at each intersection.

• FLEXITE

Flexite is a steel alloy created by advanced molecular forming techniques. Unlike standard steel, Flexite's carbon content consists partially of Fullersphere-type molecules that impart additional strength and greatly stabilize the alloy. Flexite also contains several other metals, such as iridium and vanadium, in minute quantities to improve its resistance to corrosion and surface abrasion.

2.1.2 CERAMICS

These crystalline materials were originally thought unsuitable for load-bearing functions since they were too fragile and brittle. With the discovery of new manufacturing techniques in the early centuries of the third millennium, ceramics, now stronger, saw use in a variety of items.

Most ceramics have the advantage of being extremely resistant to high temperatures. For this reason, many modern armor materials include layers of ceramic. Some armor types are specifically intermixed with ceramic compounds to be even more resistant to energy-based weapons such as shaped-charge warheads and laser beams.

Ceramics are used in internal combustion engines and other high-heat applications. They also see wide use as shielding and heatsinks for fusion reactors and spaceship hulls, particularly those equipped for atmospheric re-entry. Special ceramic coatings and glazings can also be manufactured to improve the durability of spaceships.

Natural ceramic materials, such as several varieties of rock, are also used extensively on Terra Nova. In the early centuries of colonization, most of the buildings were made out of the local variety of rock — lime stone, granite or quartz — because it was cheap, available in large quantities and easy to work with. With proper care and a thin external polymer coating, rock also proved to be a fairly durable material.

2.1.3 POLYMERS

Polymers are long strings of organic molecules artificially attached to one another. This yields a wide variety of possible material qualities. Polymers can be molded, extruded, shaped, machined, etc. They are generally light and adaptable and are used in many everyday items. Polymers are also used in the weapons industry for light gun casings and missile outer shells. An extremely tough ballistic plastic called Armoplast is used in several kinds of laminated armor, especially the personal "turtleshell" armor worn by front-line infantry. Ceramics and polymers are often used as a matrix for composite materials because they are easy to shape and contribute properties which complement those of the metallic alloys which most often constitute the fibers (see *Composites*, below).

Most polymers are created from strings of carbon molecules secured together through various industrial process. Compounds are added during synthesis to give the resulting material specific properties. In addition, special chemicals are used to plug "holes" in the chemical structure of the polymer, considerably improving its strength and heat resistance. A polymer material can often be designed to fit a specific job or application, though there are limits: few polymers can resist extreme work conditions, such as very high or low temperatures.

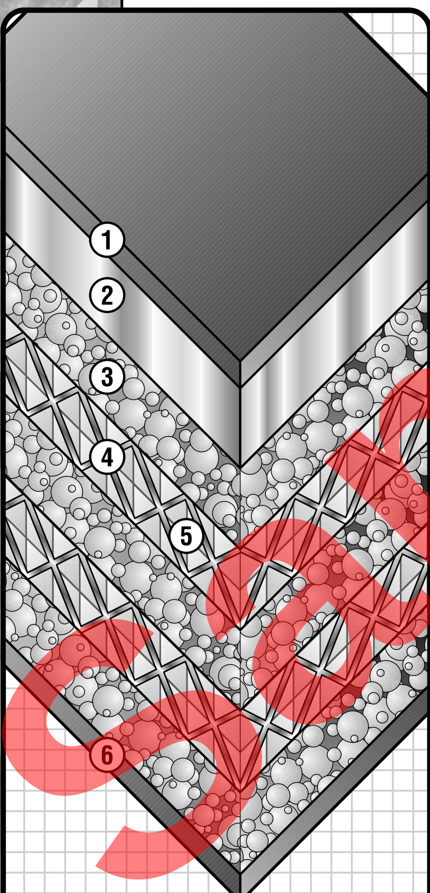
Some advanced molecular-shaping techniques can produce memory plastics, polymers whose molecules can rearrange their position and internal structure when placed under certain conditions (heat, pressure, etc.) and transform into shapes that are "programmed" within the plastic's structure. These bizarre shape-changing materials are used in very specialized functions since they are somewhat limited in their versatility and structural strength.

2.1.4 COMPOSITES

Composites, as their name indicates, are a combination of two or more different materials. Most often, this means a fibrous material encased in a matrix of some sort, the fibres providing tensile strength and the matrix providing structural integrity to the whole. Wood is a typical natural composite, a structure of cellulose fibers in a lignite matrix. Ferrocrete, a ceramic compound reinforced with metallic fibers, is another example of composite.

Composites are widely used in the 62nd century because they can be designed for almost any load and/or use. Any combination of materials — plastic, resin, ceramic or metal — may constitute a composite. For example, Durasheet is a weave of high strength alloy fibers in a semi-flexible ballistic polymer (Durasheet is widely used in armor construction; see text below for more detail). Often, more than one type of fiber is used for additional strength or properties. The fibers are aligned within the composite during the manufacturing process, providing increased structural strength only in the direction(s) required. This allows the designers to reduce the amount of material required, hence greatly reducing the overall weight of the part. For that reason, composites are widely used in the vehicle industry, particularly in aerospace manufacturing procedures.

Composites are custom designed for specific applications, creating materials with the perfect balance of strength, durability and weight. Unfortunately, composites are more expensive to prepare and much harder to repair since the damage, if any, is usually deep within the composite structure. Stress-induced core delamination, where micro-layers become separated within the material, is one such problem. In these cases, complete replacement of the affected piece is recommended.



1- Upper surface glazing
2- Ceramic layer
3- Polymer foam buffer zone
4- Flexite fiber network
5- Armoplast II matrix
6- Anti-spalling polymer

• DURASHEET ARMOR

Durasheet is a flexible but tough composite that is used in a wide variety of applications. The fiber networks used in its construction are composed of Flexite and one or two other alloys depending on the grade and intended use of the Durasheet variant. The matrix is made of Armoplast II-D, a more supple grade of the well-known ballistic plastic. The finished Durasheet is about one millimeter thick and can be worked to almost any shape. It is highly resistant to tears and punctures.

Several such sheets are necessary to create a plate of armor; often, layers of ceramic and foamed polymer are added in-between for additional heat resistance and durability. The top layer, barely half a millimeter thick, is made of an anti-corrosive metal alloy or a ceramic glazing. These layers are resin-bonded together according to the required armor panel shape. Generally, a thin ballistic polymer sheet is placed between the chassis and the armor plate to absorb any spalling or fragment that may escape the armor.

Whenever an attack strikes the plate, the outer layer shatters or vaporizes to absorb at least part of the energy. The next layer, always a rigid ceramic, shatters or tumbles projectiles, forcing them to lose still more energy. The polymer foam buffer then catches any debris or slows down kinetic penetrators by deforming instead of yielding. The same layer is also the main line of defense against energy weaponry, vaporizing to diffuse the beam and absorbing fast particles cascading from the impact. The Durasheet composite then stops and absorbs the rest of the attack. Several alternating layers of foam and Durasheet can be used for increased protection, though this increases the cost, weight and bulk of the plate.

2.2 FASTENERS

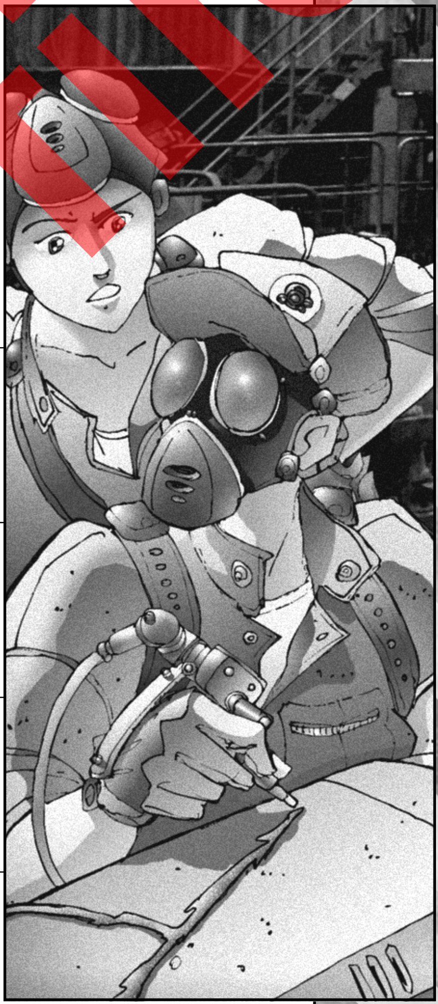
Fastener is the name given to any material or object(s) that hold(s) a given structure together. Early examples of fasteners include knotted ropes, wood nails and tree resin. As the level of technology rose, fasteners kept pace: metal nails, screws, glues, etc. 62nd-century engineering makes use of these and several others.

2.2.1 SMART GLUES

The development of polymers and composites has given rise to a whole line of structural glues, glues that not only bond two surfaces, but also serve as a proper load-bearing path. Most modern glues are rapid-forming, composite types, usually epoxy-like resins with specialized filler. The proportions are mixed at the factory, or in the workshop, to vary the glue's properties according to the task at hand. These so-called "smart glues" are used extensively in armor and aerospace construction as well as electronic assemblies.

Smart glues are one of the most useful tools available to the technician faced with the prospect of jury-rigging a damaged mechanism. Their variable properties allow different make-shift repairs to be made with a single container of glue.

Here are four of the most common combinations possible with the chemicals contained in a standard glue pack:



- **Rapid-forming mix**

Half the required repair time, but the technician must use extreme caution in choosing where to place the glue to make sure the repair will hold. If he makes a mistake, the glue bond breaks and the previously repaired damage returns.

- **Slow-forming mix**

This is the mode used for normal repair. The mix can be colored using special dyes to make the repair disappear (or stand out, if required) and can incorporate reinforcing fibers for a stronger bond. Depending on the thickness of the glue coating, this mix sets in about one to six hours.

- **Foam mode**

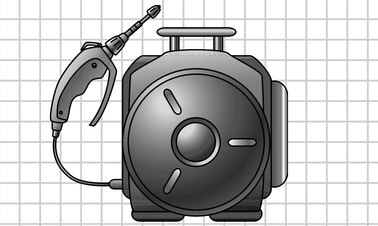
Under the action of a special catalyst, the glue becomes a foamed polymer material. This foam can be used for tasks such as plugging holes, supporting loose equipment and wiring, etc. The foam is not sturdy enough to act in a true structural capacity, nor can it be used to patch up damaged armor plating.

- **Conductor mode**

With the proper catalyst/impurity mixed in, this combination hardens into a solid paste that can conduct electricity. Depending on the "doping" procedure used, the paste can serve as make shift wiring or even low-grade capacitors or resistances. The conductor mode is far from efficient, but it does the job.

2.2.2 WELDING

Welding is often used where parts made of similar metal or alloy have to be joined. Due to the typically high melting point of modern metallic materials, however, new methods of welding, involving tools with a higher energy output, are required. Portable and semi-portable kits for flash and plasma welding, called simply "welders," can now be found in most well-equipped workshops. These can often reach temperatures of up to 10,000° Celsius for short periods of time, sometimes more (depending on the tool and the facilities). The bulk of the equipment and the short range of the torch makes for a poor weapon, however.



Portable welder with super-conducting battery pack

Most welders can act both as a high-powered cutter and as a standard welding torch. Some bulky low technology models still rely on the oxydation reaction of two gases, but more modern devices use a plasma arc instead and are electrically powered from one or more superconducting loops. Power packs using standard hydrogen fuel cell generators are also available. The entire power pack assembly is housed in a rugged high-impact casing designed to protect it against rough treatment from hurried technicians.

ON THE RUN

Dorel climbed onto yet another wrecked Gear. "Damn Jon and his gung-ho piloting," she mumbled between exhausted breaths. Right now, she was tired, worried, and thoroughly fed up. They had been scouring the junkyard for the last two hours trying to find a replacement pump control board for Jon's battered *Hunter*. Rovers weren't supposed to be a threat to them, but their near-disastrous last encounter with the Broken Tusk raiders had caused some damage to the left arm of his Gear, short-circuiting a tiny cerachip. Without it, the limb was practically useless.

"None of this would have happened," she grumbled under her breath, "if Jon could admit we were outgunned." The raiders had been using old refurbished Gears and vehicles to prey on the homesteads of the region. The *Basilisk* and *Bear* Gears may have been discontinued, but they could still pack a punch. Dorel knew these rovers. They were not the types to let their enemies walk away from a fight.

She brushed aside the dust and opened the access panel on what was left of a wreck's left arm. Peering into the opening, she pushed aside bundles of frayed wiring and oily conduits until she spotted what she was looking for: a small oblong box containing the relay circuitry for the upper arm area. Dorel flipped open the box's armored cover and retrieved a tiny square of colored plastic. "Ah-hah!" she said, triumphant. She cautiously climbed back down, almost slipping several times, and walked back to the makeshift repair scaffolding. The hills of the scrap heap seemed to go on forever; plenty of places for raiders to hide. She hurried up.

"What do you make of this? Think it could do the trick?" The young woman tossed the lightweight unit to her partner. Jon opened his electronics kit. Working with practiced ease and an all-too-casual air, he inserted the yellow chip into the kit's probe compartment but took it out almost immediately when nothing happened. Cursing the bad contacts, he cleaned them out with a small file and reinserted the chip. He then watched the readout intently, hoping for a positive match. The screen turned green and started spouting information about the chip's function, internal memory and other useful statistics. A satisfied smile came across his face, one Dorel had learned to hate at times like these.

"Well?" she said with impatience. She jumped off the wrecked Gear and nervously looked around her, as if she was expecting something bad to happen. She suddenly felt very anxious, and she had learned to always trust her gut instincts. "Is it still operational?"

Jon smiled and closed the kit's lid. "As usual, your technical flair hasn't failed." He walked to the hulking form standing nearby and climbed on the *Hunter*'s knee to get to the damaged arm. Whistling softly to himself, he used a pair of delicate-looking tools to reach into the mechanical limb, pushing aside wiring and damaged components. "Shouldn't be long now. Gimme five minutes to finish installing it."

Dorel was stewing in her own frustration when the loud "thud" of an explosion suddenly broke the silence. Then, a rolling echo boomed out from the other side of the huge scrapyard. She quickly checked the ammo clip of her heavy 9 mm pistol, then snapped it back into the gun while hurrying to her *Cheetah*. "You know, we may not *have* five minutes."

3.1 TYPES OF ELECTRONICS

Electronics. For millennia the heart and soul of the machines of Mankind, these complex items are vital to the people of the 62nd century. Circuitry is used in all types of equipment, from the lowly kitchen appliance to the most complex military dropship, practically all are monitored by a computer of some sort.

The electronic circuitry of the 62nd century can be roughly divided into three main categories: ceramic chips, neural networks and the more advanced optical NNets. All have their advantages and disadvantages, but some are more suited to certain tasks than others.

3.1.1 CERAMIC CHIPS

Silicon chips are the oldest form of computer technology still in use. Actually, "silicon" is a misnomer: this material has not been used for centuries, having been replaced by more advanced ceramic compounds and superconductors that dissipate heat better. Less heat means that more circuits can be placed on a given surface, decreasing the overall size of the chip and improving speed and processing power. However, the old name remains common in popular language; they are also often referred to as "cerachips."

Externally, the chips still look like black or colored bits of plastic or ceramic with metal connector pins sticking out. Color coding is widely used in the military, although there is no set standard (which causes many, many problems for technicians working on unfamiliar circuitry). A rough set of universal standards did emerge during the War, though, and many of the newer vehicles carry such color-coded electronics. Shape is also a common indicator or the function of the chip, though not an absolute. The table below lists the most common colors and shapes as well as their associated functions.

Although they are incredibly slow when compared to modern optical NNet systems, silicon chips have the advantage of simplicity, extreme ruggedness and ease of manufacture. Automated micro-factories can turn them out by the handful if fed the correct raw material and given the time to lay out the precise circuitry within.

Cerachips are chiefly used for low-power and low-speed applications such as door controller mechanisms, low-tech appliances and the like. Military use finds them in simple but important circuitry such as pump relay controllers, sensor sub-interpreters and many types of system monitoring devices.

CHIP COLOR CODING

Color	Shape	Usual Function
Green	Rectangular, Round	Communication
Blue	Octogonal	Sensors
Red	Triangular	Fire Control
Yellow	Rectangular, Square	Mechanic/Monitoring
Black	Rectangular	Movement

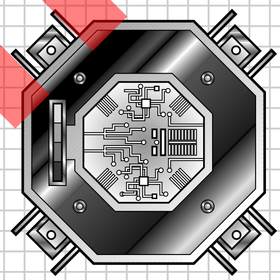
• Self-diagnosis

Some advanced chips boast self-diagnosis readouts and can offer limited troubleshooting advice — unfortunately, most often the advice is "this chip is burnt out. Replace as soon as possible."

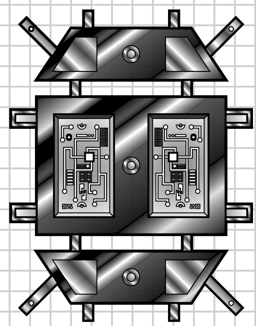
The presence of a SD readout makes the task of identifying or evaluating the chip much easier and faster. The readout is sometimes faulty, however, and an incorrect evaluation can be provided: a good chip reads as a bad one and vice-versa. A good tech knows when to trust a readout or not.

• Customizing chips

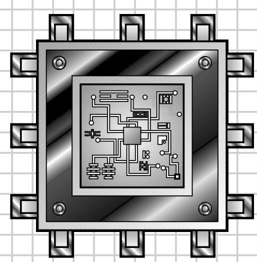
Modern ceramic chips can pack an awful lot of components onto a very small surface. Heat is not a problem since super-conducting links and ceramic compounds are used throughout. As a result, chip manufacturers tend to put more logic gates and other components than called for by the chip's intended function. This does not raise the price of the chip appreciably and enables it to fulfill several possible tasks by simply switching a couple of jumpers inside the casing. Therefore, many techs carry scores of blank, usable chips ready to replace almost anything at a moment's notice.



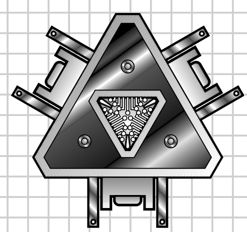
Sensor Control Chip



Circuit Monitoring Chip

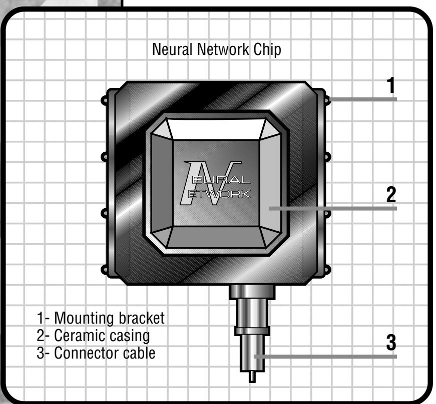


Mechanical Control Chip



Fire Control Chip

3.1.2 NEURAL NETWORKS

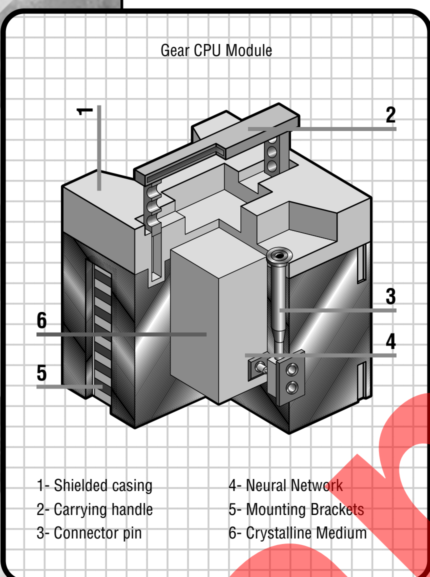


Neural networks date back to the beginning of the third millennium and have been the basis for many of the advancements in computer science that followed. Although research started as early as the late twentieth century, no significant improvements were made until the widespread use of cerachips enabled the construction of small, interconnected circuitry.

NNets are flexible electronic circuitry, so named because they mimic natural neural pathways. These sophisticated electronic circuits are able to learn from their mistakes and establish new connections within their matrix by changing their basic programming and by creating new electronic pathways through artificially forced crystal growths. Such changes are monitored and limited by design parameters that are generally implanted at the factory to prevent unwanted variations from the intended functions. These advanced computer chips form the basis of the 62nd-century computer.

NNets resemble regular cerachips except that they tend to be slightly bigger. They also sport connectors on only one side, generally an optic fiber cable leading to a standard jack. All NNets are black, a side effect of the protective coating applied to their exterior, and often boast the NNet symbol: a stylized mechanical brain. NNets tend to be more fragile than regular cerachips. As a result, neural net chips are often mounted on special isolated plates within the machine's electronics bay.

3.1.3 OPTICAL NNETS



Optical NNets are used for high speed calculations and other demanding data manipulations. They are similar in principle to the basic neural network, but use the interactions of photons in a transparent composite matrix. The size of a circuit can be scaled down to the molecular level, and the operation of such a NNet creates no heat or wear; it must, however, be well shielded against "parasite" photons and energy from outside. All optical NNets are roughly cubic in shape.

The main disadvantages of the optical NNets are their cost and the complexity of their manufacture. The actual act of building them is relatively simple, as the process is mostly automated — but the machines that make NNet chips are fabulously expensive. In addition, the subsequent period of training under the supervision of a human technician requires a considerable investment in time and resources.

Optical NNets are becoming easier to manufacture and train as the processes and techniques used to make them are better understood by scientists and technicians. However, ONNets remains costly and rare, and it is unlikely that they will completely replace the rugged silicon chips and ceramic NNets.

Like regular NNets, optical NNets must complete their programming by creating new pathways within themselves. Those found in an ONNet are molecule-thin strands of crystal that can be easily broken by excessive jarring. External "noise" (photons and other particles) can also disrupt the system. For these reasons, all ONNets are well-shielded and encased in shock-proof material.

With the development curve of the Optical NNet following that of the Heavy Gear, it is no surprise that since the failed Earth invasion, this circuitry has grown increasingly complex. The influx of Caprician and Terran technology, also due to the war, helped solve many problems that had eluded the scientists working on NNets. The latest generation of NNets are capable of surprisingly independent actions, which may lead to true artificial intelligence in the near future — with unforeseeable consequences.

3.1.4 NEURAL NETWORK EVOLUTION

With the complexity of the self-developing neural network came a surprising phenomenon that experts call Behavioral Mimetism Syndrome, or BMS for short. Neural networks that work with humans for a long time will acquire some of their work-related habits. For example, a computer that is used for processing meteorological information every morning might do so even if its operator is not present, simply because it is used to a "routine." At the very least, it will inquire if it should launch the program.

Not all of these new self-programmed behaviors are useful and/or harmless. Safeguards and limitation routines prevent most complications, but sometimes the results can be most unexpected. A perfect example is the legendary Bowser, a very old *Hunter*-class Gear that almost has a personality of its own. It has been known to move by itself when threatened and can express simple "opinions," mostly with unsavory gestures learned from the troopers it served alongside. Its whereabouts are unknown at this time.

Just as human children learn how to behave by observing adults, neural nets can learn human mannerisms by observing human behavior. This behavior usually falls into two categories: useful and impolite. Useful mannerisms include limited hand signals (provided the vehicle has hands), fetching its owner, or signaling for help. Impolite mannerisms include obscene hand gestures and other bad manners (like honking the horn in the middle of the night to annoy the neighbors). These quirks are more than compensated by the Nnet's flexibility and computing power, however. Over a long period of time, neural nets may even learn to act independently, though they remain limited by the restraining routines imprinted on their circuitry.

3.2 COMMUNICATIONS

Communications are the 62nd-century officer's nightmare. Messages can be intercepted, scrambled or just fail to reach the receiver. This has created the need for fast and powerful multi-band emitters/receivers capable of punching through the dense electronic fog created by enemy vehicles and drones.

Whenever possible, messages are sent on a microwave tight-beam, line-of-sight pulse to prevent both interception and location. Emitters not only code and compress the pulses to durations of a thousandth of a second, but also automatically vary the frequency used according to a preset algorithm. If there are no hostile units within range, a general, wide pulse message can also be used. The process is fully digital from beginning to end, ensuring crystal-clear reception under normal circumstances. Enemy scramblers can affect this, although correction routines are included in the comm software.

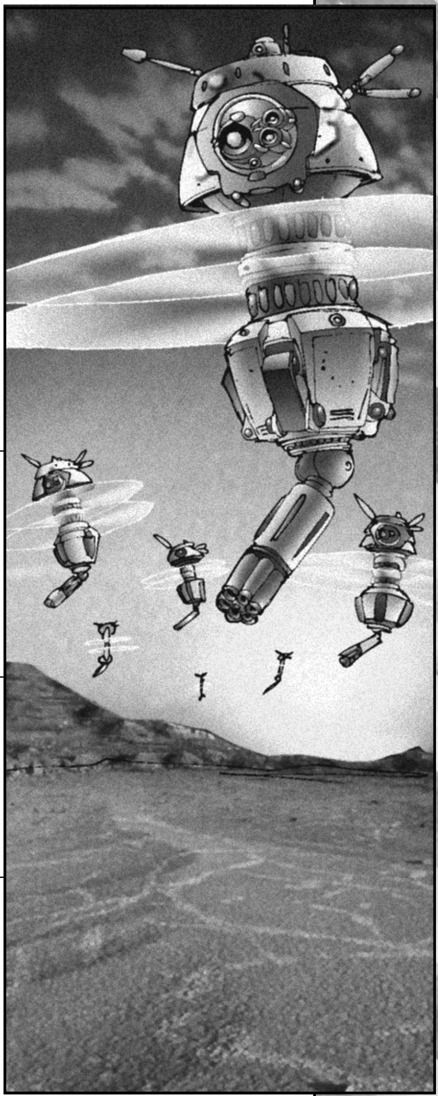
Several antenna types are in use, the exact type depending on its intended function and range band . Simple aerials are popular for low-power comm systems, while more sophisticated ones use blade or "flush plate" antennae. Blister and "combination" antennae are, in fact, low-interference pods housing several communication devices, such as directional arrays and comm lasers. Often, more than one antenna will be used by a given comm system.

3.2.1 REMOTE CONTROL

Remote controlled vehicles — also known as "drones" —are very useful in situations where a human life might be needlessly put at risk. Unfortunately, they are neither as responsive nor as flexible as a manned vehicle, which restricts them to simple operations. Almost any vehicle can be equipped for remote control, though it is rarely done except for dedicated drone designs. There are two ways to remotely control a vehicle: radio guidance or wire guidance.

Radio guidance offers the greater range of the two methods, but suffers from two disadvantages. First, there is always a time lag associated with the use of security frequency hopping and signal scrambling procedures, reducing the overall response time of the operator and thus the overall efficiency of the vehicle. These procedures are necessary to prevent hostile forces from taking over the vehicle's controls. Second, the two-way datalink flow can be easily jammed by electronic countermeasure equipment. ECCM can eliminate this, but requires expensive additional equipment.

Wire guidance removes both of these inconveniences, but presents its own particular set of problems. This method uses a fine but resilient optic fiber cable that trails behind the drone. The wire is spooled within a small container carried by the command unit (be it a vehicle, base or infantryman). This command cable can get snagged in obstacles or be cut, resulting in the loss of control of the drone unit.



• Recon Drones

Reconnaissance is probably the most common mission entrusted to drones. Small and inexpensive drones have been used for ages as communication relays, forward observers and general bait and cannon fodder material. Modern drones often carry a laser designator as well, allowing them to "paint" targets for incoming guided ordinance. Although most recon drones are flyers, ground and submarine drones are also very common.

• Work Drones

Work drones are part of another common drone category. These remotes are used for tasks too dangerous, hard or simply boring for human beings. For example, drones are used to defuse bombs, handle ammunition, conduct simple maintenance operations and examine hard to reach places and conduits. Work drones are often equipped with specialized equipment relevant to the task at hand.

• Hunter/Killer Drones

Hunter/Killer drones are dedicated combat vehicles. They are most often used to bear the brunt of the initial attack and help clear the field before the real assault starts. Hunter drones actively seek out enemy units to attack them. They often carry a light weapon for use against infantry (their most common target).

Killer drones are also attack vehicles, but use a different strategy: once they find their target, they detonate the explosives they are carrying. Cruise missiles are one type of killer drones, though they most often operate in autopilot mode.