GEAR KRIEG

SUPERSCIENCE

ROLEPLAYING SUPPLEMENT

DREAM POD 9

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The old man coughed and looked up with a defiant smile. "I do not have much time left and I face a great fear. There are dark forces growing in power each passing day; any time I had to use my abilities to help stop them has passed. I don't think the Allies have the ability to effectively fight them — now. But that can change.

"As you know, I have served as an advisor to the U.S. government on research and technology. And as you can plainly see, I can no longer perform this duty. If we are to be able to defend ourselves against what I believe to be the inevitable resurgence of world-wide warfare, we need a strong advisor on technology and science. Your country needs you!"

There is a world where war walkers and supertanks contend on the battlefield, and rocket fighters duel high in the air. A world where adventurers and super-spies battle the Nazis across the globe, and great evil is faced with great courage – with a little help from Science. This is the world of Gear Krieg!

This sourcebook for the Gear Krieg Roleplaying game covers the weird and wonderful inventions of the pulp genre: combat walkers, jet packs, electric guns and other "weird science" devices that change the face of the world on a daily basis. The book has guidelines on how to add pulp vehicles and items in a campaign, along with hints and adventure ideas to jumpstart any game.

This book features:

- An history of Superscience in the Modern Age;
- Overview of the major fields of research and invention;
- Biographies of major scientists and other important characters;
- Plot hooks and adventure seeds for all types of campaigns and locations;
- Extensive guidelines and tips to incorporate superscience in pulp-style adventuring;
- Sample archetypes and vehicles with datacards.

You will need a copy of Gear Krieg: the Roleplaying Game, a few six-sided dice, pen, paper and 2-6 players.

www.dp9.com

ISBN: 1-894578-63-5

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DREAM POD 9

Printed in Canada

"But however ignorance may have retarded the onward movement of man in times past, it is certain that, nowadays, negative forces have become of greater importance. Among these there is one of far greater moment than any other. It is called organized warfare."

— Nikola Tesla

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Special Thanks

To all the true visionaries out there who make the unsung advances that no one knows about — yet.

Produced & Published by

5000 Iberville, Suite 332
Montréal, Québec,
Canada
H2H 2S6

Stock #DP9-509

Legal Deposit: October 2001

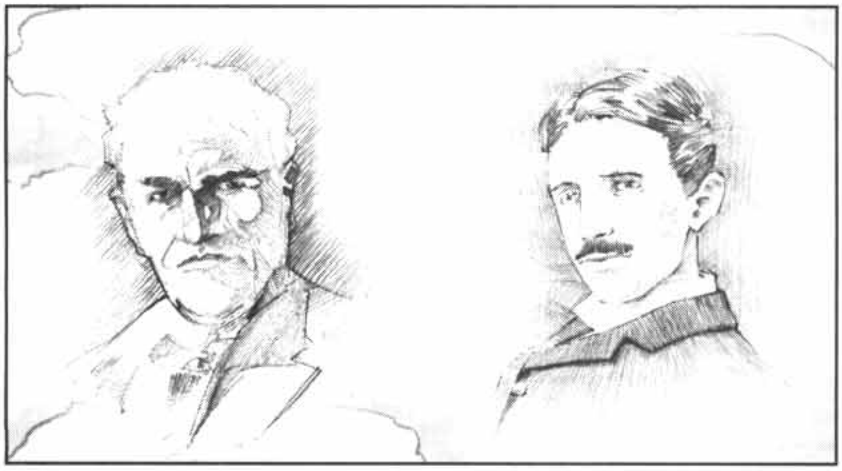
Bibliothèque Nationale du Québec
National Library of Canada

ISBN 1-896776-63-5

Printed in Canada

Chapter One: Foundations of Superscience

What is superscience? In short, superscience is an all-encompassing term for the advanced fields of research that allows for fantastical machines to walk the earth and arc electrical beams of death upon their foes. There are many inventions and gadgets that exist in Gear Krieg that most would not think possible: Gear Krieg is a world of pulp, where anything is possible, and there are many wondrous new things to behold. There are walkers, helical aerodynes, computators, televisors, rocket backpacks, and so, so much more. Superscience is an important part of the war effort by all nations. In fact, because of the escalation of warfare on a scale unheard of until now, invention and innovation have been pushed further and faster than ever before, ushering in a new age of science and technology.



THE PACT

Nikolai Tesla paused for a moment before placing his hand on the doorknob. 1931 had been a tumultuous year thus far, and this new summons hadn't done anything to improve his mood. He steeled himself for what he would see, and opened the door. Thomas Edison's bedroom was swathed in shadows cast from the dim lamp beside the bed. The shadows began to dance, slowly, as the air currents set the desk light swaying. The bed was the centerpiece of the simple room, and Tesla's eye was unwillingly drawn to the frail and wrinkled apparition lying forlornly in the midst of the vast white expanse of the sheets. He felt the fury that had driven him through the years of bad blood melt away as he took in the man's condition; despite everything, he could not stay angry at the brilliant scientist, now that he lay on his deathbed.

Edison broke the silence first, raising his shoulders from the bed and speaking with quiet vehemence. "Nikolai, if only I had listened to you, or you to me! If we hadn't acted like jealous fools, think of what we could have accomplished together!" His voice carried a wistful longing, but his eyes still blazed with that same old fire. Once again, Tesla mused to himself, they had been thinking exactly the same thing at the same time. Their competition had been bitter; no-one would ever doubt that. How had they arrived at this point, bickering like schoolboys over every invention, every advance? How had money become more important than the mentorship — dare he say friendship? — they had once enjoyed? They had let so many opportunities for cooperation pass them by; who knows what they could have accomplished together had the world worked in a different way?

Tesla stood still in the doorway, his hand still resting on the doorknob, as though reluctant to move completely into Edison's field of view. He noted, detachedly, that his old teacher's face was as drawn and haggard as his hands, as pale as the sheets he rested upon. "Thomas, save your strength." He responded, trying to keep his voice steady. The last thing Thomas would want would be the pity of a rival. "We both know that we have treated each other horribly. Perhaps, though, that rivalry is what has driven us to greater discoveries than we could have achieved together." If he said it with enough strength, or frequency, perhaps he, too, could believe it.

Edison let himself drop back onto the pillows, staring at the ceiling for a moment before replying. "Perhaps — but I simply don't have the time nor the energy to do battle with you any longer. There are a few things I wish to say before it is too late. We worked well together, those long nights so many years ago. When we worked to change the world. Before envy soured us both." He changed tacks abruptly. "Do you know, Nikolai, that I find myself envious of you even now — of your youth and health?"

Tesla couldn't help but chuckle at this. At seventy five he was no picture of boyish energy, to be certain. He moved from the doorway and took a breath to speak, but Edison cut him off with his hand.

"Enough of this fuss," he stated firmly. "I have always hated inefficiency, and bemoaning the past is one of the worst sorts of nonsense. I had a good reason for asking you here, and the fact that you answered my call so promptly only makes my decision easier. There are problems growing in the world that may soon make everything we have argued about seem petty and insignificant. I do not believe that the forces of freedom will have the ability to turn back the tides. Not alone.

"As you know, I have served as an advisor to our White House, recommending and dissuading ideas and technologies where I can. My illness has taken my strength from me, and I can obviously no longer perform that duty. The government will need someone in my place; a scientist who can interpret and teach those whose strengths lie elsewhere. I have recommended that you be given the post, as my replacement. I have no reason to believe that they will choose someone else. There is no-one else with your skill. I hope that you will consider this an opportunity, and not a burden."

Tesla dropped into the chair behind him, his circling thoughts, for the moment, stilled and forgotten. Edison had spent so many years trying to discredit his ideas, planting insults and harsh words in the ears of the influential... and now this? Such a strange offer of redemption! "It would be an honor to serve, Thomas, but after everything that has been done and said these long years, I feel that your recommendation will have landed on deaf ears. They will not listen to a Hungarian, no matter how long he has considered these shores his home." The bitterness crept back into his voice, despite his best efforts. He had expected recriminations and one last battle, or perhaps maudlin apologies and tears. Never this.

Edison looked at him, and snorted audibly. "You are pitying yourself again, Nikolai. That is a most unappealing habit. They will listen to you as they listened to me. I am no good at politics, and my clumsy attempts to discredit your name were obvious at best. Those who matter have had the matter explained to them at length. This is an opportunity for you to make good on all those promises I know you keep making to yourself."

"You ask a great deal of me, old man." Tesla bit back the rest of the tirade threatening to break forth from his lips. How dare Edison assume that he could just whisper in the right ears and reverse all these years of scorn? He took a deep breath, and when he opened his eyes again saw the twinkle in Edison's grey eyes. The old man was baiting him once again. "You ask a great deal of me indeed." He continued, calmer. Edison was trying to wind him up. If the offer was real, however, it would be an incredible honor. He was getting older himself, now — he could afford to smile at this last jab. "If my greatest critic has such faith in me, after all, I'll certainly be able to succeed in the eyes of others." He let the smile touch his eyes and found, to his surprise, that he meant it.

Edison felt the tension melt away as the smile spread across Tesla's face. The younger man was the perfect replacement; he should rightfully have held the position himself all these years. Tesla's research on electricity was years ahead of anything being worked on anywhere else, and his unceasing search for the next great achievement would keep his spirits high through the years of trouble that were certain to come. "Before you go running off, Nikolai, I have one last thing for you. This research you will undertake will cost vast amounts of money — more than the government alone can afford." Edison paused a moment to reflect. He continued, sadly, "And I know that due in no small part to my efforts that you are not as rich as you should be. On the table here is an envelope with legal papers. I have signed them already — all that is left is for you to add your name. That will complete the transfer, and put ownership of the Edison Electric Company, as well as all of the proceeds and properties of it, in your hands. Managed carefully, it will support you for the remainder of your career, and more. My family is provided for elsewhere, and the staff at Menlo Park have been informed of your takeover."

Tesla sputtered and blinked at this, warring emotions running through him like bolts of lightning. Anger at the old man's unparalleled gall and presumption, anticipation at the possibilities for the future with such resources at his command, fury that this man whom he had hated for so long apparently still knew him so well. "I will not refuse the wishes of a dying man, especially when do to so would be cutting off my own face to spite my nose. But do not think that this clears our slate, old teacher. You are as presumptuous, arrogant and egotistical as ever, you nasty, despicable old coot!" He had risen to his feet throughout this last speech, the words flying like shots from his lips. He paused for barely a second before a few tears began to roll down his cheeks. "And I do not deserve this kindness from you. I shall miss you, Thomas, and all that we never had a chance to create." Resisting the distaste that always accompanied the feel of another person's touch, he tugged off his kid-leather gloves and seized Edison's frail hand from where it rested on the bedcovers, pressing it between his still strong palms. "To the end, you have been a teacher to me — at first, technology; at the finish, my own heart."

He withdrew his hand quickly, even that brief contact sending chills down his spine. He turned to the writing desk, pulling the envelope and its sheaf of papers towards him. He scanned the contracts and signed them quickly, a few drops of the dark blue ink adding themselves to the patterns of ink stains already impregnated in the soft leather. He shuffled the papers back together once the ink was dry, bowed sharply to Edison, and left without a word to break the heavy silence that had fallen between them.

Thomas Alva Edison turned his head to look at the light beside his bed. The light bulb was one of his finest inventions, and this one had burned for many years in service to its father. The light grew blurry and the room began to shrink into darkness. Finally, only the round warmth of the light remained in his vision. He felt oddly at peace. He thought of his family. He thought of the threats to their well being. He sucked in one last breath and uttered his last words to a man he could no longer see or feel, "Nikolai, you must not fail."

WHAT IS SUPERSCIENCE?

Defining the concept of superscience, at least in the world of Gear Krieg, is important. Superscience is as much a product of the cultural implications of inventions as it is the new avenues of technology they bring. Perhaps the cultural implications even more so. For it is the acceptance of new technology instead of stubborn resistance to it that has led to such wondrous new toys. The people of the Gear Krieg world are more accepting of new things than the people of our world. The better mousetrap is indeed a desirable goal to all.

As a result, science has been able to provide better technology in a more accepting world. This acceptance has lead to inventions that have never been seen before, and used as quickly as possible. The outbreak of war has only hastened the brisk pace of development.

INVENTORS VS. ENGINEERS

Superscience is used as a blanket classification for a large number of disciplines. Many people have contributed to the science and technology of Gear Krieg, including not only superscientists, but also inventors and engineers. All this is not to say, however, that there are not individuals who combine two or even all three of those classifications. Many people have used science as a background to design a new invention, only to take the last leap of faith in themselves to make it a reality.

Superscientists are the people who discover the scientific principles upon which new technology can be built. They look at the very ways in which the world works, using mathematics, physics, chemistry, biology and more as their building blocks.

Inventors are the movers and shakers of technology. They see a machine that no one else has created, and they are the dreamers who make their dreams a reality. Some inventors have strong scientific backgrounds, but just as many create things they envision simply because they like to tinker. A few inventors have even created gadgets that scientists and others have insisted couldn't be created, because the inventor himself did not know any better.

Engineers are part scientist and part inventor. They have studied the sciences, and use that knowledge to create new technology or just to improve upon others' inventions. They may not invent the new walking machine, but they engineer it so that it can walk faster, be more nimble and go further.

THE INVENTOR AND THE INVESTOR

One important ingredient in any new invention is the money with which to pay for its development. As technology becomes more advanced and more complicated, the more money it needs to be developed into a usable form. Many times this means the inventor must seek out an investor to help fund a new piece of technology.

As one might expect, the addition of people involved in the development can cause clashes of personality and intent. Investors not only see the dream of the inventor, they see the money the creation can make for them. If the development does not go well or as intended, the inventor can see funds dry up and be left with an invention that is

Science Fiction and Science Fact

Part of the puzzle as to why superscience is a reality can be found in the writing of H.G. Wells (pictured above) and Jules Verne. These two authors pioneered the use of technological wonders in their fiction, and the use of science in fictional works led to a whole new genre of writing.

For the first time, people at large began to think about machines as great creations of man to be used for purposes never before imagined. In the works of Verne and Wells people traveled underwater with ease; they flew to the Moon; they even traveled in time! The seeds were sown for superscience to grow and blossom in the early twentieth century.

There are many flights of fancy among the technological wonders of the battlefields of the Modern Age. There are quite a few instances in history where a small amount of bad luck here or change of plans there could have delayed or even prevented amazing feats of engineering. It is those twists of fate, along with the embrace of science as a modern savior, that have brought about superscience.

Thomas A. Edison

Thomas Alva Edison was born on February 11th, 1847 in Milan, Ohio, and died October 18th 1931 in New Jersey. He amassed a staggering 1093 patents throughout his life-time-long career and earned the nickname "the Wizard of Menlo Park" for his many weird and wonderful inventions.

Edison became intrigued by science at an early age, going so far as to set up a working chemical lab in his parents' cellar at age 10. In this same lab, he became fascinated by electrical current and soon built his own working telegraph.

His experience with telegraph systems landed him a job working for the Western Union Telegraph Company. They were so impressed by his emergency repair work that they commissioned him to devise a new stock ticker design. The latter was highly successful, resulting in sudden wealth for Edison.

Edison was able to use that money to launch his own lab at Menlo Park, from which he changed the face of the world with the electrical light and inspired countless other inventors and scientists, including a young Hungarian immigrant named Nikolai Tesla. The list of inventions attributed to him and his dedicated team includes the phonograph, the mimeograph, the fluoroscope, the alkaline battery, the dictograph and the motion picture camera.

During World War I, the United States called on the genius of Edison and he answered by serving his country as the head of the Naval Consulting Board. He directed American research on torpedo mechanisms and anti-submarine devices.

half completed with no way to finish it in sight. Consequently, the world has not seen some new machines for no other reason than lack of funds.

Nowhere is this better illustrated than in the relationship between Nikolai Tesla and J.P. Morgan. Morgan was paying for Tesla's early experiments in electrically accelerated energy. Tesla was making progress in his work, but Morgan was not satisfied in how the work was progressing both in time and direction. Morgan felt it was taking too long, and with Tesla speaking of free energy applications of the technology, Morgan decided to stop funding Tesla's work. As a direct result, Tesla was compelled to work for the French government on a weapon based on his ideas in order to have the support to progress at all.

PERVERTED SCIENCE

Every scientist and engineer wrestles with the philosophical implications of their work. All must answer within themselves the burning question of how their work will impact on humanity as a whole. This question is not always answered a nobly as most would expect, and as a result perverted science is often pursued.

The Axis powers pursued perverted science a great deal in World War II, experimenting on humans on a scale heretofore unknown. Every nation could count amongst its scientific discoveries some questionable ethics, but the Axis raised the bar. Never before had people suffered so much to provide scientific data for others to use.

The question, then, becomes one of whether that data, provided at such a cost, should be used for further scientific research. Science, or at least pure science, should know no moral bounds, but it is hard to ignore the suffering that such research has brought about. This question is not an easy one to answer, and has been answered many times over in different ways throughout history.

In addition to the considerations of the sources of scientific data, scientists have struggled with the end results of their work. There are scientists who have been ardent pacifists, but have succumbed to working on weaponry for a variety of reasons. Tesla worked on wartime technology when it was the only way for him to further his work on electricity. Alan Turing worked for the British Empire because he felt it his duty, and because he wasn't directly working on weaponry. Igor Sikorsky viewed his helical aerodyne as a workhorse and aid in adverse terrain, rather than a weapon.

They all worked for the military in some form for their own reasons, despite the reservations they had. Perhaps they saw their work in the bigger picture, and felt the had to do whatever it took to see their dreams become a reality.

MENLO PARK

The extensive research facilities of Menlo Park are considered by many to be one of (if not *the*) birthplace of modern superscience. The Menlo Park laboratories were created in New Jersey by the hands of Samuel Edison; their life, however, sprang from the mind of his son Thomas, who came to be known as "the Wizard of Menlo Park." It was in the "Invention Factory" that Edison was able to make an astounding promise, to bring forth a "small thing every ten days and a big thing about every six months." From the original two-story, porched barn-like structure (100ft long by 25ft wide on 34 acres of land), Edison and

his team of about twenty-five workers poured out invention after invention. In seven years, they filed for over four hundred patents; many of these would be some of the most influential of Edison's entire career.

Perhaps rivaling the greatest invention to come out of the Invention Factory was the factory itself. It was the first research and development facility in history, and it revolutionized invention. It set the model for all research and development from that point on. In 1886, Edison began the construction of a new facility on an even larger scale in West Orange, New Jersey, with nearly sixty workers. The large size was too much for him to personally manage, however, and he wasted his genius on administrative duties instead of maximizing productivity like at Menlo Park. Even so, the new facility was able to still turn out idea after idea.

In 1931, the ownership of the facility was discreetly turned over to Nikolai Tesla. Tesla chose to keep the Edison Labs name and he also kept the labs' reputation for superscience development intact. Many inventions to help the war effort have come from the labs. These inventions include ancillary work on the many works Tesla has done in other countries. While the United States may not exploit all of this inventions, he, at least, has them ready to be produced should the U.S. wish to do so.

Nikolai Tesla

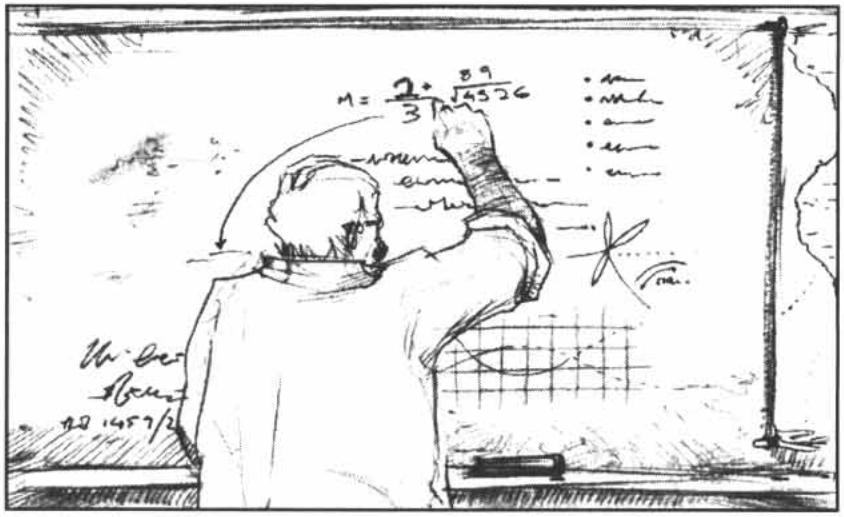
Perhaps the greatest scientific mind that ever lived, Nikolai Tesla was born in Smiljan, Croatia (then Austria-Hungary) on the stroke of Midnight between July 9th & 10th, 1856. Tesla was trained at an early age by his father to strengthen his memory and reasoning skills through regular exercise. This may have helped later lead to Nikolai's extraordinary ability to conceive of and build entire inventions in his mind. So accurate were these mental models that Tesla found it unnecessary to test his creations, simply building and using the device when the time was appropriate.

As was the case with many brilliant minds throughout history, Tesla was the subject of scorn. His ideas for alternating current (A/C) electricity were considered a science-fiction fairy tale by his college professors. Later in life, Tesla sought to collaborate with Thomas Edison, who saw no problems with profiting from Tesla's genius while in his employ while casting aside and ridiculing his concept of a future power grid utilizing A/C electricity. Eventually, Tesla became angry with Edison, left his employ and refused to ever work with him again. Fortunately, a group of wealthy individuals approached Tesla, seeking to promote the arc light that he developed, and with their help he created the Tesla Electric Company. On the other hand, they too had no desire to follow him in his dreams of establishing A/C electricity as the standard. A.K. Brown of Western Union & George Westinghouse came to the rescue of a broken and suicidal Tesla; with their backing, not only was he able accomplish his dream, but he came to power the entire state of New York by harnessing the massive power potential of Niagara Falls with his giant A/C dynamos.

In 1891, Tesla, who was nicknamed a magician for his mastery over electricity and his brilliant displays of his inventions at science shows, created a simple device that became the basis for radios, televisions, and all forms of wireless communication. Later, Tesla would create other inventions that were equally, if not even more, amazing than his previous works. Some examples include the earthquake machine, the bladeless turbine (declined by the U.S. government but used to power deadly German submarines), a devastating particle accelerator nicknamed "Tesla's Death Ray," electrotherapeutic therapy, a theorized way of manipulating magnetic waves into a force field, and even a method to use the very Earth as a giant energy transmission device. The last was the medium Tesla had chosen to deliver to the world the gift of his lifelong dream, free energy for all. He would disappear before seeing this grandiose project come to frutition, unfortunately.

Chapter Two: Pure and Applied Sciences

The age of superscience has produced hordes of inventions that spur the imagination and defy reason. Those inventions would not have been created if it were not for the discovery of the scientific principles they are based on. The late 19th and early 20th centuries have witnessed an explosion of scientific research and thought: physics, chemistry, biology and mathematics have all advanced with incredible speed. Their findings may not be as concrete to the average person as a walking tank or a radio or a computator, but they are no less groundbreaking in their own ways.



COMPUTATIONAL MACHINES

In 1934, Alan Turing received a degree from King's College, Cambridge, a Fellowship of King's College in 1935 and a Smith's Prize in 1936 for his work on probability theory. He began to delve into the areas of computation and the mathematical possibilities of creating a real, physical way for all mathematical assertions to be proven. As he began to think about computational possibilities, he realized that he had some hurdles to overcome. With a finite amount of space on which to record data (such as a tape), computations would have limits placed upon them. As he began to tinker with the relations of the numbers, he was able to explore and expand his boundaries, making it theoretically possible for a computational machine to communicate a broader spectrum of answers. He believed he could create a universal Turing machine, capable of answering any mathematical question, if given enough data. He toiled at this concept endlessly and was always at work on his "hobby."

By that time, machines had been designed and built that could compute numbers. They had all been analog devices, meaning they used moving parts and multiple non-discrete positions in their computing. They moved gears and cams in very complex arrangements to come up with a result. All of the machines built were special purpose machines that could perform limited types of computations; if one needed a different type of task to be performed, one needed to build another machine.

All that changed in 1937, when Turing published his paper "On Computation Machines." In this progressive paper, Turing was tackling a popular mathematical problem of the time. Another mathematician, David Hilbert, had asked the question, "Can it be proved that all mathematical problems are solvable?" Turing set about to test this statement, and did it in a novel way that forever changed people's perceptions of what machines could do as a result.

In order to answer the question, Turing postulated that a machine could be built that could read, write and erase symbols on a tape that could be moved forwards or backwards. The tape itself was theoretically infinite in length. The machine could be provided with instructions telling it how to interpret the symbols and how to change them to produce a desired result. These instructions were stored in a table of states describing the machine's behavior at any given time. Depending on the current state and its instructions, the machine might read a '1' written on the tape, erase that '1' and write a '0', and then be instructed to move to a different state that would instruct a different behavior.

Turing further showed that not all problems could be written in such discrete instruction sets and therefore not all problems were solvable. That conclusion in and of itself was an amazing deduction by Turing but the implications of the paper were far more reaching than that. Turing had shown that a machine could theoretically be devised that could compute problems in ways never before seen. The state table he used to describe the machine showed that a problem could conceivably be broken down into discrete steps, or in a digital fashion.

Likewise, his work with binary numbers in the papers, which were represented with just ones and zeroes, were not only digital, but perfect for fully electrical machines. Electrically operated machines would be much faster than mechanical machines that were previously used, and could easily be more efficient as far as power usage, with no moving parts.

As a result, Turing had inadvertently given birth to entirely new way of designing computators. Many of the early computator scientists read Turing's paper, including von Neumann, whom Turing had studied with briefly at Princeton University. Von Neumann regarded Turing's work highly, and certainly looked to it for inspiration for his own work on computators years later. The concepts Turing wrote about would serve him well later in his work in cryptanalysis.

It was also during this time in 1939 that Turing began working with the British cryptanalytic department, and after the British entered the war, he began working on cryptanalysis full time. Along with partner W.G. Welchman, he was able to break Luftwaffe code, and later the two tackled Hitler's Naval Enigma code. The Enigma code was considered unbreakable by the Allies, and Turing was able to help create the Enigma Engine, capable of deciphering the heretofore uncrackable code. But Germany's cryptologists retaliated with added complications to the code, and it again became indecipherable. Turing continued his work throughout the war on both the Enigma Engine and the universal Turing machine.

Bletchley Park

Bletchley Park was the seat of the cryptanalysis effort for the Allies in World War II. Many dedicated people worked there, including Alan Turing. Situated in Milton Keynes, Buckinghamshire, England, the park was transformed into a massive code breaking machine in 1939. Several small buildings were converted to individual centers for breaking particular codes.

The original people to work there arrived under the guise of "Captain Ridley's Shooting Party." Over 10,000 people worked at the facility at one time or another during the war. They helped to provide excellent intelligence on German positions before and during the various invasions. Groundbreaking computator development was performed here as well. While it never produced highly visible superscience gadgets, Bletchley Park was as important as Edison Labs in advancing the Allied cause.

CRYPTANALYSIS

The art of cryptography has been used throughout human existence to shroud messages and communications in secrecy. By the time of World War II, man had developed nearly unbreakable ciphers in the form of one-time pads. These forms of enciphering used methods that would convert a message into gibberish that could only be made readable again by using the same method. The method would only be known to the sender and the recipient, and would only be used once. Without knowing the encryption method, the message would be impossible to decode.

World War II changed the world of cryptography forever in one fashion: the generalized use of machines to both encrypt and decrypt coded and enciphered messages. Most nations already used teletype machines to send messages back and forth, and relatively simple techniques were used to obscure the messages, only to be made clear in the receiving machine. The Germans, however, were the first to utilize a machine to encrypt messages on a large scale. The machine they created was called *Enigma*.

ENIGMA

The original Enigma used three code wheels, called rotors, to perform the conversion from plain text to gibberish. Each rotor had letters along the outer rim and wiring on the inside. The machine would allow the user to enter a letter and the machine would indicate the encrypted letter by lighting it up. Then the machine would advance one or more rotors, changing the internal wiring for the next encrypted letter. By knowing the original setting of the rotors (which letters were up top on each rotor), the receiver of the message could use the same machine to decrypt the message. Later versions of the machine used additional rotors to further increase the possible combinations of wiring configurations to make the job of cracking this method exponentially more difficult.

The Germans were very confident that the Enigma would be impossible to defeat, but they had not counted on the rise of flexible programmable machines that could be used to break the Enigma system. The Allies were able to build machines to do just that. Without machines, the number of possible combinations would take far more time to manually sift than was humanly possible. However, a machine could try complicated possibilities in a much shorter period of time. What was once thought unbreakable was now at least possible to crack.

The British were able to acquire a machine pioneered by the Poles, who had started using it before they were conquered. The machine used electromechanical relays to help rapidly sort through the various combinations the Enigma could produce. The machine was called a Bombe, due to the ticking noises the relays would make while operating. The British brought the machine to Bletchley Park, where Alan Turing and his team of cryptanalysists set about improving it.

The key to the process was figuring out the initial rotor settings an Enigma machine used when encrypting a message, and the bombes allowed for many possible settings to be tried in a manageable amount of time. The pro-

cess was far from perfect, and many messages were not decrypted within the short amount of time in which they would have been useful to the Allied military forces.

THE LORENZ CIPHER

Meanwhile, other parties were busy at Bletchley Park decoding other German transmissions. The Germans used many different methods of encrypting messages, one of which was the Lorenz cipher. The cipher was based on an additive method for enciphering teleprinter machines. Teleprinter machines used the Baudot code to send messages, using a five-digit binary sequence to describe each character.

The Lorenz cipher used a machine to generate a key and use it to start the sequence chosen to encipher a message. Each character in the sequence would have its code added to the each character in the original message to form the encrypted message to be sent via radio. The receiving party would then take the key to start the sequence on their end and add it to the message they received, and the original message would be reproduced. This additive process could be repeated to reproduce the encoded message and the original message in alternating sequence. As long as there was not a key, the message was safely encrypted.

The machine used to generate the sequence was believed sufficiently random by the Germans to produce unbreakable keys. And they were right. Bletchley Park personnel had a tough time breaking it, even with computator help. However, the Germans made a fatal mistake in early 1941.

The Germans made the error of retransmitting a message with the same key. The message, nearly 3000 characters long, was in a different form the second time, but was long enough and similar enough to allow the cryptanalysists at Bletchley to try and crack the code. They discovered that it was periodic — the machine producing the sequence was taking a sequence of a set length and repeating it. Through a lot of hours, long into the night, they were able to determine the inner workings of the Lorenz machine.

COLOSSUS

What they then needed was a machine to help them try out different keys rather quickly, since the method for producing the sequence had been determined. That machine was the Colossus, built by Bill Tutte, Max Neuman and Tommy Flowers. The machine allowed them to try several keys very quickly to seed the machine. Each resulting message could be scanned for usable German language results.

If the message was gobbledygook, the codebreakers could try more settings. As a result, the messages sent through this method (and most German Army messages were sent this way) could be decoded in a matter of hours by the people at Bletchley. This capability would serve the Allies very well throughout the rest of the war.

Alan M. Turing

Alan Turing was born in Paddington, London on June 23rd, 1912. During much of the first ten years of Turing's childhood, he lived in very rigid foster homes. His interest and experiments in chemistry and science were frowned upon, and Alan struggled greatly in school. He is said to have had terrible writing and communication skills.

His status as outsider could have meant the end for Turing's potential, were it not for a powerful attraction to an older classmate by the name of Christopher Morcom. This fascination bloomed into something more in 1928, and inspired Turing to expand his horizons. During this time he was exposed to Einstein's work, and was able to comprehend and follow his theorems. When Morcom passed away in 1930, Turing was devastated.

Turing often mumbled and talked to himself. More than one student had heard him talking as though in a discussion, only to see no one about. One professor theorized that Turing believed that he could communicate with the spirit of his deceased "soul mate," Chris Morcom.

ALLIED MACHINES

The Allies used some mechanical innovations of their own for message encryption. They went so far as to design a method of encrypting voice transmissions. They could take a voice recording, convert to very crude values for small frequency ranges, encrypt those values, and transmit those values in a signal. The receiving party would decrypt the values and reassemble a version of the original signal that was at least recognizable as speech. Much of the original fidelity was lost in the end result.

As the vocorders were refined and computators advanced in capability, radios using the refined technology were eventually produced. These radios were fully encrypted and decrypted in real time. They were unsophisticated as far as the encryption, but any machines that could reliably be used to break the code were not available on the field, where they would be used.

Shadow Games

Colossus and the other codebreaker machines, as well as their designers and operators, are kept under round-the-clock security wherever they are located. Many a scientist has grumbled about having one or more watchguards from the FBI following him or her around, but after a few close-calls with Axis agents no one is taking any chance.

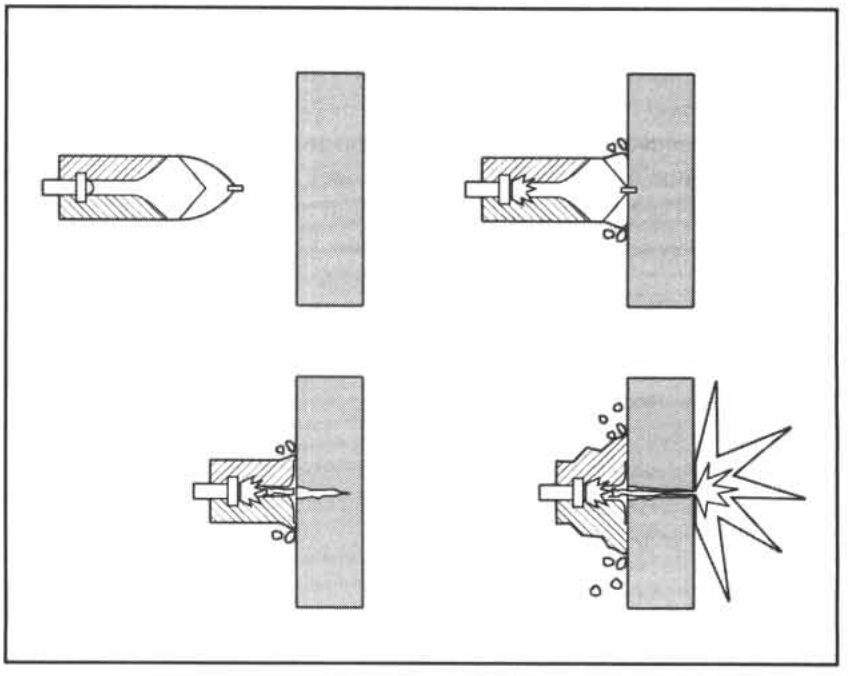
The protectors' task is made more difficult by the fact that the machines and the scientists are often located in universities and other places of learning that are more conductive to the free exchange of ideas than secrecy. It is a delicate balance between safety and freedom.

HEAT WEAPONS

High-Explosive Anti-Tank weapons are a new development of explosive weapons used to fight armored vehicles. They use a shaped explosive charge in a manner first pioneered by Dr. Charles Munroe in the 1880s. Dr. Monroe discovered that by taking a block of guncotton with letters stamped in it, and detonating it against a steel plate, that the letters would be imprinted on the steel. The explosive force was directed into the cavity formed by the letters, concentrated, and thus caused the impression. The effect was dubbed the Monroe Effect.

HEAT weapons take this principle and apply it further in an armor-penetrating weapon that is effective at any range, unlike solid-slug armor-penetrating rounds that depend on kinetic energy for their penetrating power. HEAT warheads charge with a conical or hemispherical hollow section. A metal liner is placed in that hollow section, which faces the intended target. When the warhead makes contact and explodes, the detonation wave sweeps through the charge from back to front, squashing the metal liner, liquefying it and projecting it forward with great force. The resulting metal slug travels at extremely high speeds and acts as a directed kinetic energy penetrator, punching a hole through the metal.

Due to the extremely high temperatures involved, the slug is very malleable and is more susceptible to deflection and dispersion than conventional AP weapons. Armored skirts are particularly useful to help stop HEAT weapons. Even with this limitation, HEAT weapons tend to be very light and are highly effective, even out to the extreme ranges of the weapon. They are ideally suited to man-portable anti-tank weapons, and the first examples in common use are in anti-tank mines and rocket launchers. The German armed forces are already experimenting with HEAT-effect shells, and other armies will no doubt follow suit.



SYNTHETIC MATERIALS

Most synthetic materials were initially designed to replace naturally occurring materials and later combinations of natural and synthetic materials. One example of material that was replaced was varnish. Varnish was normally made up of natural saps combined with oils such as linseed, or boiled and thinned with a solvent such as turpentine. Unfortunately, natural varnishes would yellow and crack with age. In order to eliminate these flaws, many inventors, scientists, and business people sought to design a better varnish from synthetic substances.

PARKESINE

One early substance was discovered in a family of substances that would come to be known as plastics. This new material was invented by Alexander Parkes. Parkes invented Parkesine, which he described as ". . .a substance hard as horn, but as flexible as leather, capable of being cast or stamped, painted, dyed or carved . . . " Parkesine was a celluloid plastic, made from cellulose nitrate for the base and using comphor as the solvent to make the material pliable and moldable.

His invention won a bronze medal at the International Exhibition in London in 1862, but the applications for his new material were limited in practice at first. Parkesine was not popularly used for anything other than billiard balls, men's shirt collars and photographic film stock. Other than Parkesine, plastics didn't really take off until the beginning of the 20th century, when new plastics appeared that were cheaper, could be produced more easily and were more versatile in application.

BAKELITE

Bakelite was invented by Leo Baekeland, who was born in Ghent, Belgium and immigrated to the U.S. in 1889. His early work included inventing Velox, a photographic printing paper that can be developed under artificial light. He sold the materials to Kodak, and with the proceeds he bought a lab in Yonkers, New York.

Leo invented Bakelite in 1907. The compound was valued for its light weight and high endurance. Bakelite was a synthetic thermosetting phenol-formaldehyde resin. It was found to have many characteristics not anticipated when it

The Discovery of Bakelite Armor

Maik Thorsen was applying shellac to a wooden sculpture for an employer when he accidentally spilt the varnish on silk draperies that were being stored nearby. To cover his mistake Maik hid the shellac-soaked draperies. Weeks later, in trying to eliminate a recent infestation of field mice, Maik hit the hidden shellac-soaked draperies full force with a shovel. Maik, thinking he had hit a stone or brick the mice were hiding behind, went to push the offending object out of the way with the tool.

The thing went flying, travelling further than a stone or brick might have. Maik went to inspect the strange object and found that it was the drapes. Maik then noticed that his shovel was bent from hitting said item. Maik could not believe the shellac and draperies had become so hard as to bend a metal shovel, so he picked up a pitchfork and attacked the bundle again.

It was at this time Maik's employer, an officer in the infantry, walked in to see the bundle of silk draperies bend and break a tine of the pitchfork. After questioning Maik how the material could accomplish such a feat, Kaptain Schuller brought the bundle outside and shot at it with his rifle. When he saw the slug did not penetrate, he immediately knew he had a substance that would help protect his men.

It was only a year later that a form of the strange new material was made into wearable armor and was being tested by Wehrmacht researchers. Hitler, after seeing it demonstrated, said that, "With this German soldiers will be the reborn as the Tectonic Knights of old!"

was created. For example, Bakelite was found to be an electrical insulator. It became widely popular in the 1920s due to the wide variety of products that could be manufactured with it. Bakelite was used for everything from buttons, electrical device cabinets (radios and televisors), pipes, parts for aircraft, parts for automobiles and even toys. Bakelite could also be made into a liquid varnish called shellac, that became extremely hard once cured (see sidebar on the previous page).

Another very important application for Bakelite was discovered, but that purpose was realized not by Baekeland but by Maik Thorsen, who did odd jobs until his amazing good fortune. Thorsen discovered a way to use Bakelite in an unheard of manner: armor. Following its accidental discovery, Bakelite armor was refined continuously. It was vastly improved by replacing the silk with Rayon fibers in Germany. Japan used silk for some time until Germany gave them the technology to produce Rayon on an industrial scale. This transition did not occur until 1944; it was only after the invasion of France, when several captured examples of Bakelite armor made it back to the United States, that the Allies were capable of fielding Bakelite armor of their own, using Nylon fibres as a base.

RAYON AND NYLON

Other early materials focused on artificial fabric fibers. These fibers could repel water and resist rot better than natural fabrics. Rayon was one of those first materials; like Parkesine, it was based on a celluloid substance and was of limited usefulness.

DuPont, in search of a material that would make better stockings for women, developed a new compound called Nylon 6,6 in 1938. It was called such due to the six carbon atoms in each of its two monomers; Nylon was the easier-to-pronounce commercial name for Polyhexamethylene Adipamide. It would have three significant military roles once hostilities started in Europe: rope, parachutes and armor. It was used for its light weight and great strength, and both ropes and parachutes made from nylon benefited from those traits.

TEFLON

The Allied forces on the islands in the Pacific Ocean were having a hard time dealing with the environment. The constant rain and humidity made short work of most clothing and metals, quickly causing them to rot or rust. In 1943, the military put out a call to solve this problem. A DuPont researcher, Roy J. Plunkett, answered within the week, much to the surprise of everyone involved. The military was so shocked at how well this substance worked for wet weather coats and ponchos. The fabric resisted rain unlike any previous types ever tested.

Discovered by a chemist working for them in 1938, tetrafluoroethylene resin, or "Teflon" as DuPont called it, shed water better than a duck's back. In fact, it repelled just about everything DuPont tried to stick to it! As a result, it could be manufactured in green only — the original color of the Teflon compound. Being so resistant to adhesion, the only product DuPont could make from Teflon was one based on Teflon strands. This meant that only fabrics could be produced, or sheets from fabrics where the strands were melted into one another. The clothes made from Teflon were not comfortable in the least — Teflon undergarments and boots never made it past a short (and painful) testing phase.

Soon, the military used machine bushings made from the sheets for vehicles deployed in humid climates. These worked better than the original cloth and rubber ones, especially when there were moving parts involved. This success led the military to quickly order Teflon bushings to replace all other types of bushings a few months after the new material's introduction. Though the parts lasted longer and worked better, DuPont struggled to fill all the replacement orders the military was placing. Plunkett's invention greatly curbed the effects of the Pacific Islands environment on Allied equipment.

Though DuPont kept trying, they could not get Teflon to bond with metal, nor could they get any adhesive to stick to it reliably.

Field Testing

Labs across the world are continuously try to discover new substances and compounds that might come in useful for the war effort. Even the most mundane of material can save thousands of dollars and man-hours if it replaces a weaker material in a small but crucial parts (the Teflon bushing are a good example of this). Often, however, new compounds that work just fine under laboratory condition do not fare as well in the fields, and extensive testings is required before the armed forces will allow it to be used. Time and again, small groups of soldiers are equipped with some newfangled device made out of the wonder substance of the week, with strict instructions not to lose it (especially not to the enemy!) and to report its performances faithfully to the brass.

ATOMICS

As scientists have begun to unravel the structure of the atom and explore the implications of that research, some have theorized that the very building block of nature may be further broken down to release untold of amounts of energy. While scientists would love to explore the peaceful applications of splitting atoms, the military minds of the world would much rather think about the powerful weapons that such research could allow. No scientist knows what this weapon could do if used, but, not surprisingly, that is not stopping anybody.

SUPPLEMENTAL MATERIALS

The Manhattan Project got its start as a group of concerned scientists who had determined that it might be possible to use the newly discovered process of nuclear fission to develop a weapon of awesome power. Scientists like Enrico Fermi and Albert Einstein came together to draft a letter to President Roosevelt explaining what this weapon could mean for the U.S., and more so, what it could mean if the Germans developed such a weapon first. Roosevelt immediately authorized a program to develop the process that would bring forth atomic weaponry, as well as the means with which to make the fuel that would ignite a bomb.

The actual implementation of the project fell to General Brehon Somervell, commander of the U.S. Army's Services of Supply. The scientists and some administration officials, like Vannevar Bush, wanted General W.D. "Fat" Styer, because he had a good working relationship with most of the academics that would be involved in the project. Somervell did not want to lose his best and most involved commander to what he thought was a fool's errand at best. His next choice had just accepted a combat command in the Pacific, so he went with Colonel "Gentleman Jim" Marshall, a capable if cautious administrator. The project labeled "Supplemental Materials" foundered for a year while Marshall scouted for sites to build the plants needed to separate the uranium isotopes the project would need; he also could not make a decision on which of the five methods might produce the best results. Marshall also horribly underestimated the money that would be needed. Combining all these factors, the Supplemental Materials project was proving the worst fears of Somervell. Worst of all, Marshall deferred to the U.S. Navy, who was taking a good deal of the talent pool and coming close to developing a design for a practical nuclear fission reactor that could be used to power a submarine. What was good for the Navy was bad for the Army. As Somerville contemplated replacing Marshall, the officer he had originally wanted to run this project, Leslie Groves, returned to active duty after a severe injury while on a combat assignment in the Pacific. He offered the project, and a star, to the newly recovered Groves.

THE MANHATTAN PROJECT

Within days of his promotion in September of 1943, Groves had accomplished more than his predecessor had in the past year. He had chosen the necessary locations in Washington state and Oak Ridge, Tennessee to build the plants, proposed and acquired a new budget several times larger than Marshall had requested, and was raiding all the top universities for the talent

Brain Drain

Lise Meitner, a well-known physicist who has been working at the Reich University in Berlin and Jewish, is trying to flee Germany and reach the relative safety of Sweden, by way of the Netherlands. With her colleague, Otto Hahn, she is responsible for proving that bombarding the nucleus of a uranium atom with neutrons caused it to break down into recognizable elements and release a sizeable amount of energy in the process.

The year is 1938. Hitler has declared open season on all Jews in Germany, especially those from other countries. Meitner happens to be a visiting Austrian, and her visa has expired. She is taking a train to the Dutch border in the hopes of getting out before the Gestapo catches her. The British government has requested that the U.S. send a small special operations team (or is sending one itself, depending upon the campaign) to make sure this physicist gets out of Germany. It is decided that in order to avoid an international incident, the assistance must be as discrete as possible.

Operatives already in Germany have provided the information regarding Meitner's assumed route of escape, but there must be a team in place to replace the border guards at the Dutch border at just the proper moment, and make sure Meitner gets through. This is the job of that special operations team. They must deploy by plane into Germany, infiltrate the border installation, eliminate and replace the border guard attachment, then escape via means of their own after they have completed their assignment. This small operation is one of many that will tip the scales of technological superiority from the Axis to the Allies.

Leslie Groves

The son of an Army chaplain, Leslie R. "Dick" Groves showed an early aptitude for engineering and mathematics. He spent three years in college, mostly at MIT, until the loss of his older brother. He had always intended to go to West Point, but this tragic event drove him quicker than he had planned. Groves chose engineering as his career in the military. After a stint as a training officer, he was assigned the project of restoring the channels and facilities at Port Isabel near modern-day Brownsville, Texas. He was also responsible for restoring water to beleaguered Managua in Nicaragua after its great earthquake. He had been there with a detachment looking into the feasibility of a second Panama Canal. He spent the next few years in charge of the Military Supply Division, where he oversaw the development of new equipment for a rapidly modernizing army. This experience would prepare him for his later command in the Manhattan Project. He maintained steady contact with inventors and scientists. In response to their often difficult natures when it came to producing new technologies and the desire to constantly improve and tinker with those designs, Groves was often hear to say "Let's get something we can work with now, and save the improvements for later."

In late 1942, Groves received the assignment for which he had been waiting since his graduation from West Point in 1918, a combat command. He was sent to the Pacific as a colonel in charge of a regiment of combat engineers. Groves had a "lead from the front" style of command, a trait which would almost cost him his life. Ten months into his command, he was badly wounded in a suicide attack by a Japanese walker carrying an explosive charge. He spent two months in San Francisco recovering from his injuries before rejoining his family in Washington D.C. His superior, General Somervell, offered the command of a top-secret project to Groves, a project, Somervell hinted that might end the war if it was successful. The General wanted Groves to take command of this stalled scientific project and get some results. In addition, he wanted Groves to handle more mundane issues like construction of the new Pentagon. Groves was horribly disappointed, and saw this as a lack of trust in his combat abilities. He did have to admit, though, that after his injuries, he was physically not in the best shape to lead another combat command. This new offer of command was his chance to stay in the war, and maybe even help end it. Although he feared originally that this would be a lose/lose situation (The plan would either fail, in which case he would be blamed, or it would succeed and the use of such a destructive weapon would become mired in politics and never used.), he entered the project with his characteristic zeal and determination. Within a few months, a project that had been stalled for over a year under a more complacent colonel was now leaping ahead to meet the perceived threat of a similar German program head on.

he would need. Groves also changed the name of the project to the Manhattan Engineer District, noting that the name "Supplemental Materials" just begged a spy to pay attention to it. It wasn't long before tens of thousands of construction workers were on site at Oak Ridge and Washington, building the factory shells that would house the uranium separation units and the towns that would support them. Marshall's key failure, the straw that broke the camel's back, was that he endorsed the gaseous diffusion method as the only method to be used. Groves felt this was dangerous, and chose to pursue three of the methods all at the same time to see which bore fruit.

An unusual defensive weapon came out of the gaseous diffusion method of separating the heavier U238 atoms out. This process required the highly corrosive uranium hexaflouride, a gas that only nickel was resistant to. Groves, with the help of a handful of engineers, developed a unique nickel piping system that could disperse the used gas at the perimeter of the factory complex at Oak Ridge. This gas could discourage any unwanted intruders who were detected and act as a last-ditch defense mechanism should a ground assault threaten the facility. There was even talk of building bombs containing the gas as a chemical weapon, but the substance was deemed too expensive and important to be used so frivolously.

CURRENT EVENTS

With all this going on, and the project's size growing to a quarter of a million workers, Groves along with J. Robert Oppenheimer, managed to recruit enough scientists and build the bomb lab at Los Alamos, New Mexico. Problems plagued the colloquially dubbed "Manhattan Project" from the onset. The two favored methods of uranium extraction proved woefully inefficient for providing useful quantities of material. The breeder reactor at Washington was proving equally incapable of creating useful amounts of plutonium. These procedures suffered from the newness of the scientific and engineering theory behind them and had to go through growing pains before coming into their own. The bomb lab had its own issues with trying to figure out a method of detonation for the bomb, as well as determining the critical mass necessary to begin the chain reaction. Their greatest stumbling block was lack of useful material coming out of the factories, but they too were stymied by the youth of

the science needed to clarify the factors necessary to build a working bomb. At times, these problems seemed insurmountable, and at times the answers seemed right around the corner. With the dynamic team of Groves and Oppenheimer constantly pushing these disparate groups to succeed meant that a working bomb (or at least a radio-isotope dust dispenser) was only a matter of time.

A concern shared by Groves and just about all the scientists involved in the Manhattan Project was that the Germans were nipping at the heels of the American Atomic program. Some of the scientists even proposed and developed a means for low-level bombers to carry a krypton detector that could sniff the air for the tell- tale element even in minute quantities. Its presence would indicate that the Germans were working on separating uranium. That the Germans controlled the uranium mines of the Belgian Congo and Czechoslovakia and had the vast expanse of the Ukraine to build factories only served to further those concerns.

Groves considered any intelligence gathered about German physicists and their projects for the Fatherland as vital and had orders that all such intelligence make its way to his desk first. The only way to be sure, of course, was if Fortress Europe was invaded, and that matter was not even in the cards when Groves took control of the Manhattan Project.

Robert Oppenheimer

Julius Robert Oppenheimer, Robert or Oppie to his friends, is a New York-raised physicist who has spent much of his life in academia, working his way through the circles of scientists in the newly developing field of nuclear physics. Oppenheimer, a frail sort of man described as constantly having a cigarette dangling from his fingers, had studied under the famous Ernest Lawrence at Berkeley. It was Lawrence who introduced him to General Groves. Despite numerous links between friends and relatives of Oppenheimer and the Communist Party, Groves sized him up almost immediately as a potential director of the bomb assembly lab.

The two were fundamentally different people from very different backgrounds. Groves, Oppenheimer later observed, had a "fatal weakness for good men," though, and apparently saw something in the young scientist that he felt would provide him with a powerful ally in a lab full of scientists who were suspect about the military at best. Both shared a love of horseback riding, and had attended riding academies in their youth in the area where the bomb lab would eventually begin construction. Although it had been scouted as a possible build site before, Los Alamos, with its box canyons and remoteness, was picked by Oppie and Groves as the ideal location to figure out how to build and detonate an atomic bomb.

Even early on at Los Alamos, the scientists had a very adversarial relationship with both the soldiers there to guard them and General Groves. It was Oppie who kept them directed and focused on the goal at hand. He was also their confidant when they had problems with the military or each other. He would then carry these concerns to Groves, and the problem would be solved. Even though the base was technically under military jurisdiction, Oppie shared command with Groves. This was necessary, he reminded Groves, to keep the peace. A decent physicist, Oppie turned out to be an incredible administrator, with a gift for sizing up people and empathizing with their problems.

His life is not without problems while at Los Alamos. Oppenheimer is constantly harassed by Army Intelligence, who suspect him of being a potential leak to Communists trying to gain access to the research data at Los Alamos. His wife and brother were both at one time members of the Communist Party, and he has even had to turn in one of his dearest friends trying to steal information on the Project for the Communists. The irony is, he himself does not subscribe to Communist beliefs and has never been a member.

He is also not a strong man, physically or emotionally, and the tough job of running the bomb labs is taking its toll on his health. Oppie always seems on the verge of a physical or mental breakdown, and it often takes the presence of Groves to reinforce him and return his resolve. His colleagues also try to take it easy on him, not wanting to lose the one person they feel can keep the military off their backs. Regardless, he is determined to see this project through to its completion, and one way or another to build a weapon based on atomic theory.

CHAPTER THREE: ELECTRONIC SCIENCES

The harnessing of electricity in the 19th century has given birth to a whole new field of invention and discovery. Instead of mechanical contraptions being designed to perform work, more and more new gadgets are taming the electromagnetic spectrum to perform their feats of wonder. From the ordinary light bulb to the computator, people's lives are being completely changed by the field called electronics. Still in its infancy, the field of electronics has achieved a degree of advancement unheard of previously. This progress is fast even for world familiar with superscience. No one know where this field will lead eventually, but the one certainty is that it will go very far in a very short amount of time.

GENIUS UNRECOGNIZED

"Verflucht! I need more engineers and evidently a smattering of competence is too much to ask! The Luftwaffe has snatched everyone that shows the least bit of genius and initiative. They're like an obese child at a dessert table! We must have competent personnel to complete our work. I have to find a way to find them before our 'illustrious' Luftwaffe does... but how?"

"Well Erich, the Luftwaffe has contracted several companies who are coming up with the most brilliant designs. Maybe you could tour the facilities and try to pick out some of their younger but more promising engineers?" replied his assistant, looking over his shoulder at the progress reports on the newly formed, approved and funded PanzerKämpfer project.

Dr. Langhauser suggested mischievously, "What an interesting idea, but maybe I should not sneak behind their back. Perhaps I could just forget to inform the directors... just talk directly to the managers and supervisors," His tone was accentuated by the pleased upward curl of his lips and brow

"I do not know. The supervisors might push their 'unwanteds' off on you. You might get the dregs of the cask," replied his assistant. He took the beer steins from their worktable, waving one for effect.

"The dregs might have something to prove and will work hard," Dr. Langhauser got out before an enormous yawn. "What day is tomorrow?"

"Forgetting what day it is again? Too much time in the lab decays your mind. You need more time outside the factory," quipped the assistant. "Tuesday or der Dienstag."

Dr. Langhauser was still alert enough to cringe when he heard the butchering of his language and turned to face his assistant. "If you were not the best assistant I have ever had, I would fire you for your horrible die Aussprache...umm pronunciation. How is it I — the boss — often find myself speaking your — the assistant's — language, Goldstein?"

"As you say, Dr. Langhauser, because I am the best assistant," smiled the older man. "Now go to bed, and I will arrange for a tour on Donnerstag, Yah?"

"Danke, Goldstein," replied Langhauser as he walked out the door. "Bis morgen früh."

"Such a good man," said Goldstein after Dr. Langhauser had left. *Especially compared to all those racist mamzers out there trying to blame all their problems on we Jews.*

Goldstein could understand Dr. Langhauser's patriotic feelings as well as wanting to help his country overcome the crippling it had received from the Great War. Even reviving his people from the poverty and shattered dreams; but the thought of the world with the Nazis in power...

Goldstein was not sure what scared him more; the sadistic lack of value the Nazis placed on any life but their own, or the incredible things that they were able to accomplish and the speed at which they did so without any sense of responsibility.

* * *

"...and here is the computator section, where engineers compute the curves of the wings and fuselage," stated a portly supervisor to an exasperated engineer and an exhausted assistant.

Goldstein translated the supervisor's explanation all to English in his head. *Maybe this was not a good idea,* he contemplated silently. *No one here seems to have any initiative or creative spark.* Goldstein wondered if the constant pressure of his finger and thumb on the bridge of his nose had lessened any the distance between his eyes. He would have to check for signs of self-mutilation in the mirror of the pub's bathroom later. After he had downed at least three of many beers he needed so desperately right now.

Proving that great minds are at least tried at similar rates, Langhauser was thinking of anything but the torturesome droning of their tour guide's voice. Langhauser's eyes wandered. His attention was drawn to a peculiar machine setting off to the side and a man sitting near it and working with it. "Pardon my interruption, but what is that machine? I don't think I have ever seen one."

"Oh, that?" sighed the supervisor. His tone shifted to echoing the same bored indifference his audience was experiencing. "That would be Herr Zuse's means of cheating at his job." The supervisor continued to walk.

Interest in their mission to find some talent rekindled in both Langhauser and Goldstein. They exchanged a glance, seeing life returned to each other's faces. "How does he cheat at his job?" inquired a confused Langhauser.

The supervisor stopped and turned around. He rolled his eyes and waved his hand to show his disdain. "Zuse doesn't like to work the mathematical calculations that his position requires. So he created this machine to do the work for him, leaving him free to work only when he decides he wants to and on what he wishes. You shouldn't let him concern you. He is lazy and unfitting an honor such as your project, Dr. Langhauser."

Goldstein and Langhauser looked at each other again, not believing what they were hearing. Goldstein was certain that this time his nasal area had suffered irreparable damage as he squeezed the bridge of his nose again. An obviously frustrated Langhauser inhaled deeply and posed a question to his long-winded guide. "So let me see if I am hearing you correctly. The work Herr Zuse had been assigned bored him, so he created a machine capable of performing the laborious task without any of the effort. Doesn't that seem like he may be demonstrating some form of initiative, not to mention rather extraordinary creative skills? These tasks that no longer require his work are now accomplished almost automatically, leaving him to perform other duties with his extra time!"

"Uhm, well...yes I suppose that does make some sense..." muttered the dull man.

Goldstein added quickly, "Don't you think you should introduce him to Dr. Langhauser?"

"Yes, of course. Right this way, gentlemen." The man's tone did nothing to hide the fact that he would rather be doing anything else *but* introducing these men to the lazy Zuse.

• * *

Zuse was growing more nervous by the moment. His supervisor and two rather important looking men had mentioned his name in their discussions and gestured in his direction. Considering his boss's opinion of him, this couldn't be good. *...Here they come. That's it. I'm done. This job rivaled some of the most painful experiences of my lifetime anyway. At least this will give me incentive to find something else.*

The trio approached Zuse and his machine. His supervisor introduced Zuse. "Dr. Langhauser, Herr Goldstein, this is Herr Zuse."

Zuse's eyes darted back and forth trying to decipher the facial expressions of the jury in front of him. *Which one is the executioner?* he thought. *Whichever man speaks next, that'll be him.*

"Nice to meet you. How can I assist you gentlemen?" he answered. Zuse figured he might as well get this over with. The butterflies in his gut seemed to be breeding at an astounding rate.

"Herr Zuse, it's a pleasure. I'm Dr. Langhauser and this is my assistant Herr Goldstein. I'm given to understand that you've developed a rather astounding machine. I'm told that you can simply program in complex mathematical formulae into this machine and it will perform the calculations for you. Is this correct?"

Zuse had not expected interest in his computator. "Uh... well, yes. That's correct. Perhaps I could show it to you, Herr Doctor?" Herr Zuse was stunned almost to the point of loss for words.

• * *

The revamped airplane hangar bristled with activity. Langhauser and Goldstein walked the floor looking over the project that filled the hanger. "See Goldstein, I told you that the dregs might have something to prove." Langhauser smiled in Goldstein's direction.

"Okay, this time you were right. Zuse appears to be an excellent worker now that he has been given something worth his interest to apply himself to. Makes one wonder if his old employers will ever realize how they were wasting his talent." Goldstein gazed into space as he reflected back at the events leading to Zuse joining the team. "Its too bad that I didn't have a camera to snap a picture of that supervisor when you asked to speak to him. I'm sure it would brighten the day for Herr Zuse to walk in and gaze at it."

"Or at least to launch darts at it during break time." Langhauser chuckled at the thought.

Zuse approached the Langhauser and Goldstein quickly. He was completely unaware that the two had been discussing him for the last several moments. "Excuse me Doktor, Herr Goldstein. I have something that I would like to propose." Zuse was obviously excited and nervous.

"Go ahead, Zuse. By all means." Langhauser recognized the look, which normally meant good news from an employee. "Doktor, we all know that your walker design is beyond comparison to any competitor's in the world. But... well... sir, I think I know how to make operation smoother, decreasing the amount of training that would be needed." Zuse held forward the papers in his hands as evidence.

Langhauser was flabbergasted. He took the papers, ignoring them for the moment. "How? What's your idea, Zuse?"

"Well, Doktor, my computator can calculate limits of movement and can be set to translate any rapid movement from the controls into a fluid operation. Pilots won't have to be as specific, not so precise in action. Instead of tripping up in a panic situation, the walker will smooth out the jerky, haphazard control inputs of the pilot. The end result will achieve the effect that the pilot wanted, without the walker trying to go in ten directions at once." Goldstein and Langhauser were speechless.

Zuse continued. "It's a simple adaptation of the formula calculation the Z series already does. Even more so, we can program it to accept certain combinations of control input. For instance taking three quick movements like a tap left, left again, and a tap forward and it will jump over an obstacle. Or tap forward, back, back and it reloads the magazine on the gun. The pilot no longer has to work out the complex action. It's already programmed in!"

Langhauser launched the papers skyward and grabbed Zuse "Yes! That's brilliant!" Langhauser's face was glowing with his excitement. He grabbed the papers quickly off the floor and grabbed Zuse again. "Come on, let's go start work on the new program!"

As the two men walked away Goldstein thought *Zuse is right. With that kind of ease of control the pilot's ability to control Langhauser's walkers will be without equal. This time, dear friend, I fear I must actually perform my assignment.* With that Goldstein sucked in a breath and jogged to catch up with the two men, smiling as he reached them.

ELECTROSTATIC DEFENSES

If Tesla is remembered though the ages, it will most likely be for his work with electrostatic weaponry. The principles used in the creation of electrostatic weapons were discovered by Tesla while working for J.P. Morgan in the early 20th century. They arose out of his work on free energy for the masses. The work on free energy transmission led to his loss of financial backing from Morgan, which in turn led Tesla to France where the French government agreed to fund his research, although they agreed to fund the military aspects of his work rather than the peaceful applications he preferred.

The fruits of his labors with the French were the electrostatic weapons and the EAE weapons, both used in the Maginot Line defenses. Once he returned to the States and took the reigns of research for the United States government (through Menlo Park), his work on these weapons largely went unfulfilled. However, in an unprecedented move by the U.S., Tesla was asked to help the U.S.S.R. in the war effort, and the Soviets were very interested in the work Tesla did for the French. He thus took up his research again on electrically accelerated particle weapons.

ELECTROMAGNETIC WAVES

What Tesla had discovered while working with the French was nothing short of revolutionary. He discovered that normal electromagnetic waves like light radio, could be separated into component waves. The electromagnetic waves traveled through time and space, thus having an effect in a direction, such as forward, in time. These kinds of phenomena are called vector waves. These vectors can be broken down into scalar values or waves that describe the movement of the effect in a direction. The scalar waves have no direction themselves and are just an effect with a value, and thus have a scale.

In other words, Tesla found that by generating two separate scalar waves of energy, in particular in the form of electrostatic potential or charge, he could combine them together to form a powerful electromagnetic vector, releasing the charges violently in the form of electromagnetic radiation. The resultant sudden release of energy could be like an explosion.

He was able to design generators that could send the Tesla waves through space. In essence, the generators were like radios that emitted the Tesla waves instead of radio waves. He furthermore designed the generators to send out the waves in pulses. By carefully timing the pulses, Tesla could set the distance at which the waves would meet and combine to 'explode,' anywhere from 10 meters to thousands of kilometers away. The generators and timing apparatus were collectively called Electrostatic Defense Artillery by Tesla, but they were commonly called Tesla Howitzers. They required vast amounts of electrical power, and thus they were only suitable for static (no pun intended) defenses.

The types of energy released in EDA explosions are still being explored, but it is known that sound, light and electrical energy are released through the combining of the scalar Tesla waves. Rumored effects range from affecting the local gravity fields to effecting the very fabric of time itself. No matter what the exact results are, however, the firing of an EDA is a true sight to behold!

Tunguska Rumors

In June of 1908 the Tunguska region of Siberia, a remote area in northeast Russia, experienced a bizarre event. Locals reported seeing a bright light and hearing a fantastic explosion one night. Upon further investigation the next morning, the apparent location of the event was found. They found that a force of some type had obliterated everything up to 20 miles away from the center of the blast. Timberland was crushed in an area measuring 2,000 square kilometers. Shock waves from the blast were reported to have been felt as far away as London! Later calculations estimated that the force of the blast was roughly equivalent to 15 megatons of TNT!

The effects witnessed in this event bear a striking resemblance to the effects of Tesla's electrostatic weaponry that were operational much later. However, no one has ever been able to determine if the Tunguska's cataclysmic event was due to an early experiment of Tesla's, or even if it was an early success or failure. Tesla never spoke of it, and nobody ever asked him directly about it before his death.

TESLA DEATH RAYS

Tesla developed a more precise weapon based on his work with the electrostatic defense artillery. The EDA effects were like an explosive shell, causing an area effect, and worked best against soft targets. The French, and later the Russians, were looking for a weapons that could penetrate armored plate better. The resultant weapon would then be effective against the new armored vehicles becoming prevalent in the armies of the world.

Through research, Tesla found that he could combine the effects of the EDAs with a secondary spike to produce an energy-based anti-tank weapon. By combining a small EDA with a secondary generator that emitted charged particles of matter after the initial Tesla waves were combined at the target, the new weapon produced an entirely new effect. The initial release of energy by the EDA created the expected discharge of EM energy, but by carefully timing the release of the charged particles from the secondary generator, a new potential of electrical charge was produced between the weapon and the target. This potential would form an arc of electrical current, like two wires held close together, but over much greater distances. The arc created a vacuum in the air, which allowed the charged particles from the second generator to easily travel to the target at relativistic velocity. The resultant collision of the particles and the target was like an armor piercing round from a tank gun.

The first prototypes of the weapon required generators that used much less power than the EDA generators, but they were still too large to be carried by anything smaller than a superheavy tank. Thus the first field models of the new electrically accelerated energy cannon had to mounted on the only French vehicle big enough to carry them — the Grognard. Luckily, while the power supply needed was rather large, it was only required for a short period of time. Therefore, Tesla designed new high-charge capacitors to provide the pulsed energy required. Once the weapon was fired, however, the capacitors needed to charge again off of the vehicle's engine-driven power generators, which could charge the capacitor over many seconds. As expected, this meant the weapon could not be fired as quickly as a conventional tank gun.

Tesla kept on working with the Russians for a long time, and they continued to develop the weapon system after his disappearance. As research progressed, the capacitors grew more efficient, as did the power requirements of the weapon itself. These developments led to a much more efficient weapon that could fire more quickly. By the end of the war, the EAE cannon was a weapon to be feared.

Free Power!

One of the related effects of Tesla research into electricity was the possibility of using the Earth itself as a giant capacitor to store electrical charge and discharging it anywhere else on the globe. The result would be free power available to anyone with the means to tap it.

The operation of the device that Tesla envisioned would use Tesla waves to form interference patterns (and thus electromagnetic energy) in a multitude of areas over the Earth. Receiving devices would have been able to receive this energy much like a radio receives a radio signal, only the device would receive the energy in the form of electricity and thus power itself.

Obviously such a device for the free transmission of energy didn't go over well with any of Tesla's financial backers, and his visions of global, abundant power were never realized.

MAGINOT LINE FORTIFICATIONS

The French were the first to reap the benefits of Tesla electrostatic weaponry. They put a great deal of faith in the weapons and used them extensively in the design of the Maginot Line. Both the ED artillery and the EAE cannons were used as the main armaments for the fortifications, providing offensive power against hard and soft targets alike.

The Line itself stretches from Switzerland to the Ardennes in the north, and from the Alps to the Mediterranean in the south. Originally the fortifications only covered the border between Germany and France, but once the Belgians revoked the Franco-Belgian Alliance of 1920 the line was extended to cover part of the border between Belgium and France as well. The extension was not as formidable as the original fortifications, however, and did not have the Tesla weapons.

BASIC DESIGN

The entire defense line was carefully designed for maximum protection and survivability. Each elements to maximum advantage of existing natural cover, carefully located observation points, wide-open fields of fire and extensive anti-tank obstacles. River crossings and crossroads were protected by anti-tank positions and minefields, while frontier houses were fortified to provide forward positions.

Further back, about a mile apart, casemates filled in the gaps between the forts. A casemate was a two-story building with a firing chamber on the top floor and a diesel generator below. It housed a crew of around thirty men equipped with arms, munitions and stores. Anti-tank rails and a network of barbed wire formed an additional line of defense along the frontier.

The main forts, called *ouvrages*, were found every five to ten kilometers apart along the frontier. Large ouvrages were equipped with high caliber artillery guns, EDAs and EAECs, along with a 1000-men strong garrison. The forts were never more than ten or twelve kilometers apart (the maximum range of their main guns) so they could bring down fire on the smaller works if the latter were captured by the enemy. They thus formed the "bastion" of the defensive position and occupied the dominant points on the line. The medium forts housed 500 men and the smaller ouvrages only up to 200. Storage depots, concrete shelters for the interval and reserve troops, barracks and casernes for the troops' families were places behind and between the above.

Each fort was designed to take direct hits from its neighbor without damage, should part of the line be captured and turned against friendlies. Forts could be swept of attackers by neighboring forts. Major studies revealed that steel-reinforced concrete afforded the best protection for the surface blocks. The underground galleries were made of masonry with at least twenty meters of earth overhead. Surface concrete was between three and four meters thick, with only one to two meters for the least important casements. The steel cupolas had armor nearly 300mm thick.

The Philadelphia Experiment

The Philadelphia Experiment refers to a little known project of the U.S. Navy called Rainbow. It is thought among intelligence circles that the project deals with either degaussing ships to avoid mines, or for radar invisibility. Even America's allies aren't fully sure of the project's intention, but it would appear that sometime during the period of July to August, 1943, a Navy destroyer either vanished from sight and/or was rendered radar invisible for a period of several minutes.

The sketchy reports that have been cobbled together provide this information: the destroyer was most probably the U.S.S. Eldridge. One witness reported to a German operative that a destroyer with the Eldridge's hull number appeared in the harbor at Norfolk, Virginia about the same time that the destroyer is rumored to have vanished from Philadelphia harbor. Whether this indicates that the Navy succeeded in some kind of teleportation experiment, either by accident or design, is still in question.

Rumors also indicate the involvement of Nikolai Tesla in the early phases of the project, and it is believed that his Tesla coils were among the devices used in the experiment. What the Philadelphia Experiment truly set out to accomplish and what it actually succeeded in doing may well not be known until after the war is over.

FORTIFICATION WALKAROUND

Gaston hated giving tours to government bureaucrats, but since they tended to pay the bills around here, he could hardly argue about it. Today it was two officials from the Ministère de l'Economie, des Finances et de l'Industrie. Bean counters of the worst kind. Still, he was performing a duty to the state, and he might as well look sharp doing it. He finished smoothing his uniform into place just as the two visitors entered his office.

The room was tiny and spartan. The underground complex would permit nothing more. Cold, grey concrete formed the four walls. Bare wire ran along the walls, terminating in electrical outlets near the floor and dim lamps on the ceiling. Some bookcases, a desk and some chairs completed the ensemble. His guests were wearing conservative suits and carrying briefcases. Stereotypical accountants. Gaston rose to greet them.

"Good afternoon, gentleman. Lieutenant Gaston Patriat, at your service!"

"I am Cristophe Dauzat, and this is Monsieur Paul Lebel. I believe you are to give us a tour of this facility?"

"This way." He led them out the door into the long hallway. He turned left towards the casement, away from the barracks. As they walked he began the tour. "Back there are the living quarters. Nothing too exciting there, just the bunks for the men manning this casemate and the proper facilities for food, bathing and such. We're currently twenty meters undergound, and surrounded by over 1000 tonnes of concrete and steel." One of the two men pulled a small pad and pencil from his jacket and began to jot down notes. Gaston rolled his eyes internally.

They reached a large steel door. It looked formidable, with a large wheel in the center and immense hinges. "This is the door to the casemate itself. It is locked from this side, in case the enemy somehow gets into the turret. It can withstand several hundred pounds of TNT. But for now, we'll just open the easy way." He smiled at his own joke, but the visitors showed no emotion. He sighed and turned the wheel to open the door. The door unlocked with a deep thump as the locking bars retracted from the walls. Gastong grabbed the door handle with both hands and grunted as he opened the door. As it opened it revealed its 15cm thickness. Despite its obvious mass, the door made no sound as it swung on its well-oiled hinges.

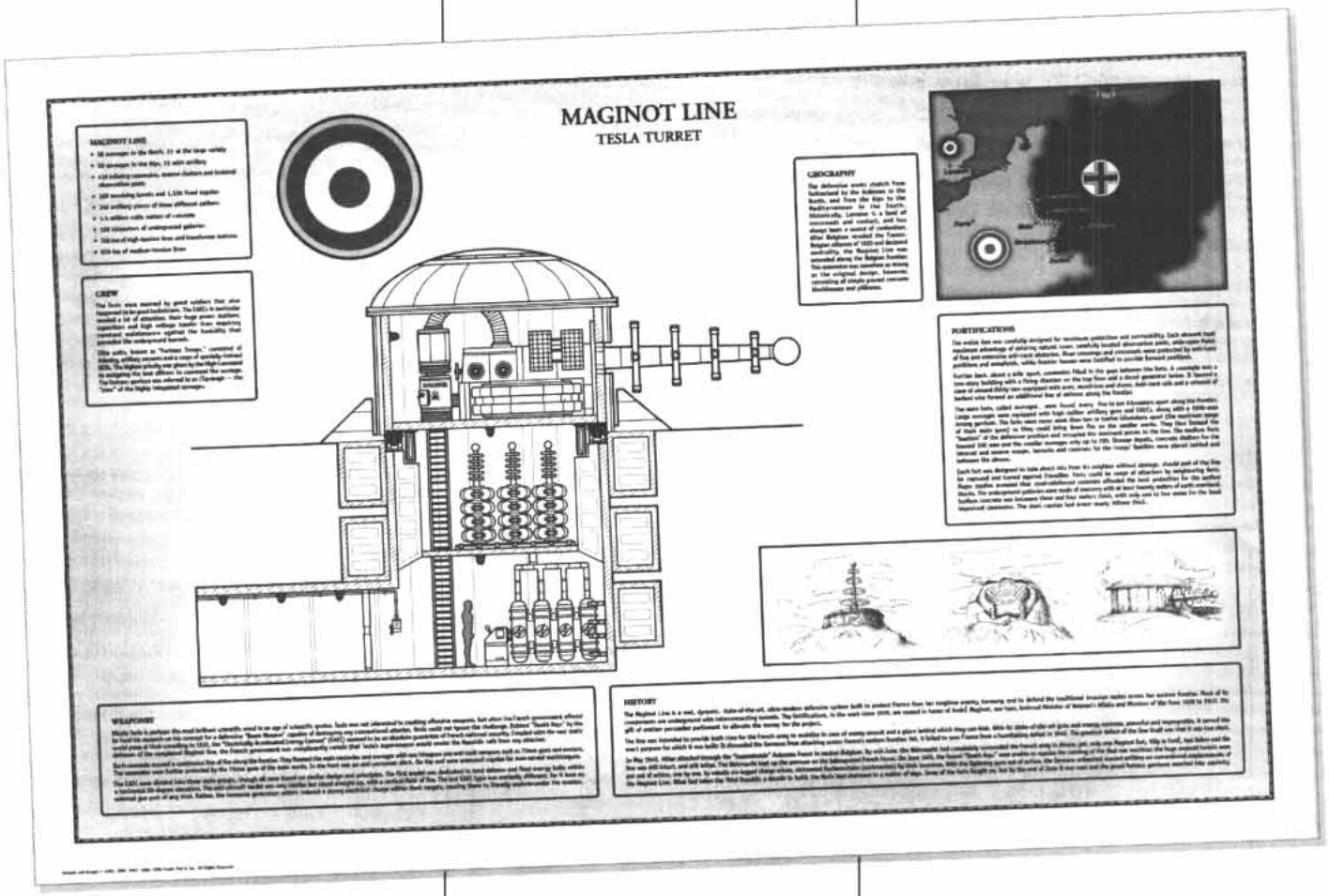
POWER

"Apres vous, messieurs." He followed them into the main generator room. A technician was inspecting the instrument panel, oblivious to the new arrivals. The generator was as tall as a man, and just as wide. It was comprised of four housings for the induction coils. Huge conduits ran from the top of each housing to one of the walls. They joined together into an even larger conduit that ran through the ceiling to the next level. The generator hummed quietly.

"Here is the main generator for the EAEC. It is capable of producing over one million volts, enough to light any of the towns nearby. It feeds the capacitors used to fire the weapon as well as all of the electronics used to aim and fire it. We had some fun when we first installed it. We would blow each and every lamp in this casement whenever we charged the capacitors. But Jaques here helped us sort that out. Helped save us a lot of time spent changing bulbs." The man with the pad jotted down more notes. "Those wires transfer the power from the generator to capacitors on the next level. Shall we?"

STORAGE

He led the men up a ladder that led from the bottom floor to the middle floor. The ladder continued up the wall to the next level. "This level houses the capacitors that store the energy for each shot with the EAEC." He gestures to the seven capacitors in the middle of the room. They were arranged in a circular pattern on the floor, six of them surrounding the seventh. They reached from the floor to the ceiling. "Each capacitor is constructed of copper, gold and ceramic and is capable of storing over 2 million volts of potential. Together they can provide nearly 15 million volts of electrical power to the main cannon. If they were charged right now, your hair would stand on end and your entire body would be tingling. It disturbs some of the men, but personally I love it. Makes you feel so alive! Now if you look up top around here on the wall, you can see the shock absorbers and wheels that allow the turret to turn smoothly. You'd think something like this would make a lot of racket when turning, but it's amazingly quiet. Now if you'd be kind enough to follow me to the next level, I'll show you the cannon itself!"



WEAPONRY

The climbed the ladder to the remaining level. It was the only one above ground. "And here is where all of our precious francs are being spent, Messieurs. I present to you the Electrically Accelerated Energy Cannon, known the world over as the EAEC." The two guests finally showed some emotion as their jaws dropped in wonder at finally seeing one of the great inventions of Tesla. Wires ran everywhere, over and through various unknown metal housings.

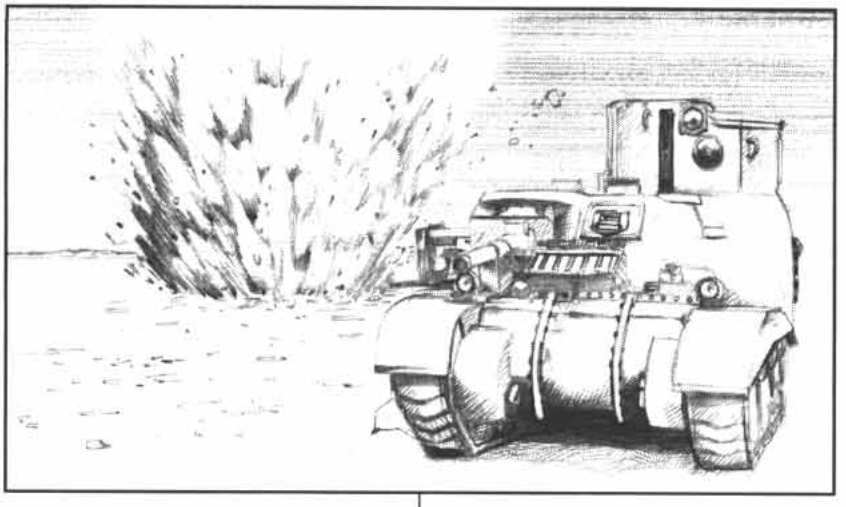
"Ah, where to start? This right here is the induction coil, which transfers the charge from the capacitors to the weapon. It powers the Tesla wave part of the weapon. That power travels through the large conduit you see above here. The waves are fired out the front of the weapon over there. They combine on the target to form the end of the electrical potential arc on the target, through which the voltage is sent and the electrical circuit is completed. Then, a microsecond later, the particle generator sends its charged particles down that circuit. The particle generator is down on the bottom there — the large round thing there. Scares the hell out of the wildlife whenever we test fire this thing! Luckily were shielded from most of the racket it makes when fired. He just get a loud hum. This weapon can destroy anything the Germans can send at us with ease. Our country is perfectly safe with these kinds of weapon in place!" Gaston thought a moment and continued, "Would you like to see a test fire of the EAEC?" There was a twinkle in his eyes as he made the offer.

The two government men looked at each other. The one without the pad replied slowly. "I don't thing that would be a wise expenditure of government funds, do you?" Gaston sighed. He hated bureaucrats. No fun at all.

WEAPONRY

Vehicles designed for war, especially the tank and airplane, with their increased mobility, heavier ordinance and increased battlefield endurance, have become machines of destructive might. The earlier supporting role gave way to more complex tasks such as rapid assault and front-line fighting. New and refined manufacturing techniques gave their weapons a higher rate of fire, reduced cost for ammunition and increased range.

By the late 1930s, armaments had reached an impressive level of performance, and new types were introduced almost every month. By the early 40's, a few Russian tanks were sporting scaled-down versions of the Tesla projectors, while British troops were fielding the first of their "Canal Light" primitive laser guns. Others, even more esoteric weapons would also appear from time to time, most of them prototypes or limited production devices that would often be as dangerous to the user as to the target!



CANAL DEFENSE LIGHT SYSTEM

In 1937 a group of private individuals, including Harry Grindell-Mathews, presented an intriguing idea to the British War Office. The idea was to mount a powerful searchlight in a special housing on a tank to provide 'artificial moonlight' during night attacks. Trials of the system, known as the Canal Defense Light, proved that the system could be beneficial. Trials also showed that the system could be used in an offensive fashion by aiming it at the enemy and blinding them.

The system was mounted on experimental tanks in 1940. It was used operationally in Africa, where it helped British forces fight more effectively at night. This early success led to further development. The next incarnation of the CDL used the infrared spectrum to illuminate the night sky. IR light required the use of special weapon sights to detect and use to fight at night, but now the enemy wouldn't see the lights as easily. They could also be used to blind the new IR equipment the Germans were beginning to field. The IR CDL system was used in Europe from 1943 on.

One of the original people who presented the CDL system to the British War Office, Harry Grindell-Mathews, has continued work with the system. He is said to be working on a version that can actually damage enemy vehicles with nothing more than concentrated light. No such weapon has been fielded operationally, and any testing is presumed to be secretive. If his research is successfully made reality, the Axis powers will have a remarkable weapon to try and defend themselves against.

'SECRET COMMUNICATIONS SYSTEM'

A beautiful movie actress, Hedy Lamarr's striking visage hid an equally striking intellect. Hedy had learned a lot from her first husband, a Viennese industrialist who not only made munitions, but also got into aircraft production after Hedy had moved to America. Hedy wanted to help her adopted country at a time when the world was creeping towards war. George Antheils was a musician and a composer. He had moved to Hollywood to write music for the movies, and was Hedy's next door neighbor.

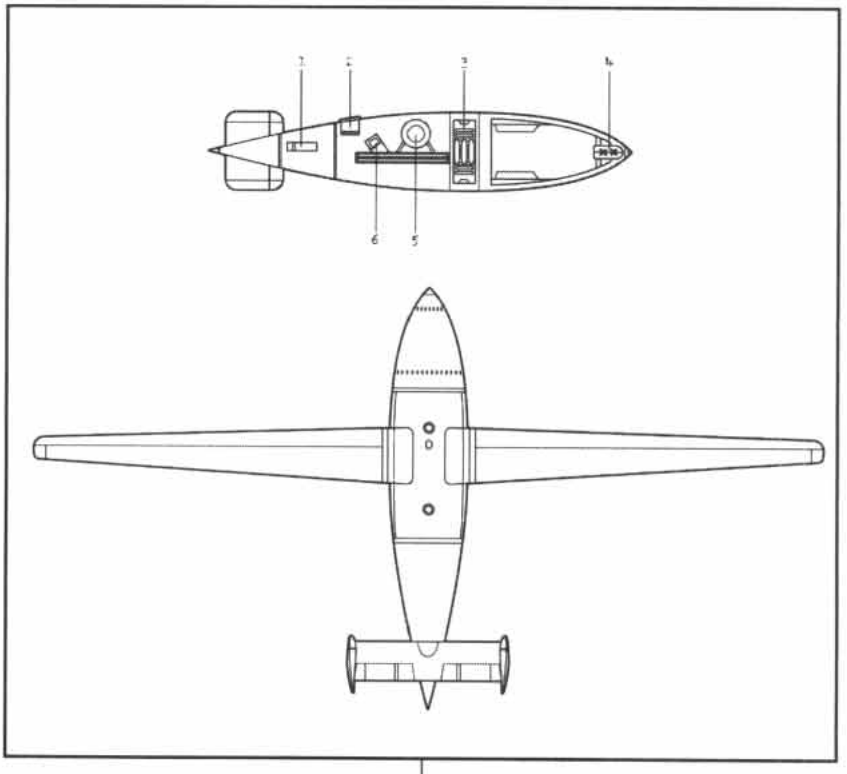
Hedy and George were having a lengthy conversation about the impending war and what could be done. They spoke of various bits of new technology, and how it could be exploited. Hedy had an idea to skip or 'hop' frequencies quickly to confuse anyone trying to jam or intercept communications. They both thought this idea would be grand for remotely controlling torpedoes. The concept used piano rolls to set up the sequence of skipped frequencies. The sender and receiver would synchronize their rolls, insuring that they would both be skipping the same frequencies and maintaining a communication.

They worked out their idea and submitted it to the National Inventor's Council. Hedy's and George's concept was so revolutionary that the chairman of the council, Charles Kettering, contacted them immediately. He suggested that they contact Edwin Armstrong at Columbia University about their concept. When ask why, Kettering responded, "Well, first off, he knows everything about radio and second, he is rich."

With some technical and insightful input from Prof. Armstrong, some prototyping by an undergraduate student of Armstrong's (Pauline Collins), and polishing by Lamarr and Antheils, a system was devised and submitted for patent. They were granted a patent on Friday, November 14, 1941. Though the patent was granted under the title of 'Secret Communications System', it was really intended and written up as a remote control radio set for torpedoes. The system led however to frequency hopping radios that where are hard to intercept.

TV-GLIDE BOMBS

The United States worked on many models of guided bombs during WWII. They called them the Vertical Bomb series. The culmination of their research was a radio-controlled guided bomb with a televisor in the nose called the VB-10 ROC, prototyped in 1943 and deployed operationally in 1944. The weapon was dropped from specially equipped B24 Liberator bombers and later from attack helical aerodynes. The bombardier controlled each bomb from a control set, viewing the bomb's flight path through the televisor camera in its nose. The bomb's 1000lb warhead could be delivered with surgical accuracy, or at least surgical accuracy for the time.



The ROC, while very useful, required an awful lot of time to guide in. It required a great deal more time than dropping normal bombs in large numbers. As a result, the weapon was not used in large numbers for general purpose bombing runs. The ROC was used for specific targets where a hit was crucial, such as bridges and secret weapon projects, and most importantly anti-aircraft artillery. Helodynes with glide bombs were particularly effective against AAA, since they could hover out of range of the guns and guide the bomb in from that distance.

The success of the ROC, while limited, was enough to at least start rumors of a larger bomb based on English 12,000lb bombs. If such a weapon exists, it is most definitely still in development.

National Inventor's Council (N.I.C.)

Headed up by Charles F. Kettering, who was also the research director of General Motors, the National Inventor's Council would play a significant part in bringing together many unusual creative minds. Though accused at the time of forcing applicants to do his job for him, Kettering suggested that applicants seek out other inventors to help each other advance their concepts. After many marvelous inventions came out of the National Inventor's Council, many stopped criticizing Kettering. Still, it would jokingly be called the National Inventor's Coffee due to the large number of women inventors (after coffee clutches: social groups of women who met over coffee). The National Inventor's Council not only counted Hedy Lamarr as one of their members, but also Pauline Collins, Beulah Henry and Tina Matthews .

RADIOS

Pauline Collins thought that the concept of frequency hopping was wasted on torpedoes. She felt it would do much better in the radios of aircraft, tanks, and maybe even on the backs of infantrymen. With reassurance from her mentor, Prof. Armstrong, Pauline laid out several prototypes, trying to find the most robust way to provide seemingly random frequency changes that could be easily matched by another radio set. Her first patent, in March of 1942, used mechanical gears to change both coils and resistance as they turned. The N.I.C. helped Pauline get her patent and made sure her patent was used. They concentrated on communication between naval ships as the safest way to test the new technology. The Navy thought that aircraft or infantry could be too easily captured and didn't want to risk the capture of this new technology.

Pauline later went on to try to invent a way for the transmitter to signal the frequency about to be changed to, but in a way that would not or could not be intercepted by enemy equipment. She spent all of her money from her mechanical frequency hopper to fund the research for this new device. She has not had any luck as of yet, but is making progress.

FREQUENCY MODULATION

Frequency Modulation, or FM radio, is the direct the result of one man's research. Edwin Armstrong, when trying to create a radio that had less interference and noise than AM radio, devised FM as a new method for broadcasting a radio signal.

The main advantage of FM radio is that the signal is of constant amplitude. The resulting signal is resistant to the electrical storm interference, the interference of motors, and signal strength variances. The frequency modulation carries the proper information, unaffected by the amplitude of the signal. This new method allows for more easily understood voice communication over distances and through electrical storms.

Another advantage of frequency modulation is that amplifying the signal, either at the transmitter or the receiver, did not tend to distort the signal as was true with AM. As a result, communication over much greater distances is possible with FM signals.

FM radio could be broadcast at almost any frequency, so HF (High Frequency) and VHF (Very High Frequency) were options with FM. The new ranges allowed for more possible channels of communication. More people could now communicate in the available ranges. Armstrong has even proposed a new band of radio, but is not sure he can build the equipment to actually use this Ultra High Frequency band.

Edwin Howard Armstrong

This professor of electrical engineering at Columbia University started inventing and improving upon radio circuitry while a student there. He served as a Major in the Signal Corp. during World War I, and he returned to Columbia University after the war.

Professor Armstrong not only invented the first reliable continuous-wave transmitter, he also invented the superheterodyne circuit. He continued with high-frequency electromagnetic wave research when he invented and patented wide-band frequency modulation, soon to be known as FM.

Professor Armstrong was often sought for his input on other inventors' concepts. It was well known that Kettering, chairman of the N.I.C., offered to pay Edwin for reviewing applications that involved radio technology. Armstrong refused because he had more than enough money from the royalties of his previous inventions. Columbia University saw to it that he had all the equipment he needed. He was also invited to join Tesla at Menlo Park. Edwin turned it down, saying that he had become part of the Columbia University campus.

SENSORS

Up until the 20th century, the only sensors humankind had available to them were the human senses. Sight, sound, and smell were the only way to detect from afar, and only sight had enjoyed any devices to enhance or correct it. In the Modern Age, however, new ways to detect others have started to appear.

Like most inventions, the newest detection methods are not yet perfected. The early prototypes of detection devices were housed in huge contraptions and totally impractical for mobile use. This limitation did not hamper some inventions such as Radar, which was useful for fixed installations. Other types of detection equipment, however, remain unsuitable for widespread use. The Modern Age has begun to see smaller versions of these devices, and their exploitation on the battlefield is beginning.

INFRARED SENSORS

Devices that see into the infrared spectrum of light have started to be used in war. The devices see light that is invisible to the human eye, and allow a clear picture of a target where normal light would not. Radiant heat emits infrared light, making running vehicles and human beings excellent emitters of infrared radiation. As a result, infantry, vehicles with running engines and even weapons that have recently fired can be seen with ease even if they are camouflaged. Even with this advantage, IR sights are more useful at night due to the large amounts of infrared light present during daytime. Too much infrared light saturates the sights, making them useless.

The primary use for infrared sensors is as weapon sights, both man-portable and vehicular. The man-portable models are still rather bulky, using a large backpack for power. The sights themselves dwarf any infantry weapon they're mounted on. The Germans and the British are the chief experimenters with this new technology. Both sides have used infrared spotlights to illuminate the battlefield as night, invisible to those without IR sights. The British have gone so far as to use IR light in an offensive capacity with their CDL system.

RADAR

Radar, or RAdio Detection And Ranging, has its roots in the late 19th century, when radio waves were first being used. In 1887, the German physicist Heinrich Hertz was experimenting with radio waves. He found that they could be directed at various objects. Some objects would absorb the radio waves, but some would reflect them. He also found a way to measure the speed at which the reflected waves returned to the sender.

Not much was done with Hertz's findings until the 1920s and 1930s. At that time, other inventors began to tinker with the phenomena that Hertz recorded. A British man, Robert A. Watson-Watt, was inspired by reports of planes causing radio interference. He found that by sending out radio signals along a narrow path and measuring the time the reflected energy took to return from objects, that those objects could be accurately mapped. The applications for reliable tracking of aircraft and naval vessels were enormous. In 1935 he sent a proposal for Radio Detection Finding to the British government. He submitted his paper under the codename of "radar." His theory was tested with large, building-sized radar prototypes. They could only reliably detect planes out to twelve kilometers or so.

Others also started research in this area, and by 1939 the Germans had a version that could detect British bombers out to 114 kilometers. Further research was conducted, and soon reliable radar systems were being mounted in naval vessels to help guide planes.

By the time of the Modern Age, radar systems are now small enough to be used on walkers and tanks, giving them detection abilities in the most adverse weather conditions. Research into systems small enough to fit into a weapon such as a rocket is being conducted. Such weapons may even be able to hit targets so far away that the human eye cannot see them!

SONAR

Sonar is the American name for sound-detecting systems. Sonar stands for SOund Navigation And Ranging. The first systems to use sound to detect objects in water were invented by Lewis Nixon in 1906. His system was used primarily to detect icebergs, and relied solely on detected sounds.

World War I encouraged further development of the sonar systems. The use of submarines in the war posed a need to detect objects under the oceans. Sonar provided a means. By 1918, active sonar devices had been built by the U.S. and Great Britain. These systems sent out active sound signals that bounced off of objects, to be reflected back and detected by the detection sensors. Objects could thus be more easily detected at great distances. By the start of the war, they were in common use for the detection of navigational hazards as well as submarines.

COMPUTATORS

Modern Age computators have their roots in the 19th century and early 20th century. Early forms of computators were purely analog mechanical contraptions used to calculate relatively simple mathematical problems. As technology progressed, the designs became more complicated, to the point that mechanical operation became so inefficient as to be useless. The simpler designs were still used, mostly as tabulation machines for accountants.

In the early 20th century electricity came into practical use, and as a result new designs for computational machines developed. Electromechanical and later purely electrical machines were designed. Memory storage came into being, allowing for programs to be stored on a machine. The very idea of a reprogrammable machine was developed.

DIFFERENCE ENGINE

The first steps in creating the modern computator were taken by the British mathematician Charles Babbage in 1822. Babbage conceived of a machine to help calculate logarithmic and trigonometric tables The resulting machine was huge, weighing in at over three tons and had 4000 components!

The machine helped to save computers — people hired to actually compute the mathematical tables — incalculable amounts of time. No sooner was the Difference Engine constructed that Babbage started to design another machine, the Analytical Engine.

ANALYTICAL ENGINE

The Analytical Engine was a design far ahead of its time. In 1830, Babbage started designing a machine that could accept programming, which meant that it could perform tasks based on the result of previous tasks the machine performed. He envisioned the use of punched cards, which had previously been used for rug loom design storage, for the machine's decision-making.

In the programming department Babbage enlisted the aid of Ada Byron, one of the brightest mathematicians of the time. Her work was to design the actual decision making process the machine would use for its intended first program. For this program, she had decided upon the Bernoulli number sequence.

Unfortunately for both Babbage and Lady Lovelace, the Analytical Engine was far too complex for the time, required more power and mechanical might than was currently possible. As a result, the machine was never built, and programmable machines would have to wait another century before being realized.

PUNCH CARDS AND THE 1890 U.S. CENSUS

Although the Analytical Engine was never built, the concepts it explored lived on. One of those was the use of punched cards in computing machines. Herman Hollerith, while watching a conductor on a train punch tickets, conceived of a method by with the U.S. Census Bureau might speed up the census-taking process.

The 1880 U.S. census had taken eight years to tabulate, and experts feared the 1890 census would take even longer if the work continued by hand. Hollerith's idea was to use cards that recorded census data by punching holes in the card. The cards would then be read by a machine that pressed pins against the card. The pins that protruded through the holes completed an electrical circuit.

The results from reading each card would be collated by the machine, providing totals and statistics in record time. It could even be modified through a series of switches to tabulate data based on particular criteria, such as the number of families with two or more children.

Charles Babbage

Born in 1791, Charles Babbage was a noted British mathematician and inventor. He pioneered work in computing machines with his Engines. He also worked on other important inventions like the cow catcher for locomotives and uniform postal rates in Britain. At the time of his death in 1871 he was virtually unknown, even mocked in some circles. It was only later that his contributions to computator design and concepts were recognized.

Ada Byron, Lady Lovelace

Ada was born in 1815 to the poet Lord Byron and his wife. Five weeks after her birth, her parents divorced and Ada was taken to live with her mother. Her mother trained her in mathematics and science, hoping to prevent Ada from becoming a poet like her father. She had crossed paths with Babbage many times in her life, and when she learned about his plans for the Analytical Engine, she jumped at the chance to explore its possibilities. Her first practical plan for the Analytical Engine was the computation of Bernoulli numbers. This plan can be considered the very first computator program.

ROCKEFELLER DIFFERENTIAL ANALYZER

One of the last of the analog computers created, the Differential Analyzer was designed by Vannevar Bush in 1940 to help calculate artillery tables for the U.S. Army. These tables were used by crews to easily determine the way in which an artillery gun would have to be zeroed to deliver a fire mission to a given location. The tables saved the crew the drudgery and time of calculating the required settings themselves. Ironically, Bush would later work on computators that would make the Analyzer obsolete.

MODERN COMPUTATORS

Computators have finally come of age in the era of global warfare. Based on the work before them, modern computators allow data to be calculated, tabulated and collated. Computators can also be reprogrammed, can store data for later use and even operate digitally. Digital operation is perhaps the most important new feature, allowing computing machines to operate with discrete pulses of electrical current. Digital computators can take up much less space than an equivalent analog computator, losing much less energy in the computing process.

Data storage allows Modern Age computators to perform very complex calculations, saving the results of earlier calculations for later use to produce highly filtered results and saving many man-hours of effort in the process.

Reprogrammability allows current computators to be very flexible. One machine can perform many different operations, making them more efficient than any computing machines that have been constructed before them. The visions of Turing are becoming a reality.

• Z SERIES COMPUTATORS

The very first of the modern computators were designed and constructed by Konrad Zuse in 1935. He needed a solution to the problem of computing wing surface geometry all day long. The work was boring and tedious; many values had to be correctly recorded during the intermediate steps of the calculations. A single error in any of the values could ruin hours or even days of work. Konrad decided to construct a machine to help calculate his wing surfaces.

His first machine, the Z1, had many of the elements of modern computator design. He included the ability to do floating-point arithmetic, memory for storage of intermediate values and a calculating unit. The unit was electromechanical, using sliding rods to store information in memory as well as for calculations. It was the first calculating machine to use binary arithmetic. He built the machine in his parents' kitchen.

His second computator, the Z2, was a refinement of the Z1, built in his parents' living room. Zuse used telephone relays for the calculating unit, which considerably improved reliability. However, it wasn't much of a advance over the Z1. The location of the machine also didn't sit well with his parents: he was asked to take his work elsewhere.

His third computator would achieve the advances sufficient enough for Zuse's satisfaction. The Z3 was constructed at his workplace in 1939, and used relays for memory storage as well as for calculations. The Z3 has very reliable, and Zuse developed the very first practical

Vannevar Bush

Vannevar Bush was born just as Hollerith's tabulating machines were beginning their valuable role in 1890. He worked at M.I.T. for years in the field of electrical engineering. His master's thesis was the invention of the Profile Tracer, used in surveying work to measure distances over uneven ground. In the early parts of WWII he was recruited to oversee the administrative aspects of two important governmental science and technology organizations, the National Advisory Committee on Aeronautics and the Office of Scientific Research and Development. He was appointed to the latter role by the President himself, and Bush was responsible for over 6,000 scientists working for the war efforts as a result. In addition to his duties for these two organizations, he worked on the Differential Analyzer and on radar antenna profiles.

Herman Hollerith

Herman Hollerith was born to German immigrant parents in 1860. He had trouble in school, facing teachers who did not take kindly to his lack of spelling skills. He began to skip school, and eventually was tutored at home. He fared better in college, where his engineering studies earned him distinction. He worked for the U.S. Census in the 1880s, where he saw the need for a machine to help tabulate the collected data. He created his tabulating machines while teaching at M.I.T. The success of his machines led to his creations of the Tabulation Machine Company in 1896. He earned many patents on his work, and his machines were used in the censes of other countries. His company survived the release of competing machines from other companies and was later renamed International Business Machines.

Konrad Zuse

Konrad Zuse, born in 1910, was destined to become a man well-regarded in technical circles for his contributions to modern computating. Konrad earned his Degree of Civil Engineering in 1935 from Polytechnical Institute of Berlin-Charlottenburg. He thought his lot would be the boring, unexciting life of an engineer. His very first job, however, proved to be just the opposite. The young engineer was hired by an aeronautical design firm and given the task of doing endless computations for wing curvatures. After a few weeks on the job, he could not take the drudgery and decided to do something about it.

In his parents' kitchen and later their living room, Konrad built an experimental computator. Running out of room (as well as their patience) at his parents', Konrad moved the contraption to his place of work. There, he used it to make his job less menial, letting the machine crunch the numbers for him.

Destiny favored the bored Konrad when Dr. Langhauser toured the factory in which Zuse worked. Dr. Langhauser liked what he saw of both Zuse and his contraption and recruited him on the spot. Zuse moved from the Henschel Flugzeugwerke to work at Traumshoteneun Panzerfabrik. He continued to modify his programmable computator, eventually modifying it to become an control interpreter for a walker. Zuse continued to update and revise his new computator, the Dolmetscher.

Dr. Langhauser almost lost his incredible Dolmescher man when the Wehrmacht heard of one of Zuse's experiments, an automated anti-aircraft battery. By using a combining a modified Dolmetscher 4, a modified ground radar array, and some modified 88mm AA Guns, Zuse was able to construct a working prototype a multi-barreled and completely automated defense system. The Wehrmacht decided that they wanted this system on a mobile platform. The resulting walker did not work as well as the original invention. The computator had to fit in a walker chassis, and was therefore not as capable. Additionally, the walker did not mount 88s, but smaller 20mm cannon. It worked well enough for hasty defense, but the Wermacht was not satisfied enough to steal the talents of Zuse away from Langhauser.

programming language to instruct the computator what to do. He stored his programs and results on celluloid film. Paper punch cards were hard to come by, being produced almost exclusively in the U.S. It was the strength of the Z3 that led to Zuse being hired by Dr. Langhouser to develop control computators for walkers.

• D SERIES COMPUTATORS

In 1939, Konrad Zuse was hired by Dr. Karl Langhauser to develop his Z series of computators. Langhauser was assigned the first military walker project, and he felt Zuse's new machine might be useful in the new walker. The Loki had been in production for a full year, but had still had problems with control and staying upright. A way to help pilots control the machine was needed, and Langhauser figured Zuse could find it.

Zuse presented a new computator, the D1, to Langhauser in early 1940. The machine was a refinement of the Z3, with modified programming to produce output suitable for the control of a walker. The D1 was smaller than the Z3 and still used electromechanical relays. While the computator did provide much improve control over a walker, it was problematic due to the tendency for the relays to reset whenever the walker experienced a hard enough hit. For a machine intended for combat, hits from enemy fire were likely and a control computator that reset in the middle of combat was less than ideal.

The Wermacht found the D1 to be useful enough to use in later model Lokis and other walkers, but they wanted Zuse to work on the reset problem. He convinced them to fund the purchase of expensive electron tubes to combat this problem. He built the D2 series with tube electronics instead of relays. The D2 proved to be very stable over the D1, although it did produce more heat. He was able to control the heat problem in follow on D series computators. He also has able to expand on their complexity.

His D4 became a staple of German walker control. Zuse wrote an entire programming language dedicated to the late D series. The language was called Plankalkül, and introduced concepts such as array style data storage to computating. Arrays allowed for non-sequential access to data, creating more flexible machines. He even built versions of the D4 to play games for his own amusement. He wrote the first chess-playing program on the D4.

• ABC COMPUTER

The ABC computer was completed around 1939, a project originally undertaken by its creator, John Atanasoff, and his assistant, Clifford Berry, in 1937. The computating machine was the first fully electronic digital computer, a daring undertaking that made large leaps in the science computating, such as a binary system of mathematics, parallel processing and regenerative memory which was separated from its computing functions. It was also the first machine to use electricity, vacuum tubes

and capacitors. It was capable of computating one mathematical calculation every fifteen seconds or as many as three calculations per second, depending on complexity. It was the size of a large desk and weighed over 700 pounds. It was made up of over 300 vacuum tubes and over a mile of wire. While all of these statistics sound impressive, however, the computer was essentially used for mundane calculations. The creators would go on to work on the U.S. walker effort, designing computators to help control them.

• COLOSSUS

The British government was hard at work deciphering German radio transmissions through World War II. The collection of genius at Bletchley Park was having success, using crude calculating machines to crack the Enigma codes. Another team was working hard to defeat the Lorenz cipher used in teleprinter transmissions. In 1941, the code-breakers got their chance. They received a duplicate message that allowed them to truly decipher the Lorenz code.

John Tiltman and Bill Tutte had done the decoding, and they enlisted the aid of Max Neuman to design a computator to help decode future messages. Their work resulted in the Heath Robinson, named after a famed cartoonist of fantastical and fanciful machines (no doubt the machine would have been called a Rube Goldberg in the States). The machine proved unreliable in reading the input data and the decoding sequences. Each of these stream of data was stored on long punched tapes. The Heath Robinson had problem keeping these two tapes in synch.

While the Heath Robinson was problematic, it demonstrated that using a computator to help decode messages was sound. The trio of gentlemen turned to a fourth to help them design a better machine. Tommy Flowers was an electronics wizard who worked for the Post Office. His new machine used electronic storage for the code sequences, eliminating the need to synch two tapes. The machine needed a large number of electron tubes to store the code sequences and decipher the messages. The new machine, dubbed Colossus, could read in messages at over 5,000 characters a second. Different initial setting for a Lorenz machine were set through plugs and wires, similar to a telephone switchboard.

The machine helped to decode messages in hours instead of days. It was vital in the intelligence gathering for the landings, and proved to be a robust base for further computator experimentation. Bill Tutte and Max Neuman went on to work with Alan Turing the following year to help design and perfect British walker control computators in 1942.

John V. Atanasoff & Clifford Berry

John Vincent Atanasoff and Clifford E. Berry worked together in 1939 to create one of the first digital computers in the basement of a building on the Iowa State University campus. It was incredibly fast for the day and included several major advances in math and science.

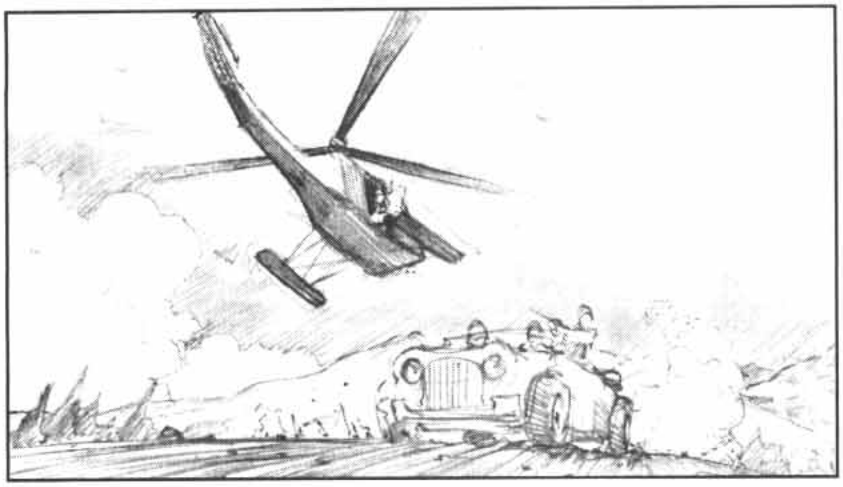
Atanasoff was born October 1903 in New York. His father, Ivan Atanasov (renamed John Atanasoff after his immigration from Bulgaria) was an electrical engineer. From a young age, he learned the basics of electrical wiring, and even found faulty wiring in their home at the age of 9. He had a love of baseball, just as all young boys did in America. However, after his father brought home a slide rule, John's interest in baseball faded and his curiosity and interest in the slide rule and the related logarithms grew. This new interest continued up through his master's degree in mathematics, which he received in 1926 from Iowa State College.

Atanasoff felt there must be ways to do computations of complicated problems faster and more efficiently. While conducting experiments with vacuum tubes and electricity, he classified computers into two different categories: analog and "computing machines proper" – what came to be called digital. He felt that there had to be a way to get around all the parts capable of malfunction in an analog computer. After "an evening of scotch and 100 mph car rides... the concept came, for an electronically operated machine, that would use base-two (binary) numbers instead of the traditional base-10 numbers, condensers for memory, and a regenerative process to preclude loss of memory from electrical failure." Atanasoff wrote most of the concepts of his computer on a cocktail napkin.

He received a grant from Iowa State College and hired his assistant, Clifford Edward Berry. Berry was born in Iowa in April 1918. When Clifford was young, his father Fred had an electrical appliance store, and one of his projects was the first radio in the town of Gladbrook. Many visitors came to hear the radio, and after some coaxing, Fred taught his son about the construction and use of the radio. Like Atanasoff, Clifford was hooked, and began to toy with electricity and built his own radio by age eleven, and continued with a passion through his graduation with a B.S. in Electrical Engineering from Iowa State College in 1939. He was introduced to Atanasoff through one of his professors, and accepted the job to assist in the project of building a computator.

Chapter Four: Mechanical Sciences

The 20th century has birthed an entirely new way of waging war, in the form of mechanized warfare. The refinement of the internal combustion engine has allowed the creation of new vehicles to help men accomplish their tasks more easily. This list of breakthroughs includes tanks, planes and ships that rely not on the elements or the strength of animals for movement, but on man-made engines of fire. This fire has also been harnessed for use in rocket engines, used in various new forms of travel. Through the internal combustion engine, man has conquered the air, sea and land, and soon he may conquer the stars.



SCRAMBLED EGGS

Robert "Eggbeater" Holden twisted the throttle on the collective stick, increasing both the engine's power and the helodyne's altitude. He coaxed the helodyne higher with practiced ease, clearing the trees behind which he and his observer had been hiding until just a moment before. He continued their ascent, waiting for the signal from the observer beside him. It came and Robert obeyed, beginning the subtle dance to keep the aircraft fixed in its current position.

The observer, Ezekiel "Zeke" Mortenson, brought a pair of binoculars up to his eyes; adjusting the focus, he began to scan the landscape for the enemy. He could have used some of the very latest televisor optics with the newfangled filters, but Zeke preferred to trust his instincts and better than average eyesight. He was infamous in his squadron for his talent at sniffing out Germans. Besides, the binoculars were reliable to a fault and so much easier to carry.

Several minutes passed, and Robert could feel the hairs on the back of his neck standing on end. They were too exposed — too vulnerable up above the cover of the trees. "Uh, Zeke," He began, turning his head to glance at his passenger, "I think we better duck and cover. We can look in another spot."

Zeke sighed, keeping the binoculars to his eyes, "I suppose you're right, Eggbeater. Let's scoot." He continued his search even as the pilot started to drop the 'dyne back behind the tree cover. They had just about pulled out of their descent, when a flash of light caught Zeke's eye. "Hold it! There they are!" Robert fought to halt the helodyne's rapid drop, as Zeke pointed to a spot at about one o'clock to the helodyne's facing. "See it? Looks like the fox we've been hunting." The younger man paused, assessing the situation. "Looks like a jeep. Hrm. Are those antennas?" Robert could hardly comment; his vision was no where near as capable as Zeke's. He shrugged slightly, keeping his attention on the controls. "I better call this in." Zeke switched his radio frequency to that of air command. "Lodge, this is Hound Two. We've spotted an enemy vehicle. Looks like a jeep of some kind. No other enemy sighted. Repeat, no other enemy sighted. Over."

The radio crackled with headquarters' response. "Roger that, Hound Two. Your current position? Over."

Zeke snapped open his map, nodding grimly as Robert indicated their current position. "Looks like we're in grid Fox Niner, HQ. Over."

"Roger that. Looks like you found a thorn in our side, Hound Two. That Hun sumbitch has been calling down artillery fire on us all day long! Of course, we don't have any artillery to fire back with. No other enemy spotted you said? Over."

"That an affirm, HQ. Over."

"Son, I'm gonna ask you to do something that's never been tried before. I want you fly over to that damnable spotting team and eliminate them. Is that clear? Over."

Zeke swallowed hard and replied calmly, "That's a roger, HQ. Over and out." He switched back to the cabin frequency commenting, "Well, you aren't going to believe this, Eggbeater, but they want us to take out that vehicle."

The helodyne drifted slightly as Rob's concentration was broken momentarily. "They want us to do what?" he asked incredulously.

"They want us to take out the vehicle. Apparently HQ doesn't like getting shelled by the artillery that little bugger's spotting for. At least I brought this Tommy along for emergencies!" He grabbed his Thompson and shook it for emphasis. "You fly me over there through cover. Get me over top of it and I'll waste 'em with this."

Rob nodded and turned to his new heading. He flew as low as he could, using small hills and tree cover to mask his approach; a few moments later, he stopped the helodyne to pop up and

check his bearings. He rose up about twenty feet, and as he examined the terrain Zeke took another sweep with the binoculars. Rob noticed a plume of dust and smoke just as Zeke exclaimed, "Damn! They're moving!"

Rob muttered, "So much for surprise." He moved the cyclic to start the helodynes moving forward, easing up on it while pulling back on the collective. The helodyne tilted forward, gaining speed faster than might be expected. Zeke grabbed his gun in one hand and wrenched open his door with the other.

Within seconds they reached the enemy vehicle. Its antennas had been hastily thrown into the open-topped crew section of the vehicle. The driver was intent on getting the small observer car going as fast as it could while the two forward observers bounced around in the back, grabbing on for dear life. Zeke leaned out of the door as the helodyne approached. He fired just as Rob pulled back on the cyclic to tilt the craft back and slow its forward momentum. Zeke's burst went high as they matched speeds with the fleeing vehicle.

"Geezz, Eggbeater! Warn me when you do that!" Zeke turned back to the vehicle and took aim at the German crew, who had started to scramble for their rifles. Zeke's fire hit one German, who slumped to the floor of the car. The burst of fire and the soldier's scream alerted the driver. He looked over his shoulder, eyes going wide. He started to bob and weave as best as he could with the vehicle, throwing clouds of dust into the air.

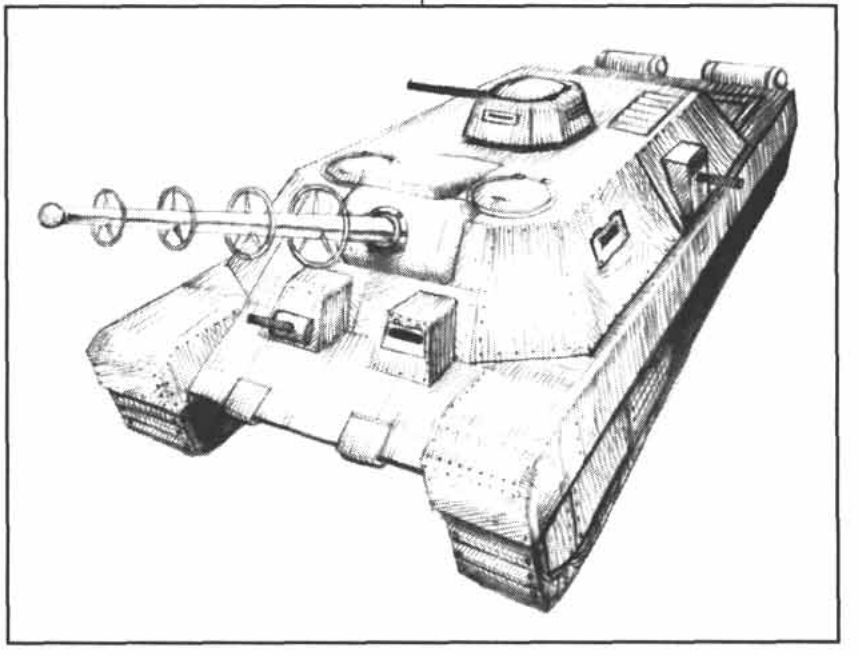
Zeke started spraying the car with fully automatic fire from his Thompson. The remaining soldier in the rear of the vehicle tried to fire back, but the bucking movement prevented him from hitting the R-1. Zeke emptied his magazine into the target, managing to miss the driver and observer. Zeke swore and started to exchange the spent magazine for a fresh one. Zeke was scrambling for the new clip when Rob calmly handed him a grenade.

"Might want to try this out, Zeke."

Zeke grabbed the grenade. He pulled the pin and threw it into the vehicle. As it arced through the air, the observer in the observer car fired another shot. Zeke felt a sharp lancing pain in his right shoulder. "Sonuvagun! I'm hit!" He grabbed at his shoulder with his left hand, and the sticky wetness he felt there confirmed his suspicions. A second later the grenade exploded in the car, eliminating any chance that the crew would either fire back again or escape.

Rob deftly worked the control of the R-1. It banked left and reversed its course. "Time to get you home, buddy." Zeke fumbled for the first aid kit and sloppily bandaged the wound as best as he could as they returned to HQ. His right arm felt numb already. "So how does it feel to make the first attack from a helodyne, Zeke?"

"Remind me to deck you when my arm heals up, Eggbeater."



RUSSIAN TESLA TANKS

While the French were the first to field armored vehicles with Tesla-based weaponry, the Russians went further with the technology than anyone else in World War II. By special agreement with the United States, the Russians hired Tesla himself to develop his electronically accelerated energy weapons. He worked constantly to make the superscience weapons more reliable, more energy efficient, more powerful and longer ranged.

T-45 LAND BATTLESHIP "NIKOLAI TESLA"

The Soviets showed as much interest as the French in the weapon designs of Nikolai Tesla, if not more so. They funded considerable research into Tesla's theories, and as a result, Tesla was able to improve upon the designs he developed for the French. He devised a directed energy weapon that was longer ranged than his previous designs, which the Soviets named the *Electricheskiya Uskoracya Energia Artilleria* Tesla Model 39. This fearsome weapon was able to fire at nearly twice the range of the French versions, and the Russians mounted it into the T-44 land battleship hull. They had to remove the heavy weapons in order to make room for the new design, and it was still difficult to fire the weapon rapidly due to the power it required. Still, the T-45 put on a spectacular show when used in combat, demolishing the enemy and providing a boost to friendly morale. The official name for the tanks was the "Nikolai Tesla," which was so close the T-44's name that the Soviet forces in the field came up with a new nickname for the vehicle: "Troll."

KV-IIC

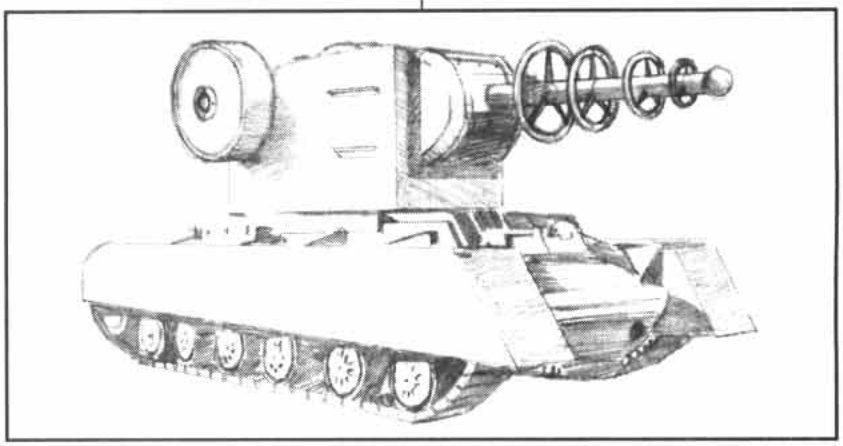
The Soviets needed a tank on which to field their Tesla weaponry that could overcome the main problem that the super heavy tanks like the T-44 and T-45 suffered — lack of mobility. The huge tanks were just too easily out-flanked, which made them vulnerable. The Soviets decided to take the KV-II tank, already a strange combination of a KV-I and a large artillery piece, and mount a new, smaller Tesla weapon in a large slab-sided turret. The new weapon, the EUEA Model 40, sacrificed hitting power for a more efficient power supply, but could fire more quickly than earlier models. Unfortunately, the new tank wasn't much faster or more maneuverable than the land battleships it was designed to replace. The design was, however, a step in the right direction for the Soviets, who continued to develop Tesla guns throughout the war.

T-44/E43

Questing for a more effective tank in which to mount Tesla weaponry, the Soviets tried in vain to mount a useable weapon on the T-34 tank. Unfortunately, the tank just wasn't quite big enough to allow for the power systems that a EUEA required. A promising new tank was under development in 1943, however. The new tank, the T-44, was based on the designs used for the T-34. It had a lower overall silhouette and exaggerated the already well-sloped front armor on the T-34 for better protection. The most important change, though, was not external, but internal. The engine in the T-44 was mounted transversally, or sideways, and it helped to create more space within the tank. This space was ideal for installing the auxiliary systems for a EUEA, and the Soviets did just that. The T-44 was faster than any previous Russian tank that carried mounted Tesla weapons, and it could keep up with the T-34s already in use. The weapon mounted was the EUEA Model 43, which had twice the range of the Model 40, with only slightly reduced ability to penetrate armor. With the T-44/E43, the "Death Ray" had finally come of age.

IS-IV

With the Germans developing larger and more powerful tanks, the Russians answered in kind with the Iosef Stalin series. These heavy tanks suffered none of the problems of the earlier land battleships, particularly the reduction in speed. The tank was suitable for a EUEA-equipped design, and the Russians built the IS-IV as a result. The tank was large enough to mount the improved models of weapon previously considered suitable only for the KV series, and was finally faster and more maneuverable than previous heavy tanks. The tank was fitted with the EUEA Model 44, which had a powerful Tesla wave projector. This projector allowed for the initial electrostatic discharge to be generated over a greater distance, and thus the charged particles could be projected over a greater distance. The new weapon could fire roughly 50% further than the weapon in the KV-IIC. The IS-IV was easily the most feared Tesla Tank of all those that the Russians fielded in WWII.



T-44/E43 WALK-AROUND

Soldat Buranski approached the group of men and women already gathered around the new tank. The stench of cigarette smoke almost, but not quite, overpowered the haunting smell of oil and fuel emanating from the vehicle. He stopped a few paces away from the group, smiling to himself as he listened to the idle banter of the comrades who stood there, waiting for the starshina to arrive and brief them on this new weapon. The laughter and conversations trailed off, and he glanced up to see the briefing officer stride over to them.

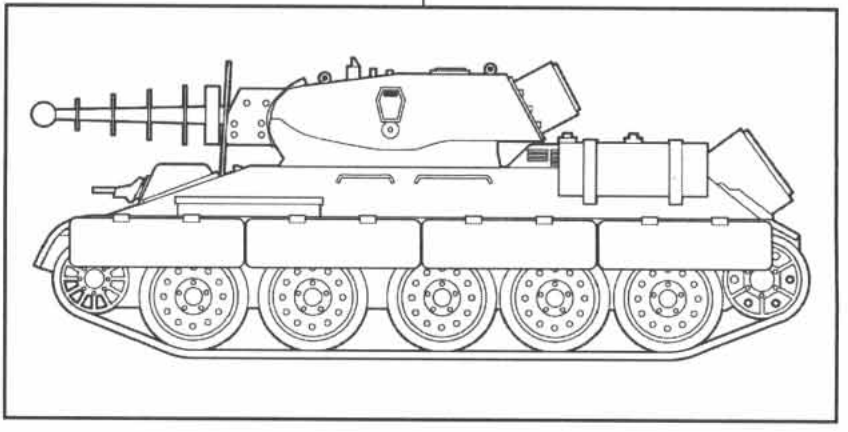
"Good day, fellow comrades! I see you have all been lucky enough to get an early look at the latest fruit of the Rodinya! This tank is special, and you all are lucky to have been chosen to fight the Germanskii back to Berlin in this fine specimen of Russian engineering. This..." The officer waved to the tank and paused for dramatic effect. "*This* is the T-44/E43. Those of you familiar with the T-34 series should feel at home in this tank. It is very similar to the T-34. But it is an improvement in many ways. Note the front, for instance. It is sloped even more than the T-34, which should help against those new German guns, eh? The side armor here, while now vertical, is almost twice as thick. Overall, this tank is superior to the T-34 in protection.

"Moving on, you can see that the turret is mounted closer to the rear of the tank than on a T-34. I see that many of you are looking at the weapon mounted on the turret. I know that you have heard rumors of this glorious piece, and I can say here that those rumors are true. This weapon is a magnificent leap forward in tank gun technology; it is the pinnacle of energy weapon technology, the *Electricheskia Uskoracya Energia Artilleria* Model 43. I don't know exactly how it works, but it can penetrate the armor of a Tiger, and that's all that matters. The coils you see along the barrel are the focusing and accelerating coils. Be careful with them! Any damage to them will render this fine weapon into a lump of metal that will do you no good!

"Enough about what you can see on this tank. Let's go over what you can't see — it's almost as exciting as the outside! Help me up onto this thing, would you soldat? Ah, thank you. Gather around the rear please... Thank you. The engine will look extremely familiar to anyone with T-34 experience. There's a good reason for that: it's the same engine! This tank, however, is different in one very important aspect: the engine is now mounted transversally! This way of mounting the engine has given us more room inside, and that's important, as the additional room has allowed us to mount the necessary capacitors and generators for the EUEA up front. The engine is used to run the generators, which charge the capacitors and operate the weapon. I wouldn't be moving around with this tank while charging the gun if I were you. In my experience the tank tends to run a little slow when putting out all of that power! But, on the good side, the weapon tends to run a little warm, which should help keep us soldats warm in the cold, eh? Those Germanskii will be freezing their asses off, wishing they could be us!

"The T-44 has four crew members: the commander, the gunner, the driver and the gun technician. That's where most of you come in. Any poor slob can load a conventional gun, but you all will be keeping an eye on the weapon and making sure it works properly. You are our most valuable crew members, you technicians. See that you all don't become posthumous Heroes of the Soviet Union. Dismissed!"

Buranskii pondered the new tank while the others struck up their conversation again and slowly left. This was indeed a fine new tank, and he was looking forward to helping run one of them. It was just what the Rodinya needed to send the Germanskii back to where they belonged, outside of Mother Russia! Good thing he had managed to survive the purges Stalin was so fond of.



WALKERS

By 1943, walkers had become a staple on the fields of war, coming a long way from their first tentative steps. Each of the major nations involved in the conflagration had their own approaches to walker design and deployment. Unique and novel versions of walkers were designed to fill specific tactical and cultural needs.

The Germans placed an importance on the task of tank hunting for their lighter walkers. They also designed and built some amphibious walkers for a planned invasion of England that never materialized. They started work on large walking behemoths, fulfilling the dreams of Goeble. They designed additional walker designs to fill rapid deployment needs, such as FlakKampfers, for instant airfield and factory defense.

The Americans became quick studies of walker design out of necessity. Their early designs were excellent. They had to adapt to a wider variety of environments than the Germans, producing walkers suitable for fighting in Europe and also for the island-hopping fighting characteristic of the Pacific. The Army forces used well-armed armed walkers that had increasingly sophisticated computators and sensors. The Marines used a light, fast walker type that could fight toe to toe with the frightening new Japanese jungle-fighting walkers.

The British were for the most part the heirs to American walker design. All of their early walkers were derivatives of American designs, some built under lend-lease programs and others built domestically. The preceding is not to say that the British didn't innovate themselves at all, however. They pursued four-legged designs with a gusto never shared by the Americans. They were able to build many tank-destroyer walkers, exploiting the stability benefits the four legged platforms exhibited. They also began to take American designs and surpass them in the areas of motive power and navigation abilities.

The Japanese, like the British, based their early walkers off of designs bought from their allies. They soon began to design totally new walkers that moved in directions taken by no other walker design, although they relied on German computators throughout the years of the war. They adopted the German amphibious walkers designs and improved upon them in several respects, using them quite successfully for their invasion of Australia in 1943. They also designed a walker for use on the jungled islands of the Pacific. Those walkers, like the ancient samurai that inspired them, used extremely high-quality swords as their primary weaponry.

The Russians, for the most part, ignored walkers as a vital part of their fighting forces. Instead, they concentrated on tank design, in particular tanks with Tesla weapons. They drew most of their walker forces from lend-lease stocks. They did employ some cold-weather walkers, suitable for use in the bitter Russian winters; they also used walkers to help sustain their insatiable use of artillery.

MOTIVE POWER

As walker technology progressed, so did the need for improved engines. The radial engine was still the dominant power source of choice by 1945. The technology had seen many enhancements by this time. The British had pioneered liquid-cooled radial engines, and then further advanced engine design by experimenting and manufacturing engines with turbochargers. The new devices would capture exhaust gases to activate a pump, which would, in turn, compress the air used in the combustion process. The increased amount of oxygen from the compressed air allowed the fuel to burn more completely. The end result was more power out of an identical engine, at the expense of some fuel economy. In walkers, where space was at a premium, the additional power from seemingly nowhere was a welcome benefit.

Other nations, particularly the Americans, enhanced their engines' power through the use of supercharging. The principle of supercharging was the same as that of turbocharging, but the process was different. The compressor was driven not by exhaust gases, but through a direct mechanical link. In some cases it was a belt, others a gear drive, and in others it was still something different entirely. The end result was the same: more power. Supercharging had the additional benefit of being immediate — turbochargers often experienced some lag transferring between normal engine power and the additional power the turbocharger provided. This benefit hardly mattered, however, in combat vehicles where transmissions had so many gears that a lag of a second was barely noticeable considering the amount of time it took for a walker to gain full speed.

Bigger walkers demanded more than the benefits of being able to supercharge the engine, and they had the internal space to place a larger engine in. Radials, being "stackable," were more versatile: one radial 'layer' of pistons could be placed upon another, creating more rows of cylinders. The result was engines that were modular, changing strength to the needs of the machine. The larger walkers being developed in Britain and Germany reportedly were being designed with engines three rows deep!

The amphibious walkers used by the Japanese had more in common with submarines than with other walkers. They used a radial engine for surface movement, but an electric motor for submarine movement. The electrical drive was nowhere near as powerful as those in contemporary subs, but, then, it didn't have to move as much mass, either.

Only an American, Preston Tucker, would try and use a non-radial engine as the primary engine for a walker. His preliminary prototypes for a walker used a horizontally opposed gasoline engine, a departure from the diesel radial engines. His walker had more in common with a finely tuned race car than a combat walker. He even tested his walker at the Indianapolis Motor Speedway! Whether his innovation will be successful remains to be seen.

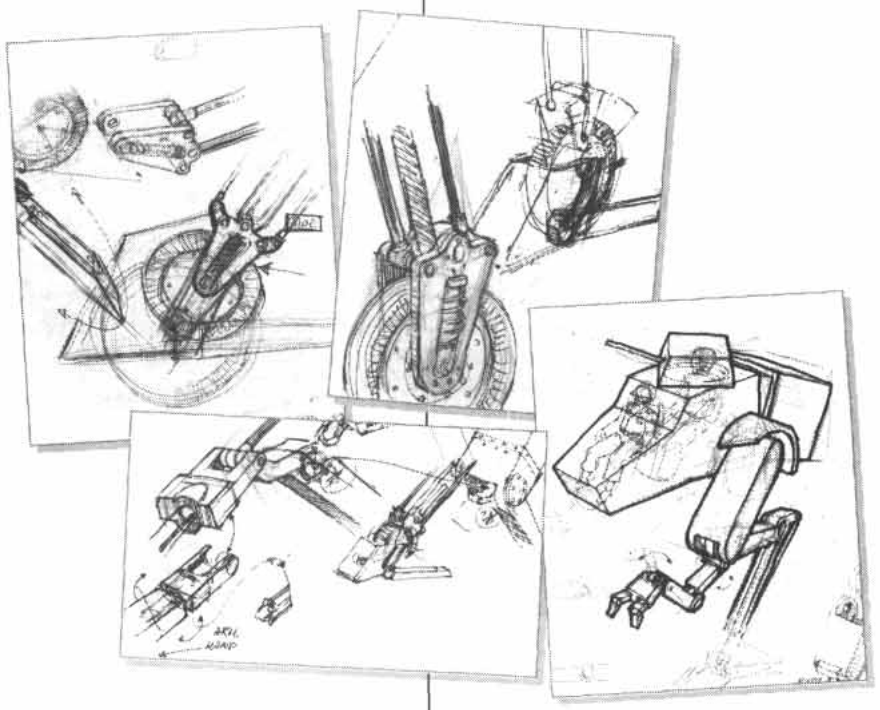
SUSPENSIONS

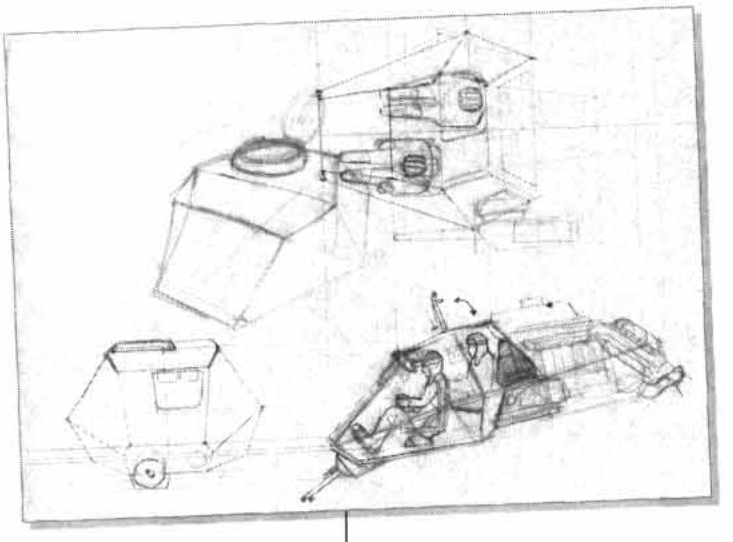
Walkers were unique in that they were the only vehicles built to date with dual suspensions. All of them used a form of bipedal locomotion, of course, but from the very first mass produced walkers on they were also given the capacity to move on wheeled suspensions. The wheeled suspensions served them well, allowing for rapid movement over paved ground and road systems. Walkers were the best of both worlds, able to get to the front of battle quickly as well as able to traverse difficult terrain upon which wheeled vehicles could not venture.

As new walkers were designed, their size and mass increased. The original wheeled secondary suspensions proved inadequate, and tracked suspensions began to make an appearance. With the change in ground movement systems also came improvements in their smoothness. The early suspensions used leaf springs and sometimes coil springs. The ride in the first walkers was jarring, to say the least. New walkers added suspension improvements that were already being used in contemporary tanks. The coil springs were improved, and in some cases hydraulic suspensions were tested. Torsion bar suspensions were never usable for walkers, but because of their design walkers' suspensions were all independent. Each wheel, tread and leg could be shock absorbed and moved independently of each other.

CONTROLS

The years comprising the early part of World War II saw incredible advancement in walker control; gone were the early, rickety mechanical methods of





yesteryear. The Germans had led the world in the development of computator controls, and the Allies were not far behind. The brilliant minds of Zuse, Turing, Atanasoff and others were put to use melding the computator and the walker into a dexterous single entity.

All new walkers used computators to augment pilot input to create smooth response to the vehicle movement. Pilots, instead of using a series of levers similar to construction equipment, now used stick controls similar to those used in aircraft. Walkers used the first non-direct controls, and as a result their stick controls were small and easily moved. They could be placed very flexibly in the cockpit, and many designed started to use side-mounted sticks placed to the side of the pilot, rather than the center-mounted sticks any aircraft pilot would have used.

In Germany, Zuse pioneered the practice of creating specific control manipulations to trigger pre-programmed moves the machine would then execute smoothly. Instead of directly making the motions for a walker to, say, move erratically for a few second and turn left, a pilot would tap his control stick left twice and the walker would perform the maneuver automatically, freeing the pilot to concentrate on his next maneuver. Many pilots balked at the system at first, but once they got the hang of it they swore by it. American walker control systems quickly adopted a similar system once their computators were advanced enough. The British were always resistant to using this method, preferring to have more direct control of their walkers. His Majesty's pilots prided themselves on having sufficient training to equal alone the skill of any Jerry pilot using a computator.

In addition to the sophistication of movement controls computators provided, they were growing sufficiently advanced and small enough to help with targeting the weapon systems. The D series of German computators had grown in complexity enough that they could control movement as well as direct fire with the same electronics. The Allies favored smaller, task-specific computators, separating movement systems from fire control systems.

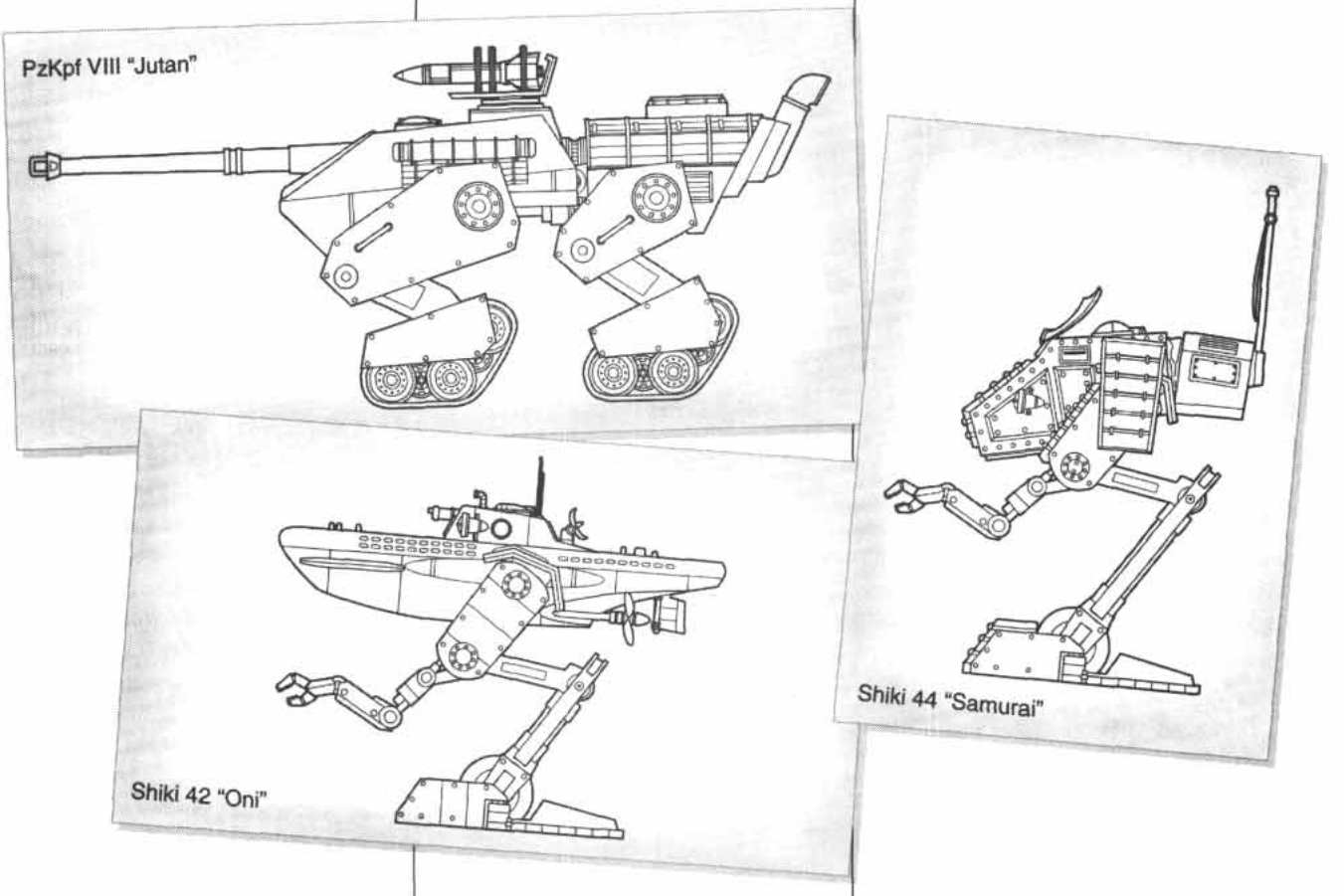
Further in the war, the weapon systems became gyro stabilized and computator assisted, allowing walkers to fire on the move more easily than any other ground combat vehicle could. Fire control systems on walkers were so successful that they soon started being installed in tanks as well.

J. Walter Christie

The father of the Modern Age walker, J. Walter Christie, was born in 1865 in River Edge, New Jersey, USA. He worked in the Delamater Iron Works while attending college. He earned a degree in engineering, going on to design several front-wheel drive cars that he also raced.

In the 1920s, he turned his eye towards both tracked and walking vehicle suspensions. His main interest in tracked vehicles was with an eye towards increasing their speed. Most existing designs kept throwing tracks when the vehicles moved at any speed worth noting. Christie sought to change this, designing many fast suspension systems throughout the 20s and 30s. He had hoped to use those successes to fund the research into his walking designs, but the United States Military was not interested in any of them. Eventually the British and Russians would take interest, but their funding came in the 1930s, too late to assist Christie during his near bankruptcy in the mid 1920s.

Christie's true fascination was with the idea of designing a machine that could walk around on legs. Unfortunately, his goal nearly did him in financially. His two early tank designs, the M1919 and the M1921, met with only tepid interest from the U.S. Army. Undaunted, Christie changed domain and achieved some success with his walking W1923 and W1924 designs. He showed the W1924 to the Army; they expressed interest, and he worked on the W1926 as a result. Again, the Army decided not to purchase the design. If it had not been for the timely interest shown by Germany, Christie would have surely gone bankrupt and never developed further suspension designs.



PZKPF VIII "JUTAN"

The Germans truly loved experimenting with armored fighting vehicle design, and walkers were no exception; they had been early adopters of walker technology and tactics. Freiderich Goeble was an early proponent of walkers, but his wish for large walking battleships gave way to Dr. Launghauser's nimble two-legged variety of walkers. All that changed when Goeble presented the Wehrmacht with the Jutan walker blueprints. The Jutan was a beast, using four legs for added stability and weight distribution, and featuring the latest in weapon technology. Armed with two of the latest guided rockets and the universally feared 88 mm gun, the Jutan was more than capable of hunting tanks. His engineers had taken the latest D series computators and modified its programming to operate effectively on four legs. Heavy tread systems augmented the walking suspension. Alternate versions replaced the treads with train wheels, enabling the Jutan to deploy rapidly via rail. Gyrostabilizers and televisor sensors complete the package. The Jutan catapulted Goeble right back into the thick of walker design.

SHIKI 42 "ONI"

The Japanese continued their practice of building German hand-me-down walker designs in the early years of World War II. One of the last designs heavily influenced by German walkers was the Shiki 42. The design was based on the Tausch walkers conceived for Operation Seelowe, the proposed invasion of the British mainland. The Tausch walkers were originally modified Valkuries fitted with snorkeling devices to allow the walkers to deploy off shore and walk onto land ready to fight. They eventually evolved into their own design that was fully submersible. The Japanese took this version and developed it into their own machine.

The walker has a small auxiliary electrical motor for submersed propeller movement. The main armament is a new version of the venerable teppoyari used by all Japanese walkers thus far. The new weapon uses an anti-ship magnetic mine. The Shiki 42 was thus mutated from a beach assault walker to an anti-ship walker. The walker could sneak up on small naval craft and destroy them, returning to shore bases to re-arm and refuel. It was highly effective in the island hopping campaigns characteristic of the Pacific theatre of war. They would also prove highly useful on land during the attempted invasion of Australia.

SHIKI 44 "SAMURAI"

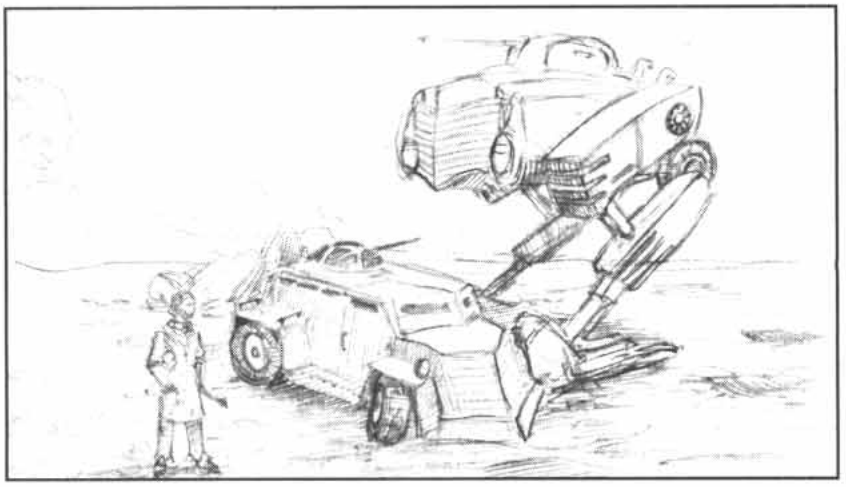
By 1942, it was clear to the Japanese that they needed a walker that could effectively fight in the jungles of the Pacific. German walker design was based on the needs of warfare in Europe, and the unique environments Japan had to fight in was not a concern to the Germans. The Japanese had no choice but to design a walker themselves.

They took the German computators as the heart and soul of a new design, and the rest was their own creation. They decided to concentrate on a highly agile walker system that could maneuver through thick jungle foliage, eschewing the additional mechanical complexity of an ancillary movement system. The standard teppoyari was deemed too limited, and a weapon that was used gloriously in the past was selected instead — the katana. Early tests demonstrated the incredible lethality of the sword against soft targets, but it was totally inadequate against armored vehicles. No one knows how, but the Japanese achieved a breakthrough in their testing sometime in 1943, just before the Australian invasion. They started to manufacture walker-sized katanas that could somehow cut through rolled armor-grade steel. Later reports would tell of the almost brilliant light the blades would reflect. The pilots of these new fearsome walkers were highly trained, combining Shinto spirituality and martial arts to become one with their machines. The first operating prototypes were tested in the battles of the Australian front, with the fully operational models taking the field in early 1944.

AUTOMOBILES

Early automobile builders had experimented with many type of designs, most notably in the varied forms of motive power they tried. There had been electric powered cars, gas powered cars, steam powered cars and hybrids to boot. By the time cars had become a mass-produced item, they had homogenized to using gasoline burning engines, which had proved to be the best engine to provide the necessary power-to-weight ratios. With the innovations of Henry Ford and his assembly lines, cars had become affordable to all, instead of toys for the rich and famous.

Due to the availability of cheap, consumer-minded cars, automobiles were becoming a staple of the American economy as well as popular culture. Auto manufacturers were already planning stylistic obsolescence into their designs by the '30s, in order to 'force' Americans to buy automobiles as often as possible. In other countries cars were also increasing in accessibility, but for the most part they were still considered a luxury item. Companies the world over built cars as dedicated racing vehicles, competing with speed and endurance.



Brickyard Guard Duty

Preston Tucker, while patriotic, is stubbornly refusing government requests to keep his testing of his Hermes walker as covert as possible. He is testing the speeds of his new design at the Indianapolis Motor Speedway, also known as the "Brickyard." The racetrack is hardly secure from prying eyes, and Allied intelligence has intercepted Axis transmissions indicating that Tucker and his new walker may be the target of espionage. A team of operatives will be tasked with protecting Tucker from harm. The real threat could be assassination, sabotage, espionage or the theft of blueprints or the machine itself. Guarding Tucker could be problematic due to his headstrong nature and his likely refusal to allow any threats to modify his daily routine. Complications arise from escalating threats on Tucker's freedom or even his life, as more information about his design and government involvement is discovered by enemy agents.

WAR FOOTING

Once the war began, production focus shifted from consumer to military vehicles. This conversion was delayed somewhat in the United States until they joined the war. Even so, consumers had a dearth of choice as more and more manufacturers began to produce lend-lease equipment for America's allies.

In the early to mid-30s, in the midst of the Great Depression, automotive companies took advantage of cheap labor and materials costs to build modern manufacturing and assembly plants. The new production muscle was highly efficient: as a result, the United States were unparalleled in vehicle manufacturing ability, all due to the mass acceptance of automobiles in America.

Most of the advances in automotive technology were applied to the armored beasts of war, tanks, half-tracks and even walkers. An ex-policeman, Preston Thomas Tucker designed unique solutions to military problems, but he would echo many in the civilian designs he designed after the war. His biggest success was his Tucker Armored Personnel Carrier, which borrowed many ideas from his auto racing days.

TUCKER HERMES

After gaining success with his APC and electric turret designs, Tucker took an interest in walker design. He felt he could offer the military the same advantages his APC offered them — speed and maneuverability. His walker, which he called the Hermes, followed the Tucker mold of innovative design.

His design was fast. When traveling on its wheeled suspension, the Hermes moved as quickly as his APC. The hip joints would augment steering ability in the wheel mode, giving the Hermes unmatched maneuverability. Actuator concepts from his turret designs were found through the walking suspension: Tucker's walker had faster response time on legs than any other walker of its day.

Tucker used the latest computators to complement the increased maneuverability. The cockpit was well-designed, featuring seatbelts and padded seats. The walker was armed with a Tucker turret and twin .50s and powered by a horizontally opposed 10-cylinder engine, supercharged for added performance. The Hermes was even styled to suggest speed, to the point of having wing-like armor on its ankles. Unfortunately for Tucker, the US Army was more interested in bigger guns than it was in speed. They told Tucker that for his walker to be considered, he would have to put some bigger weapons on it. Word has it that Tucker took the advice to heart and is working on a new version of the Hermes that has the firepower the Army is looking for.

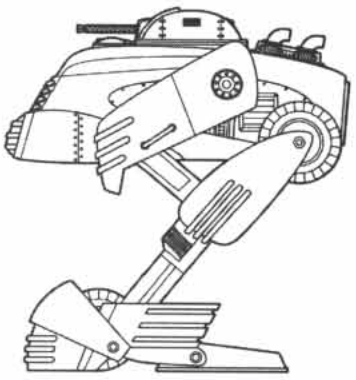
Unparalleled Vehicle Safety

One of the legacies of Tucker's design acumen as the safety of a vehicle's occupants. Perhaps due to Tucker's early racing days, he placed a high premium on keeping his passengers a safe as possible. His designs featured safety items like seatbelts, crash-safe compartments and collision resistant seats. While his innovations might have been excessive in the minds of the military, the troops in the field loved his Tucker APCs. He vowed to continue his quest for ultimate safety in the designs he had in mind for post-war civilian automobiles.

Preston Thomas Tucker

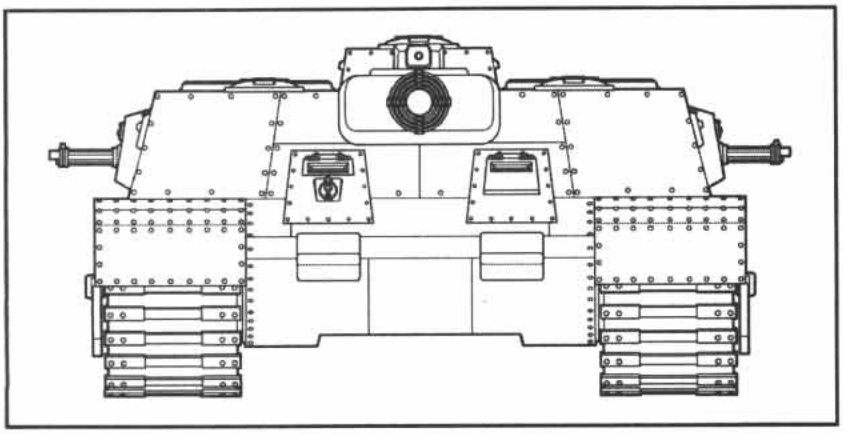
Preston Thomas Tucker worked as a policeman and used car salesman before he took the plunge into automotive design. He started his long career as a racecar mechanic and driver through out the 1930s. He then designed several vehicles for the Ford Motor company. These vehicles were the first to see Tucker's penchant for driver safety.

As the situation grew worse in Europe, Tucker's patriotism led him to try his hand at military vehicle design. He created a concept vehicle, an armored personal carrier, for the US Army. The vehicle was fast yet safe, and the Army approved its production. During a demonstration, a US Army Air Service colonel remarked to Tucker his amazement at the turret's response time, bringing the weapons to bear in any direction with ease. The colonel was involved in designing bomber defenses, and Tucker's turret was much faster than anything that his team currently had. Tucker made adjustments to the turret's design, adding a fully streamlined bubble. It was quickly adapted to many bombers still on the drawing board and in early production. Tucker's turret was highly successful, and along with the proceeds from the sale of the TAPC-1, Tucker was able to finance his new ideas.



SUPERHEAVY TANKS

The Germans and the Russians were the undisputed leaders in tank development in World War II. The Germans were more prolific in the number of designed they produced, but only because the Russians had early success with the T-34 design. Russia had designed land-battleships before the start of the war, with little success. Both nations had moved towards smaller designs with singe main guns, as did everyone else. As the war progressed, designs once again crept into the area of super heavy tanks designs. For the Russians, this was familiar territory, but with a difference. This time the new designs carried main guns larger than any tank previous to them had. The German efforts dwarfed even the achievements of their Tiger tanks with the new monstrosities rolling of the assembly lines. Tanks had come of age and surpassed anyone's expectations.



E Series

The Einheitsfahrgestell Series (general purpose chassis series) or E-Series for short was designed to replace the vehicles in wide use before 1944. Each vehicle of the E-Series was named by tonnage and used standardized parts. The design of the E-Series greatly reduced the strain on the German factories allowing them to produce more vehicles more quickly and at reduced cost. The following E-Series models were built: E-5 (5-10 tons), E-10 (10-25 tons), E-25 (25-50 tons), E-50 (50 –75 tons), E-75 (75-100 tons), E-100 (100+ tons).

The E-5 variants included a version with a light flamethrower tank and a tank destroyer armed with a 8cm PAW 600. The E-10 was intended to replace the 38(t)s and APC vehicles. The Panzer IIs and IVs were to be replaced by the E-25s. The E-50 series replaced the Panthers and the Tiger I, the E-75 series replaced the Tiger II and Jagdtigers and the E-100 replaced the Maus.

The E-Series' focus was product speed and maintenance, along with combat efficiency. The entire series was given a comparatively roomy interior, external suspension and rear drive. The standardized parts made field salvage and repairs criminally easy. The external suspension and rear drive gave more room so the crew could re·c, more efficiently.

IS SERIES "IOSEF STALIN"

In 1942 the Russians started work in earnest on tanks to replace the venerable T-34 design. One of the new tank designs was the KV-13. The design had 120mm of frontal armor, an 85mm main gun, and could reach speeds up to 55kph on roads. Unfortunately it was also plagued with problems such as an unreliable transmission and difficulty making turns without throwing a track. The prototype failed to pass its field tests and was quickly abandoned.

As the Germans started fielding Tiger tanks in greater numbers, the Russian need to field a comparable tank grew with alarming speed. They started a crash program to develop their own heavy tank design in 1943. The new program used the KV-13 chassis as a starting point, and the problems of the original design were worked out. The Russians managed to capture a Tiger tank to use as a target for weapons testing, and the main gun on the losef Stalin prototype — the 85mm — proved to be inadequate. A new weapon needed to be mounted on the tank to make it effective against the current crop of German tanks as well as ones they might fight in the future. As a result, the Russians decided to take the 122mm AT gun and modify it for tank use. The new gun needed a muzzle break in order to operate properly on the tank, and the original design, intended to reduce the amount of smoke produced after a shot, proved hazardous when a 122mm exploded during field test. The Russians reluctantly reverted to a design based on the successful German designs.

The IS tank with the 122mm also saw improvements in armor protection, in order to defend adequately against the 88s the Germans were using. The additional armor, along with the large gun

Dr. Ferdinand Porsche

Ferdinand Porsche was born in 1875 in what was to become Czechoslovakia. He demonstrated great mechanical aptitude at a young age, despite only having the barest hint of a formal engineering education. His first automotive design was produced while he worked with Jacob Lohner. The System Lohner-Porsche was built in 1900 and used an electric drive; the car broke Austrian land speed records, zipping along at over 35 mph. Porsche later added internal combustion engines that powered electrical motors mounted on each wheel, and the new design — the System Mixt — broke even more records than the first.

Porsche was hired by Austro-Daimler in 1906, where he designed several successful race cars. In the 20s, the company changed focus to produce more luxury cars, while Porsche's interests remained fixed on making race cars. Fed up with dealing with the company chairmen, Porsche left in disgust in 1923. He was hired by Daimler shortly thereafter. He worked on more racing designs, and received what he felt to be his greatest achievement — an honorary doctorate from the Stuttgart Technical University. Daimler merged with Benz in 1926, and Porsche continued to design racing vehicles for them. In 1931 he formed his own firm, designing not only automobiles, but planes, boats and even motors.

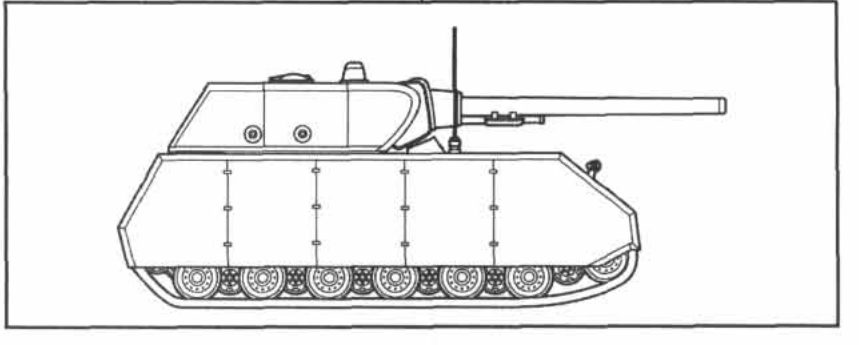
and two-piece rounds, reduced the interior space considerably. The crew also had a tough time effectively operating the vehicle. Still, it was the best tank available to fight the Germans back with, and thus it went into production as the IS-II in late 1943.

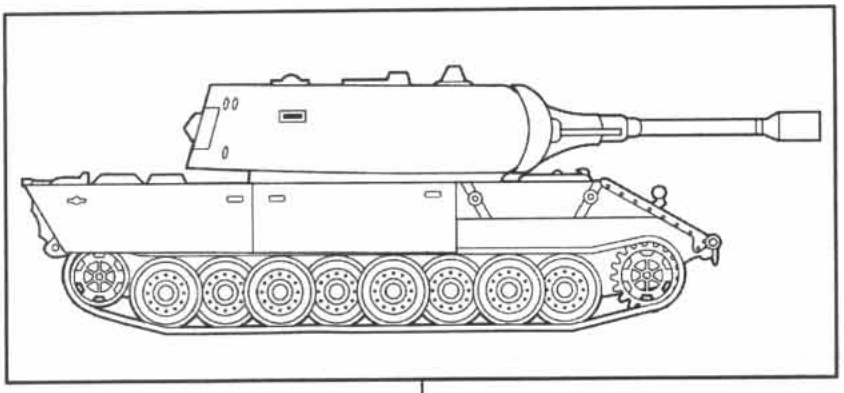
Later models were built to combat the E-100s that began to appear on the Eastern Front in 1944. To the consternation of the Russians, the armor of the IS-II proved to be inadequate to stop the immense guns the Germans now used. Additionally, the 122mm proved to be less than equal to the task of penetrating the thick armor of the beasts. The Russians tried to mount more armor on the chassis, but tests proved that additional armor was just not possible. They had more success with new weapons, as they took their 152mm howitzer and evolved the design into a highly effective tank gun. They still had to keep with the two-piece ammunition for the gun, as they did with the 122mm gun, but the gun could penetrate the E-100s armor. The IS series also proved to be an excellent platform for the Tesla weapons, and the IS-IV was produced to field the most powerful Tesla cannon to date. The IS series was the weapon that the Russians needed to turn back the tide.

PzKpw VIII Maus

In 1942 Adolph Hitler personally commanded one Dr. Ferdinand Porsche to design a new 100 ton tank. His first brush with the Third Reich occurred in 1934. He had developed a small, affordable car which hadn't caught on. Adolph Hitler, however, had just decided that every German should have a radio to hear his speeches as well as a car to drive. He called upon Porsche to design the new Volkswagen. Porsche used his current car as the template and designed the new machine. He pleased the Fuhrer, who called upon Porsche many times in subsequent years to help design tanks for the Wehrmacht. Porsche's innovative designs helped Germany make the Allies pay dearly for every inch of ground they took.

Hitler wanted it to be equipped with the monstrous 12.8m KwK 44 L/55 cannon, mounted in parallel with a coaxial 7.5cm KwK 44 L/36.5 gun. Porsche was given as much freedom with his design as necessary, as long as the prototype was completed before the Spring of 1943. What rolled off of the drawing board was a 188 ton mobile fortification he called the 'Maus'. The prototype model of this beast was armed with the 15cm KwK 44 L/38 instead of the proposed 128mm main gun, and had armor plating that topped out at 240mm thick. It was fitted with a snorkel system allowing it to ford rivers to a depth of 8 meters, since no bridge in Europe could support its mass. Mounts for a rangefinder system were included, but the equipment wasn't ever used on the prototype series. This ver-





sion of the Maus didn't take full advantage of the advanced electric steering system designed into it. The main design flaws of the Maus V1 were an extremely poor power to weight ratio, and the habit of spurring gears. Hitler immediately saw the potential in this vehicle to plug the holes in the German line on the Western front, however, despite the flaws, and ordered Porsche to solve the design problems haste-post-haste.

The second prototype, the Maus V2, was a more successful design. Using more powerful engines (provided by the Kriegsmarine) the power/weight ratio problem was solved, and a few minor adjustments to the transmission stopped the spurring. This version included the mounted rangefinder system and an option for infra-red sights. The snorkel system was removed and replaced by a new electric drive that would allow one Maus to power another via electrical cable to ford underwater.

The production version was to have two 7.92mm MG42s, a coaxial 7.5cm KwK 44 L/36.5 gun and a 17cm KwK 44 main gun as opposed to the 15cm main gun that the prototype used. Variants included the PzKpfw VIII Ausf C which replaced the 7.5cm with a massive flamethrower, and the PzKpfw VIII Ausf E which replaced the turret weapons with rapid firing twin 88s and included a target tracking system and an altitude finder, as well as a long range radio. The proposed Maus battalion was never completed, as resources were diverted to completed to develop the E-Series. The Maus provided pivotal strength in the battles to hold off the Allied invasion on the Western front, thus ensuring the Reich had the time to develop and complete the E-series.

PzKpfw E-100

The Maus' replacement, the E-100, was the first of the E series of tanks to be rushed into service on the Russian front. It was similar to the Maus in design and purpose. The E-100's more efficient design made it 48 tons lighter than the Maus, weighing in at 140 tons, while keeping the same punch with the same armament. The 17cm main gun could out-distance the main weaponry on any tanks the enemy produced. It used the standard FG 1250 Night Sight and included advanced range finding gear. Using lessons from the design of the Maus, the E-100 had engines with power in excess of 1,000 horsepower, and could reach speeds of up to 40kph with a range of 120km. The interior was designed for maximum crew space, allowing the crew to perform with unheard efficiency and comfort. The Allies truly feared this tank, and had to scramble to field weaponry that could defeat it.

Douglas K. Warner

Douglas K. Warner was born in 1894 in Cincinnati, Ohio, USA. He attended the Massachusetts Institute of Technology, receiving a degree in engineering in 1916. He loved the idea of vehicles able to travel over land on a cushion of air. He experimented early on in his career with building a working hovercraft, but technology hadn't quite caught up with his grand concepts. Any reliable engine that could pump enough air to float a standard-sized vehicle on a cushion of air was too big to lift itself as well. It wasn't until after the Great War, with it's explosion in aircraft design, that Warner would see engines light enough to possibly power a hovercraft.

His earliest working model, built in 1928, used its engine to power a pump to push air through the bottom of the vehicle in order to create the air cushion. An auxiliary engine powered a propeller that moved the vehicle forward. Simple rudder controls allowed the vehicle to turn — slowly. The hovercraft didn't use a plenum skirt, and the dust clouds kicked up by the air cushion often made it impossible to see where the pilot was going.

He worked on many improvements over the next decade, eventually constructing a vehicle that he presented to the U.S. Army for further evaluation. They accepted the design, but didn't pursue ACV development any further until the Germans fielded their first hovertanks.

PERSONAL FLIGHT

Personal flight device design has been advancing rapidly in recent years. New technologies seem to be screaming out of research and development scientists, on wings of their own. Despite the amount of research in the field, personal flight devices have thus far only taken two major forms. The first is the rocket pack from the mind of Martin Vossler. The second is the personal paraglider from the creative genius of Mr. Gordon.

ROCKET BACKPACKS

Martin-Wolfgang Vossler was a dreamer, and without his dreams the Vossler Rocketpack might never have been produced. Even Vossler himself, however, could not foresee the implications that his backpack rocket system would have upon the war. When Hitler's infamous SS shock troops strapped the black rocketpacks upon their backs, it was a new beginning for the capabilities of his army.

When the cost of the rocketpack was found too expensive to be put into wide use, it was reevaluated as to the possibility of being an effective tool for surgical strikes and espionage. With the rocketpack's diminished profile, many times radar would make it seem more like a flight of birds than a plane, and single pilots would sometimes not show up at all. While the packs were by no means quiet, they were quieter than any plane or tank, and during the din of war were the SS were able to occasionally sneak up upon their enemy. With the addition of being able to land and immediately fire or find cover, Vossler's concept became even more tantalizing to Hitler.

Initially, Vossler's idea seemed it would never leave the ground, in a literal sense. His original test was a simple rocket with fins on the side and back for stability in flight, strapped to a weighted dummy. Vossler stood back from the takeoff pad and started the ignition. The rocket blazed into ignition but failed to leave the ground, then caught the dummy on fire and burned with the heat of rocket fuel until little was left to examine.

Vossler increased the thrust by using a larger rocket. Its circumference was as large as a man and much heavier. Martin-Wolfgang again strapped it to a weighted dummy, hit the ignition, and

Martin-Wolfgang Vossler

Martin-Wolfgang Vossler was born in 1915 in Thamsbruck, Germany to parents Heinrich and Ditha Vossler. Very early on in young Vossler's life, he became interested in flight. At first, his fancy was with being a pilot, but then he became interested in the physics and mechanics of flight. He absorbed all he could about the workings of airplanes. Later, when hearing of rocket clubs springing up in nearly every town, his curiosity was piqued and he joined a nearby group in 1933. He was hooked on rockets from that moment on.

Vossler's aptitude in rockets earned him a spot on the famous von Braun rocket team in 1934. While he was the youngest member on the team, von Braun enjoyed the young man's enthusiasm and creativity. He was constantly tinkering with new concepts, and eagerly discussed with von Braun the possibility of manned space travel.

While the idea of rockets going into space intrigued him, Vossler was more interested in the idea of flight on a more personal level. A rocket, while it had unimaginable power, was still a cold and impersonal artifact next to feeling the wind from the open cockpit of an airplane. He pondered on the possibilities of combining the power of a rocket with the maneuverability and freedom of an airplane. Vossler eventually left von Braun's side, and his favor, to pursue his own dreams.

When von Braun defected to America with the help of U.S. soldiers, Vossler became concerned about his own welfare. Hitler was unimaginably upset, and wanted immediate results from his science teams. The time was ripe to show off his invention.

the rocket again ignited. It roared into life and flew up into the air with a great deal of thrust. There was so much thrust that the dummy was pressed backwards by the force, sagged into the flames and burst into a spray of flame. But the rocket wasn't done there. Without the counterweight of the dummy, it now arced towards the ground, skidded down the runway and slammed into a nearby hangar, finally burning out the remaining fuel. Vossler was once again forced to go back to first premises.

This time, Vossler did not allow Hitler's demands for speedy results push his ideas aside. He studied the physics behind several varieties of planes and even at one point demanded plans of kayaks be brought to him. Several feared that the pressure was getting to him. He stayed up all night in his workshop, many times sealing himself away, only the banging of sheet metal or the din of the rivet gun proving that he was still hard at work. Hitler's messages grew more impatient. When Vossler emerged two weeks later, he was visibly exhausted, but his creation had undergone a vast change: the Vossler rocketpack was now made up of two small rockets placed side by side, with small metal fins jutting from the sides and back. Additionally, there was an asbestos pad attached to a flat metal buttress plate to protect the wearer from the heat. The harness itself was also changed to allow for a more snug fit. It came across both shoulders and additionally came up under the crotch. The biggest change was perhaps the smallest: the controls were now on the rocketpack itself, extending out at arm's length for easier access by the wearer.

Vossler himself walked out onto the pad that day with the pack strapped to his back. His confidence was unshakable, much to the lament of his help, who were sure he had gone mad. Vossler hit the ignition, and took off! His flight was extremely short and only 30 feet in height, but with his soft landing in the target zone — and a notable lack of deadly explosions — Vossler had proven his success.

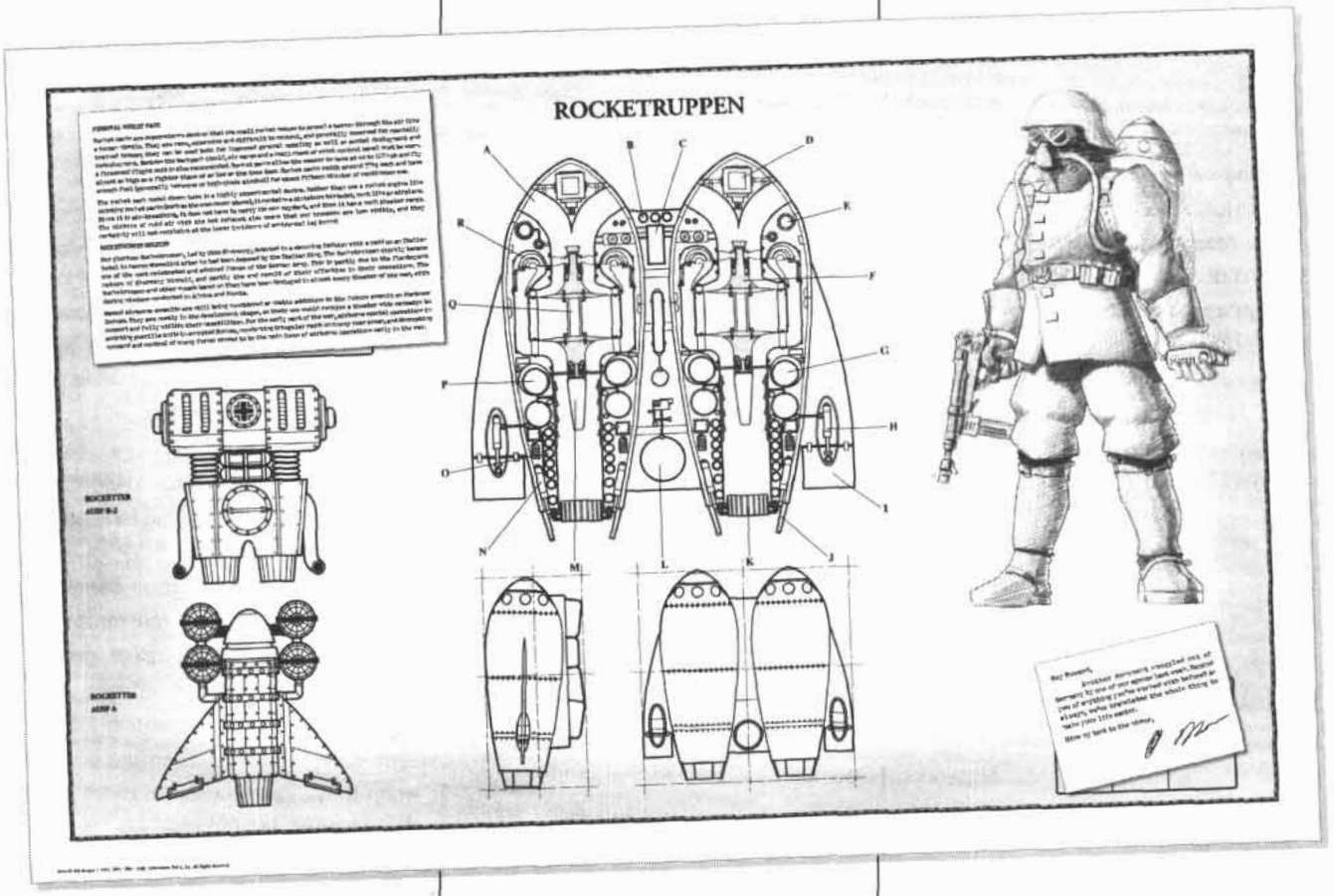
Not much later his rocketpack went into production, with a few tweaks and changes. When they came off the line, they were painted jet black. Their controls were now on a cable and were one-handed instead of the original bulky two-handed control method. The silver SS symbol was riveted on each pack. The end result was visually stunning. The SS troops would wear a short button-up black leather flight coat, black gloves, boots reinforced around the ankle with bakelite, flight pants and a grimacing black and silver metal helmet to protect them from wind and incoming fire but still allow fresh air for ventilation. SS Rockettruppen were typically armed with a Schmeisser MP40 or MP42 for ease of use in flight, and the famous SS knife in a holster on their chest for easy access on the ground. Each carried a bulky radio near their belt that ran a wire up to the helmet. Support group Rockettruppen pairs sometimes split anti-tank rifles and ammunition for assault. They struck terror in the enemy when they would swoop in during the dark of night, and they quickly became one of Hitler's pet favorites, even though they were used fairly sparingly during the war. Although Vossler contributed little else during the war, his place at Hitler's side was assured. It's said that sometimes Vossler himself would strap on his own private rocketpack and zoom off to meetings, though this has never been proven.

When word began to come in of the fearful Rockettruppen squadron, the Allied propaganda machine kicked into gear. It seemed that they had been working on a form of personal flight as well, and had their own division to bring to bear. Several covert missions were supposedly successfully launched, and nearly all went off unseen. It seemed that the Allies had a more quiet system of man-portable flight, but very little was known about their technology by the Germans.

Vossler's Device

Vossler's concept of a personal backpack rocket could not have been more ill-timed at a time when Hitler wanted less fancy and more results. Vossler became obsessed with it, preaching the benefits of the ability to land one man on an area as small as a chair seat, something incomprehensible during the time of planes using long runways to take off. He imagined the idea of explorers being able to reach new areas with ease, without the need for long expeditions. But this was not the time of exploration. It was a time of war.

Vossler, who had taken his idea of the backpack rocket to Hitler in the past, was called to Berlin to show off his latest prototype. It was obvious even with this early prototype, the backpack rocket would be a means of waging war. The Fuhrer saw the immediate possibilities, and gave the green light for increased funding and eventual mass production. Vossler shocked the Fuhrer and Otto Skorzeny (who had be asked to help guide final design and testing) with the rapid advancement. The newly dubbed Vossler Rocketpack was finished in November 1942.



ROCKET BACKPACK WALKAROUND

The grim-faced officer strutted before the small group of seated enlisted men, meeting the eye of each one in turn, as though measuring them up. His black uniform drew the eye into its splendor. His knee-high black boots, reinforced with Bakelite, clanked as he took each step. His baggy black flight pants swished lightly in the total silence of the bunker. His black leather flight jacket, buttoned up the side, creaked lightly as its stiff leather was forced into compliance with his movements. Finally, he stopped in front of a drab green tarp covering a triangular object.

"Well, *junge*, you're now among the elite," he said. "Your dedication in service to the Fuhrer has brought you here today, among the best soldiers in the German Army- the SS Rockettruppen. I've been brought before you to show you the basics of the Vossler Rocketpack." With that, he turned, and with a flourish, quickly removed the tarp to expose the black shell of the rocketpack, the SS symbol reflecting the fluorescent light. A murmur escaped the seated troops, but just as quickly silence fell once more under the officer's withering glare.

The officer slipped one arm under each shoulder strap and slipped on the rocketpack. His shoulders dipped slightly under the weight, but then he straightened up, and the backpack looked like a part of him. "These shoulder straps need to be cinched tight, or you'll end up too sore to move after a few minutes of flight." He pulled each strap tight. "The double-H straps also need to be tightened so as to leave no slack." He reached across his chest and pulled the first horizontal strap tight, then reached lower and repeated the process on the second. "Finally, you must- I repeat *must* have these straps on each side of your groin and the underside of your buttocks. If you don't, you'll be much more than sore." He paused while the troops looked at each other amusedly. "Each of these straps can be released quickly in the case of fire." He grinned wryly. "But if that happens, chances are you won't even have time to realize you're dead." The amusement among the troops died off.

The officer turned his back on the group and raised his voice to be heard. "You'll notice that the rocketpack has two small rockets, not one large one. This helps increase the stability in flight, and the

distribution of weight is much more even. The thrust comes out through these two ports where, via the controls, you can direct the thrust to help bank and turn." As he explained, he held up the control in his left hand and moved the simple metal yoke with his thumb, causing the vents to move. "Additionally, these fins help turn to a small degree." He pointed a thumb at the two fins on the sides and back of each rocket. "You'll also notice this large plate which has asbestos padding on the side closest to your body. This is to protect the wearer from the heat of the exhaust. That's enough understanding for the *common* Rockettruppen." He turned back around. "But you are not the common Rockettruppen... you will be the best. And to be the best you must *throw your weight* as you turn. If you turn to your right, you will throw your weight to the right. If you must gain altitude, you will lean back as far as possible." As he talked, he demonstrated by leaning to the left and right as though doing calisthenics. This will allow you that extra edge that will at one point save your life, and your rocketpack from capture." With that he undid the straps on the pack and set it on the platform once again.

"Each of you will be assigned your own personal rocketpack. I suggest you get to know its every nut and bolt, and make it a part of you. Have each technician check and tighten these screws here and here," he pointed to several bolts attached to the fins, "and increase the play of these hinges on the outside. This way you'll allow the fins more freedom of movement, but you may snap off a fin if you have them loosen it too much. Once that is done, the first thing you should do when you get it out of the tech's sight is to move up the shielding plate so that it does not touch your legs. This will give you more mobility in the air as well as when on the ground. It will also increase your chances of cooking off your legs if you get them too close to the exhaust." His face grew hard. "Now, let's move on to flight practice. This will occur inside Hangar B." With that each man stood up to attention, then followed the officer out of the room.

PARAGLIDERS

The paragliders used by the US Army were designed by Philippe Gordon, an aeronautics engineer for Boeing. He conceived a small pack, worn like a backpack, that could deploy small wings with just enough lift to allow one man to glide safely. He felt the wings would be safer than parachutes, and possibly allow for controlled flight as well.

He presented it to the military as a replacement for parachutes. The brass present quickly decided that Gordon's new contraption might be useful for coordinated airborne assaults, as well, to exploit the contraption's ability to glide for a distance while remaining silent. Pilots of the drop planes could avoid the dreaded flak since they could release the paraglide troops far from the drop zone, and the airborne troops would be able to stay silent near their drop zone.

Before paragliders ever saw combat in Europe, they were tested thoroughly and went through many revisions. The original wing design proved capable of lifting a man, but it was inadequate for delivering a man in full airborne combat dress. It also used wing-warping for control during flight, similar to early WWI era planes. New versions were designed to correct these problems.

While the paraglider itself was going through revisions, a small elite unit of men were hand picked after their gradu-

Phillippe R. Gordon

As a small child in Miller, Indiana, Philippe's first memories were of men coming out to the sandy beaches and flying in what looked like enormous kites. Powered flight was common by the time Philippe was out of school, but he still preferred the idea of a single man soaring like a bird, silently cutting through the sky and clouds. The image was a dream he wanted to turn into a reality.

War was approaching and Philippe's degree in engineering put him in high demand in the aerospace industry. Philippe specialized in the design of control services and wing structures. After working on several projects for Boeing, he started working on a side project, setting up a massive office in his garage at first, then latter brining the whole thing to a small corner of a factory hangar. His new contraption steadily took shape, causing raised eyebrows, comments and questions from his peers. After many months of work, he was ready to test-fly it. He had experience in flying gliders, but his new invention was not a normal glider. He spent months looking for a test pilot. He had all but given up and was about to try it himself when fate intervened.

A test crew had shown up to fly the latest Boeing airplane prototype Gordon was working on. Philippe was going over how the extra control surfaces worked and what they were for when the co-pilot compared it to a glider. During a break, Philippe and the man, Lt. William 'Lighter Bill' Rawnson of the US Army Air Corps, talked about flight experience and test possibilities. They talked through the night and by sunrise Lighter Bill was soaring through the air with Philippe's single-man glider.

Alternate Solutions

Aside from advanced parachute types and jet packs, a number of other devices have been invented to allow indidual flight (or at least a controlled fall). Most of these do not work well (or at all) and consequently they are not very well know. Others show more promises, such as the personal helodyne that Igor Sikorsky is said to be working on secretly for the troopers of the Army. He still has to resolve the power-to-weight ratio and simplify the rotor head to allow easier control, but he is confident he will succeed.

The Army is looking at alternate choices, just in case. A small firm in the Midwest has come up with a sort of flying platform: a high-speed ducted fan, placed in the main hull under the pilot's feet. Intakes on the side let the air in, and a gyroscope provides stability. Early tethered tests are promising — perhaps too much so. Strange people have been seen snooping about the test site...

ation from airborne school. They were formed into the world's first paraglider squadron. They weren't told exactly what they were chosen to do, but they were told they were now the "Daedalus Squadron."

They had over a month of physical training before they were ever exposed to a paraglider. They trained initially as the same camp they had airborne training at, but were eventually moved to training facilities near West Point, New York to start working with the experimental paraglider. The unit immediately took to the machine, enjoying the sensations that flying without noisy engines provided. They also loved the ability to control their flight, preferring the paragliders to parachutes. One rumor had it that twelve students were so determined to test the limits of their abilities that they made a game out of landing on the roof of the Commandant's Quarters to prove to themselves how precise they could be when landing. After initial training and success of the Daedalus Squadron, the program was expanded. A new unit, the 510th Icarus Regiment, was formed, attached to the glider division already in place. The original trainees became trainers themselves as they assumed the leadership positions in the new regiment.

All soldiers complained that the P14 was too heavy. The rig, along with a troopers' full combat load, could exceed 100 lbs. If the soldier landed improperly, the paraglider equipment could easily crush the hapless victim before he could discard the glider and prepare for combat. The P15 was designed to lighten loads for soldiers. Unfortunately the new lighter structure posed new problems. It was very tricky to manufacture and tended to look flimsy in comparison to the P14. The P15 did not inspire confidence in paraglider soldiers. Though almost as heavy as the P14, the P17 gave even greater control over direction and descent. It was easier to manufacture, and had a lower stalling speed making landing easier. The P17 became the standard issue to Daedalus troopers in mid 1945.

Paraglider development is continuing. The new xP18 offers something no previous model has: power. A small jet engine gives the next generation of PPGs the ability to lift off and gain altitude quickly with the wings folded, then pop the wings at the top of the assent and glide away. This allows special units the option to leave after a mission is completed behind enemy lines. Tests of the new paraglider are reportedly not going as well as would be liked, however. In tests using mannequins, the xP18 has caught fire every time. This problem represent the first substantial stumbling block in the paraglider's design history.

The P14 Paraglider

The P14 P.P.G. (Personal Para Glider) was the first operational model issued to the 510th. It was used on the unit's first flight into combat and was used up until late 1944. The P14, when collapsed for deployment, resembled a large, boxy parachute. It had control cables ending in hand holds extended out of the top of the pack, over a trooper's shoulders. An additional cord came around the side and was pulled to deploy the wings. Unlike parachutes, paragliders weren't automatically opened when jumping out of the deployed aircraft, as paragliders didn't need the wash of the plane's propellers to help open them. In fact, testing demonstrated that propeller wash could cause a paraglider to tumble out of control. Consequently, a jumping trooper had to wait a second or two to deploy his glider.

Once the ripcord was pulled, the P14 would open its spring-tensioned wings and tail with a snap. The wings, folded in half, regained their full span as they swung from their downward-facing stored position to the side-facing deployed position. The tail would swing away from the backpack, snapping its rudder upwards at the same time. The wingtips were feathered, resembling a owl's or hawk's wing. They helped keep the glider silent during landing. The control cables operated ailerons in the wings, allowing the trooper to control direction. Additional control was provided by shifting one's weight.

HELICAL AERODYNES

Work began in France in the mid 30s to construct the world's first helical aerodynes. Engines had finally progressed by that point to be able to provide sufficient power to lift a heavier than air vehicle off of the ground purely by the power of a lifting rotor. With the engine problem out of the way, engineers set out to solve the remaining problems of rotary wing flight.

The problems encountered can be summarized into three major categories: control of lift, control of lateral movement and control of torque from the engine. Only by conquering these three difficulties could the helical aerodyne move up and down, move forward and backwards, move from side to side, twist clockwise and counter-clockwise, tilt forwards and backwards, tilt from side to side, and even just hover in place. This totality of movement is called six degrees of freedom.

CONTROLS

Control of lift handles the up and down movement of a helodyne. The lift is not controlled by the speed of the rotor, as most would surmise, but by the amount of lift produced by varying the angle at which the blades of the propeller attack the air. A greater angle of attack (or the more the trailing edge of the blade faces the ground), the less the lift produced. More lift means the helodyne moves upwards, and less lift allows the helodyne to move down. The angle of all blades is changed at once, or collectively, to move vertically. The control for this movement is thus called the collective.

The lateral movement of a helodyne is accomplished by varying the lift to one side of the helicopter. By increasing the lift on one side and decreasing it on another, the helicopter moves in the direction of the most lift. This lift is also used to tilt the aircraft to a degree, which helps to accentuate the move in any lateral direction. The angles of the blades must be changed through out the rotation of the rotor to vary the lift from one side to the other, in a cycle of one blade rotation. The control for lateral movement is therefore called the cyclic.

TORQUE

The very movement of the rotor causes a torque force in the opposite direction to the direction of rotation. Unless this force is counteracted, the helodyne will

Anton Flettner

Anton Flettner was an aeronautical engineer who worked on several helicopter design for the Wehrmacht. He had been an accomplished engineer before that time, however. One of his intriguing early designs was a rotor ship. This vessel, the Bruckau, had two rotating cylinders – the rotors – that disrupted the air flow over them and cause the air on side of the rotor to move faster than the other. The effect was to propel the ship in the direction of the faster moving air, much like how an airplane is able to fly.

Dr. Flettner became interested in helical aerodynes in the 1930s, and his first model was very unique. That design, the Giant, was a torqueless rotor design. The main lifting rotor was about 100 feet in diameter, and had engines in the blade tips to provide motive power to the rotor. Each blade had ailerons to control the amount of lift, and a small auxiliary fan in the fuselage blew air over a fin and rudder assembly to help provide directional control. The craft began test flights in 1933. Unfortunately, a gust of wind overturned the craft in 193; it was totally destroyed in the accident.

Dr. Flettner then went on to design several helicopters for the German government, including the excellent Fl 282 "Kolibri." The latter saw several version that took it from a small open-frame vehicle to a much larger plane-like form. Throughout its many version, however, it kept the innovative twin interlocking rotors that eliminated torque effects while keeping the helodyne small enough to fly from anywhere, from a ship's deck to a rooftop.

Igor Sikorsky

In 1889, the world was introduced to Igor Sikorsky. He grew up in Kiev in the Ukraine Republic of the U.S.S.R. and had built his first attempts at a helical aerodyne by the age of 19. The vehicle was a co-axial design and made several short hops, but no sustained flight. Although this early attempt was not successful, it galvanized Igor's wishes to pursue aviation full time.

In 1909, a year after building his first helodyne prototype, Igor left Kiev for Paris. The French city was the center of aeronautical design and thought at the time. There he studied aircraft engines, structural design and aerodynamics. He returned to Kiev several months later with a motorcycle engine in tow. The motor only generated 25 horsepower, and proved too weak to power any of Igor's further designs for helodynes. However, the engine was of sufficient power to give a plane flight. Igor designed several planes to hone his design skills as well as to practice his flying skills.

While building these first planes, Igor developed two relationships that would serve him well through the rest of his life. The first was with Michael Buivid, who would work with Igor for most of his life. The second relationship was with the ingrained habits of methodical, thorough development. Sikorsky was not a man to skip valuable steps in design and testing in order to get a prototype off the ground earlier. By 1911 Igor had built a successful plane design that could fly. He also had enough hours of flight under his belt by this time to earn a flying license from L'Aero Club Imperial de Russie. Igor's exploits became well known in the U.S.S.R., and he was invited to fly maneuvers with the Russian Army. He designed several aircraft for the army over the next couple of years. During this time, Igor also built some of the largest planes of the time, and even set a flight distance record of 650 miles!

During the stormy first world war, Igor designed several military aircraft, but ultimately fled Russia to France, and then finally to the United States. He set up shot in New York and met up with his old friend from Kiev, Michael Buivid. During the 1920s and 1930s Igor designed some of the premiere passenger planes of the time, and he had particular success with flying boats. He also witnessed some of the first autogiro flights, including a famous one where one took from the White House lawn to go and deliver air mail.

Igor still dreamed of creating a fully functioning helodyne. From 1939 on, he methodically tried every avenue of design, trying out various methods of control for the craft. His prototype vehicle, the S-300, went through many permutations over those years. By 1943 he had started to manufacture the world's first single main-lifting rotor helodyne for the U.S. Army. Along the way he had also set distance records for helodyne flight and earned the first helodyne piloting license issued in the United States.

spin in that opposite direction while off of the ground. By varying the counter force the helodyne can spin clockwise and counterclockwise. This control has been called the rudder. The counter force itself has been generated by a variety of means. These means include counter-rotating co-axial lifting rotors, lifting rotors in a tandem arrangement and auxiliary rotors.

The French started their experiments with co-axial lifting rotors, or rotors spinning in the same axis. They spun in opposite directions, countering each other's torque and keeping the aircraft from spinning uncontrollably in one direction. The French inventors Louis Breguet and René Dorand began work on their helodyne in 1932, and had limited success by 1934. The resulting aircraft could fly, but had problems with the co-axial blades affecting each other's lift, making control problematic. Even so, they realized the dream of creating a machine that could move like a hummingbird, hovering in one place mid-air.

GERMAN EFFORTS

In Germany, in 1933, Heinrich Focke started work on his own helodyne. His machine used two main lifting rotors operating in tandem, or side by side rather than about the same axis. Cyclic control for lateral movement was only necessary for forward and backward motion, since side to side movement could be controlled by providing more lift to one rotor or the other. The rotors spun in opposite direction to balance their torque against each other. This was a complicated arrangement of control, however, and the craft was not easy to fly. Similar designs were built in Great Britain in the late thirties.

Another German, Anton Flettner, also worked on tandem rotor designs, but his design showed more flair and they were also considered by the Third Reich for operational deployment. His Fl 282 design was accepted by the Reich for further evaluation as a military aircraft. The design was agile and stable, proving its worth and accepted for production. The craft was initially used for observation and ferrying of important personnel to locations that other vehicle would have a tough time getting to. It's success would lead to further refinement by Flettner.

In the United States helical aerodyne development was spearheaded by Igor Sikorski. His goal to create a functional helodyne was different from previous successes in one very important aspect — he sought to design an aircraft lifted by a single main rotor. Engine power had reached a level where his wish could become a reality, and he began work in earnest in 1939. He was able to get funding through a U.S. government sponsored program to aid the research and development of helodynes — more important;ly, his work would soon catch the eye of the military. In 1942 Igor Sikorski built the world's first successful helodyne with a single main lifting rotor. Like the German Fl282, Sikorski's R1 would prove very capable in the observation, reconnaissance and ferrying role. His later designs led to even further expansion of the uses of the helodyne.

Even with the extensive involvement of the military, Igor Sikorski's main wish for his helodynes was that they be used for the aid and rescue of people trapped in locations unreachable by any other type of vehicle. He worked on designs of helodynes suitable for rescue even while working on behalf of the military.

VS-300

The VS-300 was Sikorski's testbed prototype for all work he did on his first helical aerodyne experiments. It was the basis for the designs the U.S. Army bought, and was the first fully successful single main-lifting rotor helodyne in the world. The aircraft went through many design changes before the final version was fully successful. The version shown here is the final prototype, with the three-bladed main rotor and single anti-torque rotor on the tail. The main rotor features all of the necessary refinements to allow the craft to fly reliably in all six degrees of motion, and is surprisingly steady in windy conditions and inclement weather that would normally down fixed with aircraft. While the wheeled landing gear configuration is shown here, it should be noted that the VS-300 was tested on many occasions fitted with pontoons that allowed the craft to take off and land on water. Igor himself has logged the most hours in the aircraft, including its maiden flights, both tethered and unfettered.

R1 HELODYNE

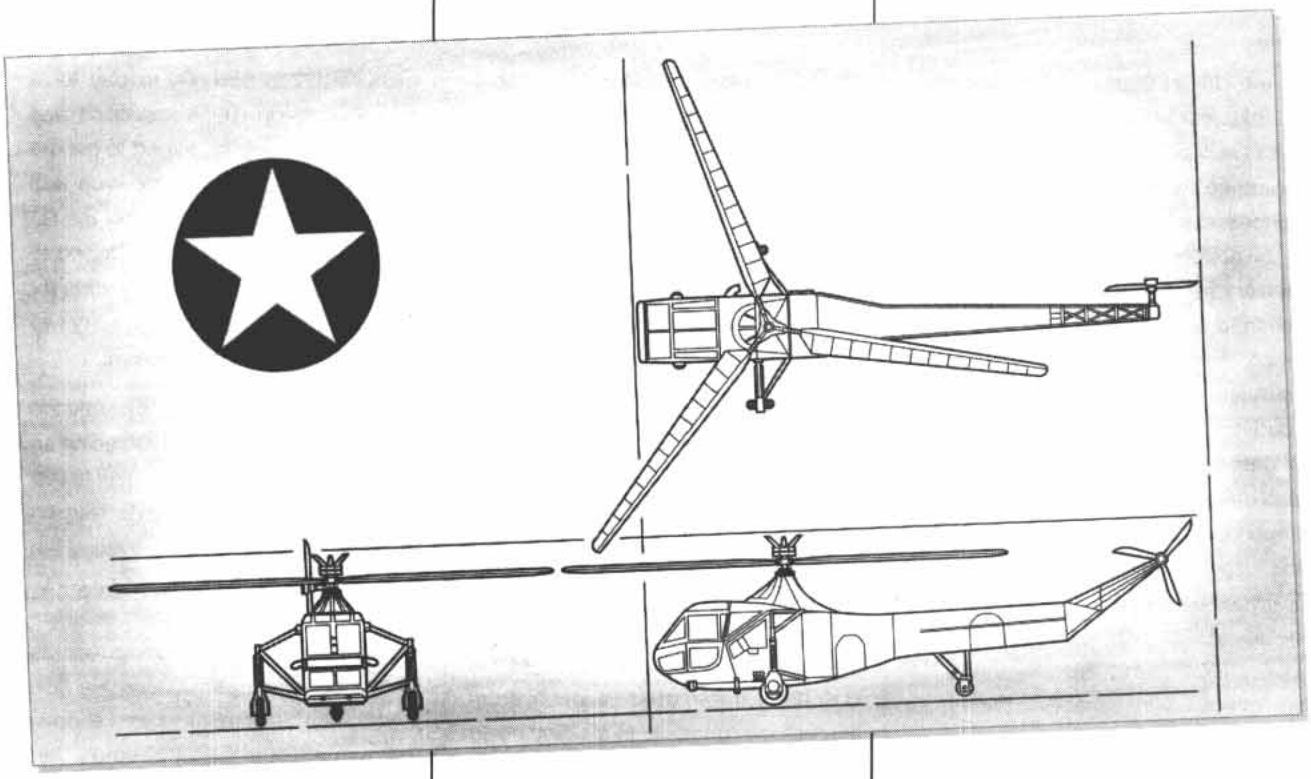
The Sikorski R1 was the first operationally deployed helical aerodyne of the U.S. Army. It was used as an observation vehicle, primarily in the battlefield reconnaissance role. It also helped server as a forward observation vehicle for artillery. The vehicle was the result of the Dorsey Bill passed by the U.S. Congress to fund helodyne development. The bill called for design proposals, with the winner getting $350,000 for development and the second place design getting $50,000 to pay for a back-up design. The competition was close, but Sikorski managed to get the first place. The VS-300 prototype was the result of the research, and the R1 was a direct descendant designed to meet the U.S. Army's requirements for the program. The craft could carry two crew: the pilot and the observer.

Sikorski used the R1 to demonstrate the abilities of the helodyne, even going so far as to deliver eggs in a basket to volunteers during demonstrations. Nary an egg was cracked. When delivering the aircraft he decided to take the opportunity to demonstrate the long distance capabilities of the R1, setting records for helodynes in the process. He flew the R1 from his company's workshop in Bridgeport, Connecticut to Wright Airfield in Ohio, a distance of 761 miles. He set the records for American helodynes air-line distance (92 miles in one flight), first helodyne flight to cross four states, first interstate passenger flight, and exceeding the world endurance record of 1 hour and 50 minutes.

The Sky Cavalry

The flight capabilities of the new helodyne did not escape the notice of the various intelligence services around the world. With their ability to hover in place, the new aircraft could not only drop agents and operatives in remote locations that were otherwise inaccessible, but also pick them up later. They were too noisy to be used in surprise operations, but this did not affect their pick-up capability.

When a daring pilot managed a smash and grab on the French coast, everyone was stunned — the operatives perhaps the most! As they were being pursued along the coastline by a group of SS equipped with bikes and armored cars, they managed to raise their pick-up submarine on the radio. Unable to do anything to help the agents, the sub captain dispatched their helodyne to a position off the coast, in the hope that the operatives could perhaps swim for it. The pilot, however, had other plans: he swung in low, coming near the cliffs, and popped out at the last moment near the team's fleeing vehicle. As they climbed aboard one by one, the Germans could only fire ineffective shots as they realized their preys would escape. As the last agent was pulled aboard by his teammates, their car fell off the cliff as the helodyne flew away — taking with it a few Nazi troopers who had gotten too close.



R1 WALK-AROUND

Peter reflexively crouched down and shielded his eyes as the helical aerodyne slowly descended for a perfect three point landing not ten feet from where he stood. The noise was tremendous — almost as loud as a B-17! Dust settled all around him as the main rotor slowed and eventually stopped spinning. The right door of the R1 opened and the pilot exited the craft. He walked over and extended his hand to Peter. He chuckled as Peter hastily remembered to salute a superior officer.

"No need to stand on ceremony with me, Lieutenant. You can call me Eddie; I'm your flight instructor on this beast." He gestured back to the R1. "No time like the present, so let's go get ourselves acquainted, shall we?"

"As you probably already know, this here is the U.S. Army Scout Helical Aerodyne designation R1, made by the illustrious Igor Sikorski. I guess if the Russians can have Tesla from us, we can have their Sikorski. That's a joke, son. No accounting for taste. She weighs in at 1,700 pounds and gets up to 102 miles per hour if you treat her nice.

"That big thing there is the main rotor. It provides the lift necessary to make this hunk of metal fly. It also controls lateral movement of this bird. The hub of the rotor is pretty ugly, isn't it? That contraption is the heart of this machine! The top there is the collective pitch lever plate. It's connected to the blades there and changes the pitch to all of the blades at once. Just below the blades you can see what's called the swash plate. That connects to the collective plate up there and the cyclic control. The plate will change the plane of the collective plane, changing the pitch of the rotors as the rotor turns. That allows you to move laterally. Pretty ingenious, isn't it?

"That smaller rotor in the back if the anti-torque rotor. It keeps this bird from spinning around like a top. Very important! See how it's mounted there? It's even with the main rotor plane of rotation and to the back of it. That keeps the tail rotor from being affected by the downwash of the main rotor. I hear they had a devil of a time while designing this thing before they put that there.

• COCKPIT

"Here's your controls. You control the plane through a joystick cyclic control, a collective lever and foot pedals to control the tail rotor. There's also a twisting grip on the collective to adjust the power of the engine. Notice how the collective is placed between the pilot and the observer, and the observer has a duplicate cyclic and pedals. That's in case the pilot should become incapacitated. The observer can take over flying of the helodyne and land safely. Always thinking, that Sikorski.

"You have a darn good view out of the Plexiglas here, and landing is pretty

easy as a result. The view is perfect for seeing those Huns and reporting their positions back to trusty American arty. That there radio is used to call in the fire. It's not too bad, but I keep hearing about this new fangled radio that will replace it. Supposed to make it impossible for the Huns to overhear our calls in. If that works half as good as they say it will, we should catch them easily each and every time.

• ENGINE

"Back here you'll find the latest in helodyne engines. This is the Warner radial engine, capable of putting out 165 horsepower. As you can see, it's mounted vertically, greatly simplifying the grease monkeys' job in maintaining this thing. I hear they've gone to a horizontally mounted engine in some birds, and the additional gearbox is a nightmare! Speaking of gearboxes, here's the box that feeds that tail rotor. You certainly don't want that hit. If you need to know any more, talk to your mechanic.

• USES

"Now that you've seen what this bird looks like, I'd like to tell you a bit about what you'll be using it for. As I mentioned before, you'll get to observe enemy positions from the air. Unfortunately this tends to attract the attention of the enemy. We've been working on techniques to help keep your skin intact. One tip I can impart is to stay low to the ground while flying around. Once you get to a good vantage point, you can pop up the helodyne and take a look-see. Stay just as long as you need to make a report and then get back down and scoot! Those Germans are using 88s all over the place these days, and a hovering bird is just asking for some flak!

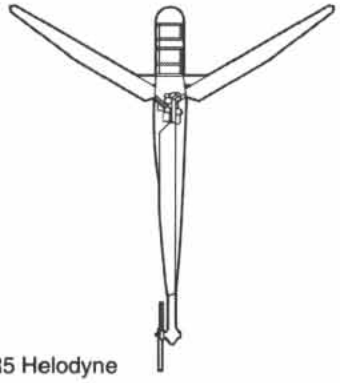
"One last bit of advice. All the helodyne crew I know have been carrying at least one Thompson on board for emergency use. You just never know when a Hun is gonna surprise you and ruin your day. At least this way you can fight back. Sort of. It's pretty tough to fly and fire one of those things, but it's better than nothing. Between you and me though, I hear they're talking about .30s or .50s on these things for some firepower. That ought to teach the Germans to try and shoot at us!"

R5 HELODYNE

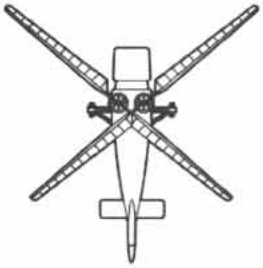
Even before the R1 could prove herself, the U.S. Army was already soliciting for additional helodyne designs. Sikorski was only too happy to oblige. His next design was the R5. The helodyne was intended to perform workhorse duties instead of observation. To that effect, a much more powerful engine, a Pratt & Whitney radial engine, was used. The engine generated 450 horsepower, capable of lifting up to 4,000 lbs if necessary. During tests, the helodyne was able to carry 10 people with ease. The helodyne was put to use helping to carry heavy loads such as anti-tank guns and supplies to locations where even the versatile walkers feared to tread. The first medical evacuations were performed with the R5. The craft itself was very well designed, with easy access to all of the mechanical parts. The pilot and copilot sat in tandem rather than side by side, and the canopy was almost totally encased in Plexiglas, offering superlative visibility.

FL 282 "KOLIBRI"

The first test flights of the Fl 282 *Kolibri*, or Hummingbird, began in 1941. The helicopter was intended to be used as a observation platform for anti-submarine work as well as battlefield reconnaissance. The design had a two main-lifting rotor design. The rotors, rather than mounted co-axially, were mounted in a 'V' shape to each other, 12 degrees outward from the vertical, and 6 degrees forward from the vertical. Each rotor was two-bladed, and synched so that the blades intermeshed with one another like an egg beater. The design also had a large rudder for directional control and control in unpowered emergency flight. The cockpit had room for two people — the pilot and the observer. The craft was highly maneuverable and sturdy, even in high winds. In 1942 the craft went into full-scale production, making the Fl 282 the first production helodyne in the world. The design was a excellent basis for further German helodyne development.



R5 Helodyne

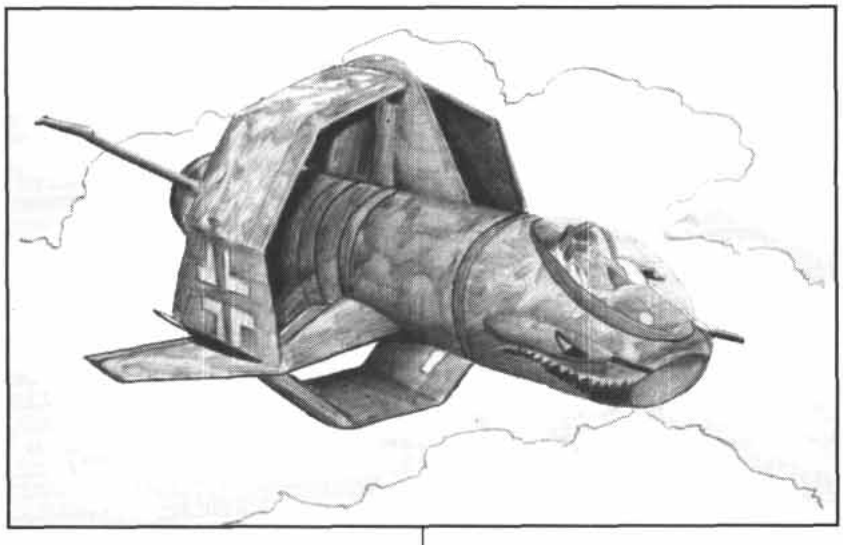


FL 282 "Kolibri"

VTOLs

In addition to helical aerodyne development, research began into other aircraft designed to take off and land without a runway. These aircraft were collectively called Vertical Take-Off and Landing aircraft, or VTOLs for short. These aircraft could operate in defensive positions without the need to construct airbases. This capability was ideal for Blitzkrieg warfare where one's position often needs to be changed rapidly and infrastructure for normal airfield operations was not available. Additionally, these craft could be hidden more easily from Allied reconnaissance and subsequent bombing runs.

The Third Reich has entertained many design concepts for VTOLs, and has sponsored the production of a few prototypes as well. The designs have varied greatly from ducted fan powered aircraft to rocket powered aircraft to jet powered aircraft. No VTOLs have been fielded operationally as of 1944, but as the situation for the Reich grows more desperate the prototypes may yet be rushed into production.



HEINKEL WESPE

The Wespe is an interceptor VTOL designed to take off and land vertically. The prototype used a jet-powered turboprop in a ducted fan wing arrangement to provide lift during takeoffs and landings and to provide thrust during forward flight. In forward flight lift was provided by a circular wing surrounding the propeller, around the midsection of the fuselage. Additional control and stabilization was provided by three rudders at the tail of the plane; landing gears were attached at the tips of the rudders. The plane was armed with two Mk 108 30mm cannons.

After takeoff, the plane would dip down into a dive to get up to sufficient speed horizontally to allow the circular wing to provide lift. In order to land, the plane would dip its tail downward and then forward to kill the horizontal movement, only then descending to the ground. The flight patterns required a steady hand and a pilot with nerves of steel.

HEINKEL P.1077 "JULIA"

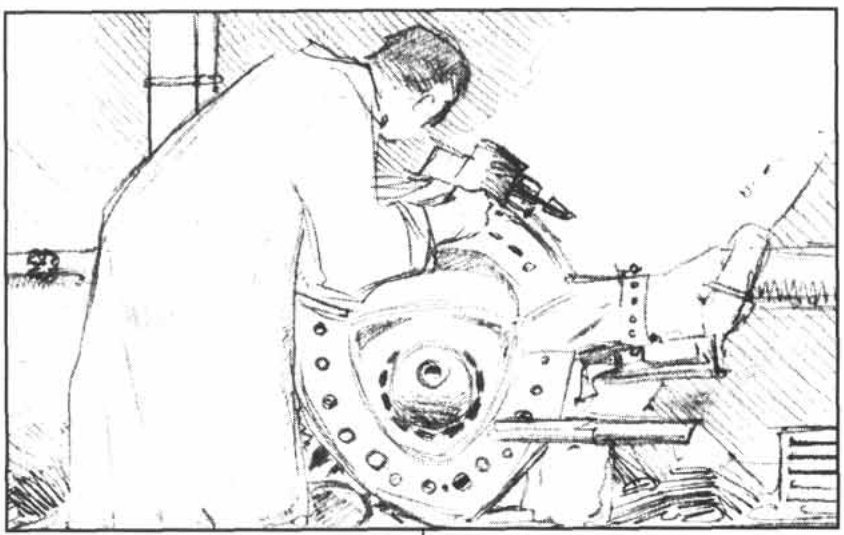
Designed by two Heinkel employees, W. Benz and Dr. Gerloff, the Julia used rockets as its main propulsion. The aircraft was designed to take off from a ramp modified from an 88mm anti-aircraft platform. The plane could take off with a climb rate of nearly 40,000ft per minute, reaching 16,400ft in 31 seconds. It had 5 minutes of burn duration from the rockets. Landing was accomplished as for a traditional plane, and the Julia had landing skids for this purpose. The prototype was armed with twin Mk 108 30mm cannon. The pilot lay prone in the tip of the fuselage, a fairly common feature of many of Germany's VTOL designs. Instrumentation was very simple although it did have a reflecting gunsight for the cannons.

FOCKE WULFE TRIEBFLÜGLE

The FW TriebFlügle is an intriguing craft. It was designed to take off and land vertically (although not easily on the latter task). It had a unique method of providing lift — three combination wing-rotors with a twisted angle of attack with ramjets attached to their tips. The wings were rotated around the center of the plane in a torqueless manner by the ramjets. The ramjets were required to power up via rocket boosters attacked to their tips. The ramjets were chosen because they could burn low-grade fuels, including coal slurry if necessary. The prototype was armed with two Mk108 30mm cannon and two MG151 20mm cannon, and control of the craft provided by a cruciform rudder. A single large wheel was mounted at the back or base of the plane, with four small wheels in each rudder tip. All of the wheels had bivalve gear coverings that enclosed them once the plane took off. The plane had to fly with the tail dipped down to provide the necessary lift in forward flight. Landing was particularly difficult, with the pilot having to look down through the rotating wings and the ramjet downwash.

MOTORS

All of the vast technological might flexed by the vehicles in the age of mechanized warfare would have been useless without the power to make them move. The internal combustion engine was single biggest power source for the mechanical monstrosities. From airplanes to tanks to submarines, these engines gave the ability of movement to what otherwise would be fancifully shaped pillboxes. Other types of engines were used as well, and up until World War II they tended to be found solely in trains and naval vessels — steam and electrical power fueled those beasts. As the 20th century unfolded, new and wondrous innovations in propulsion technology appeared.



TURBINES

Gas turbines are a relatively new type of engine, using a single spinning shaft to compress air, combust fuel, and vent exhaust. The front part of the shaft had many vanes; while spinning, these would suck in air, compressing it into the combustion chamber. The fuel, when injected into the chamber and mixed with the compressed air, ignited. The resulting explosion propelled the exhaust gas out through the rear of the shaft, which had more vanes. Those would turn the shaft, powering the whole engine to compress more air, and so on.

Other turbines were used in naval vessels. These turbines featured the vanes seen in gas powered turbines, but only the gases from another source turned the shaft. The shaft itself would turn a propeller, moving a boat through the water. They were usually fed by steam, produced from coal burning boilers and later fuel burning boilers. Turbines tended to be large in their early development, and until later advances in materials science they were not small enough for vehicles like tanks or walkers. As a result, they were mostly used in aeronautical and naval design.

BLADELESS TURBINES

In 1911, Tesla was ready to introduce a new form of propulsion that would forever change the shipping industry — the bladeless turbine. A more complex version of Tesla's air diffuser, it worked on the principle that most fluids exhibit cohesive properties, clinging to the surface of the material they are touching. By placing a series of disks very close together, almost any fluid or vapor forced between them would cling to the disks, forcing them to rotate. This would force the fluids inward or outward on the disks, depending on whether the fluids were forced into the space from the outside or the inside of the disks. Fluids forced into the disk from the outside edges were forced inward by centripetal force, compressing the fluid as it journeyed to the center of the disk. Once the fluid was compressed sufficiently, it could be combusted if necessary, as in a traditional internal combustion engine. Exhaust gases escaped through holes in the central axle. Furthermore, by pumping the fluid through the central axle, it would be forced outward and out the edges of the discs, turning the engine into a pump.

Not only was Tesla's design simple to understand, it also produces an amount of power that strikes one almost speechless. This is the description given by Tesla himself: "In most engines, a very small proportion of the total amount of material is actively employed in the production of power. For example, in reciprocating engines of the older type, the power-giving portion — cylinder, piston, etc. — was no more than a fraction of 1 per cent of the total weight of material used in construction. The present form of turbine, with an efficiency of about 62 per cent, was a great advance, but even in this form of machine scarcely more than one per cent or two per cent is used in actually generating power at a given moment. The new turbine offers a striking contrast, using as it does practically the entire material of the rotor (the whole surfaces of the disks) as an active source of power, and with an efficiency

of 80 per cent or even 90 per cent. Owing to this, it is possible to get an enormous amount of power from a small space. Assuming sufficient boiler capacity on a vessel such as the *Mauretania*, it would be perfectly easy to develop, instead of some 70,000 hp., 4,000,000 hp. in the same space — and this is a conservative statement."

Not only was the turbine highly efficient, but it was mechanically more tolerant than other turbines and engines. Tesla designed the turbine so that the disks need not even be rigidly attached to the central axle — the disks can move from side to side a certain amount and still maintain the cohesive properties necessary for operation of the engine. The materials needed for the engine can be of almost any metal and the highly advanced materials that most turbine engines require to achieve an adequate power-to-weight ratio for the engine are not necessary. So not only was the Tesla turbine highly efficient, but it was almost criminally easy to manufacture compared to other engines.

Sadly the United States would initially overlook the potential of the design. The Germans however, would not. They had need for an engine that could run efficiently and take up such a small space. They decided to explore the engine's possibilities in powering their dreaded U-boats. Powered by Tesla's bladeless turbine engines, the German submarines would for a time place a chokehold of terror on the rest of the world.

Tesla also continued work on his air diffuser, developing it into the Tesla blower which exploited the fluidic properties of air. So, by the same principles, the Tesla liquid turbine became an air turbine, capable of producing power equal to the modern age's bladed aircraft turbines and doing so more safely but without the inefficient spinning blades. As a result, not only had the nautical world been turned on its ear but so had the aircraft world. The potential for wartime development has been thrust as violently forward as the warhead on a V-2 rocket.

PEROXIDE ENGINES

While submarines were highly effective combat vessels, they were still slaves to the water's surface. Using electric engines they could stay submerged for hours, but they would eventually have to surface or use precious breathing air to get oxygen to power the diesel engines once the electrical charge was used up. The Germans in particular wished to build U-boats that could stay under water for days, not hours. This ability would allow U-boats to evade enemy anti-submarine efforts with ease.

Professor Helmut Walter was to provide the Reich with the answer to their prayers. In 1942, he designed a new type of engine that was totally self-oxygenating. Using hydrogen peroxide as the fuel, Walter's engine used a catalytic process to split the hydrogen peroxide into water and an oxygen atom. The process also produced a lot of heat, which was useful for the next stage. The water took the form of steam in the heated mixture, and the oxygen was heated enough that diesel fuel introduced to the process would readily combust with the heated oxygen. This reaction in turn helped pressurize the steam even more, and the end product was used to drive a steam turbine.

Walter designed advanced submarine hulls to go around his powerful engines. He designed U-boats that were streamlined by removing deck guns and replacing the conning towers with sleek pilot bubbles. Combined with the new powerplant, Walter's test submarines were able to achieve speeds of 26 knots — submerged. It was faster by far than any other submarine built in the world, and was even faster than most anti-submarine destroyers!

The peroxide engine was not without its problems. The fuel used was perhydrol, an almost pure hydrogen peroxide solution. It was extremely corrosive, requiring engine overhauls to be performed with alarming regularity. Special fuel lines had to be designed to prevent frequent ruptures. Furthermore, the fuel lines had to be designed to avoid any right angles in them. Perhydrol had a nasty tendency to collect in the angle and eventually build up a pressure than would cause the fuel to explode, with

Air Cushion Vehicles

Efforts at designing vehicles that literally 'traveled on air' had been made as early as the 1700s, but no practical working designs existed until the age of superscience and its engines with high power-to-weight ratios. ACVs can travel at much higher speeds than other ground-based vehicles over the most broken of ground; they are amphibious, traveling over water and land with equal ease. Though they had early problems with direction control and turning radii, the recently developed prototypes are quite nimble. ACVs do have some disadvantages: since they are not in contact with the ground, they cannot be controlled as easily as other ground-based vehicles. They do not accelerate or decelerate as quickly, and they are not stable firing platforms (although advanced stabilized weapon systems are helping to alleviate this problem). They also kick up more dust and make more noise than any other vehicles on land, giving away their positions for miles around.

the expected disastrous results. Peroxide engines gulped the fuel like mad, requiring more fuel to be placed in a Walter submarine.

Even with the numerous problems, the Reich decided that the benefits outweighed the risks. They used the critical new engine technology to power their highly secretive submarine transports, which needed the ability to stay submerged for an extended period of time more than they need safety. Walter would continuously work on improvements to his engine, such as using a Tesla-style steam turbine to improve overall efficiency.

WANKEL ROTARY ENGINES

Felix Wankel applied for a patent for a new type of engine in 1933. The engine promised some very remarkable new advantages over other internal combustion engines. The engine had nearly half as many moving parts as other engines, and vibrated nowhere near as much. It applied power from combusted fuel 50% longer than other engines. It was also very lightweight in comparison to other engines, and could run longer. The engine promised to be quite a leap in capability.

The Germans considered using the new engine in the walker designs that were being perfected at the time. Unfortunately, the major drawback of the early rotary engine design was to prove its undoing. The engine that Wankel designed gulped fuel at a greater rate than other engines. Walkers were already having trouble going any great distance before refueling. Those with rotary engines would have been able to travel even shorter distances, which was not a tolerable flaw.

FIXED WING AIRCRAFT

Superscience has touched nearly every aspect of vehicle design, and aircraft were no different. Mere curiosities in the early 20th century, aircraft had come of military age during the Great War and almost indispensable by World War II. Piston-engined aircraft had nearly been perfected by the mid-war period, and jet aircraft were beginning to appear in numbers by the end of 1943. Rocket powered fighters were also becoming widespread. Rumors of new types of rocket and jet engines abounded, in turn spawning new rumors of craft that could skim the very outer reaches of the Earth's sky, traveling intercontinental distances.

SKUNKWORKS

In 1941 the United States Army Air Corps' needs had changed dramatically. The world had been ushered into the jet age by the British, and by that point the Germans were confirmed to have operational jet aircraft as well. The United States needed her own jet fighters to combat the expected German jet advantage. The approached Lockheed was one of the companies to develop an operational jet fighter.

Kelly Johnson answered the call for designs, forming a new division within his company. The new division was dubbed the Skunkworks, and worked feverishly to product a jet aircraft for the U.S. Military. They produced the XP-80 in record time, and — even more remarkably — built it in utmost secrecy. The Skunkworks achievement was due in no small part to the genius of Johnson. He laid down a set of rules that all Skunkworks employees had to follow, emphasizing engineering flexibility, close cooperation with the government and fiscal responsibility. Employees were chosen very carefully based on skill and rigorous background checks.

The success of the first Skunkworks project would lead to many, many more.

SPRUCE GOOSE

In 1942 the U.S. Government requested designs for airplane cargo transports that didn't use valuable wartime materials. A concept by Henry J. Kaiser was chosen, and the eccentric airplane mogul Howard Hughes designed and built it. The plane, the Hughes-Kaiser 1 (HK-1), was 400,000lbs and was constructed of wood and fabric. The plane was gi-

James Howard Kindelberger

James Kindelberger, or "Dutch" to his friends, was born in 1895. When he was 17 he started working in the steel mills as his father had before him. When he turned 21 he enrolled in the Carnegie Institute of Technology. A scant year later World War I started, and Dutch joined the U.S. Army, serving as a flight instructor. After the war he worked for Martin Aircraft and Douglas Aircraft before finally settling in with General Aviation, which later became North American Aviation. He served as the president and chief engineer of the company. Under his guidance, NAA built many successful wartime planes. Two designs built by his company were the P-51 Mustang and the B25 Mitchell. He is helping shepherd the company into the jet age with new designs.

Clarence Leonard "Kelly" Johnson

Clarence Johnson (or Kelly, as he was sometimes called) was born February 1910 in Ishpeming Michigan. He picked up his nickname "Kelly" after the song "Kelly from the Emerald Isle" after he defeated the schoolyard bully. His dream from a young age was to design and fly aircraft. Before the age of 13 Kelly had designed his first plane, called the Merlin battle plane. Years later he entered Flint Michigan Junior College and began an intensive course of study in engineering, mathematics, physics and calculus. His first flight in an old biplane nearly cost him much more than the $5 rental fee, as the engine stalled at 700 feet and was forced to make an emergency landing. This didn't deter Kelly's dreams one bit, whetting his appetite for air travel.

In 1929 Kelly entered the University of Michigan at Ann Arbor where he became involved in testing of aircraft, trains and smoke removal at the university's wind tunnel. Upon graduation during the Depression, Kelly had a lot of difficulty finding work. He attempted to join the US Air Force, but was denied when he failed the eye exam. He then applied for a position with Lockheed, but was advised to enroll back in school for another year. With a $500 fellowship grant, he did just that. He returned to wind tunnel testing and even helped with the Electra, a two-engine passenger plane concept by Lockheed.

Kelly got his chance in an entry-level position at Lockheed the following year, and gave his opinion that the new Electra was too unstable. He was sent back to the wind tunnel with the model, and with the addition of a twin vertical tail and controllable plates increased the stability of the plane and ensured himself a permanent position at Lockheed. While at Lockheed he created the Fowler flap that helped with braking safety and speed.

From there, Johnson designed the XP-38, the precursor to the famous P-38 Lightning, capable of flying at over 400 mph. He also tweaked the P-38 to enable it to deal with the sound barrier. Additionally, Kelly helped to change the Model 14 Electra into a coastal reconnaissance bomber for the British in only five days.

Kelly's greatest work was with the secretive "Skunkworks" project started in 1941. The US Army Air Corps asked Lockheed to design a jet fighter after spy reports that the Germans had already built their own jets. With a tight deadline, Kelly and the boys at Lockheed created the XP-80 around a British DeHavilland jet engine in only 143 days, and successfully tested it in California in 1942.

gantic and three times larger than any plane of its day. It used eight radial engines for power and took off and landed on water. It was designed to ferry over 700 troops at a time. The design raised more than a few eyebrows in Washington, D.C. One senator dubbed the design a 'flying lumberyard'. The nickname the 'Spruce Goose' was adopted soon thereafter. Hughes despised the nickname.

The plane was constructed by 1945, and in that year it took its one and only flight. Hughes himself made the maiden flight. The plane flew a mere mile, reaching a speed of 80 mph, and made a perfect landing. Unfortunately for Hughes the government decided that the need for such an aircraft was not as great as they anticipated. Hughes was furious over their decision not to build more of the craft, and locked it away in spite.

Howard Hughes

Howard Hughes, Jr. was born in 1906 to fabulously wealthy parents. As a boy he was always tinkering with things, and his father made him his own workshop when he was 11. He built his own motorcycle in that workshop. Despite his mechanical aptitude, he never completed a degree in any of the seven schools he attended. He had few friends. He was thrust into adulthood when his parents died almost within a year of each other in 1923 and 1924. At the age of 17, the young Howard inherited his parents' fortune; he took control of his father's company, Howard Tools, once he turned 21. Using his inheritance, Howard began to forge the life of a playboy. He flew and raced planes, he began a long affair with Hollywood, producing a number of pictures, and he partied with many movie stars.

In 1939, a friend of Howard asked him his advice on what to do with an ailing company. The company, Trans World Airlines, was in dire financial shape. The company was trying to run a cross-country airplane service, and failing miserably. Hughes saw an opportunity, and purchased seventy percent of the foundering business. As fate would have it, the world erupted in war around him, and the government needed the kind of service he was now looking to provide. TWA finally achieved success by flying government and military officials around in government-funded planes.

NAVAL VESSELS

The nations of the world had built battleships as the ultimate expression of naval power in the early 20th century. Aircraft carriers had joined the battleship on the waves by the time World War II was raging. Most vessels were conventional in design, using single hull designs, floating on water, and using propellers for movement. Ship design and advancement had been somewhat stagnated by the naval treaties signed in the 1920s. The Germans, ever looking for loopholes in the treaties, devised some rather unique new naval vessel concepts. Once World War II started, their concepts became reality, but could no longer escape international law — they built their new designs to escape international notice. The Japanese, taking a cue from their fascist allies, likewise designed new ships that would evade detection.

SUBMARINES

Successful submarine craft of war were first used during the American Civil War. They were used widely during the Great War, and they became terrors in German hands, as well as others, during World War II. Silent and deadly, they wreaked havoc on enemy shipping and naval strength.

The U-boats, however, only tell half of the story. What is not known to the Allies is that the Germans have been hard at work developing submarines capable of transporting people and vehicles. In effect they have been converting their transport shipping from surface vessels to submarine transports. These craft operate in the utmost secrecy, relying solely on computator navigation to travel from their ports in Germany to their destinations, and then back again. They do not communicate via radio, for fear of risking Allied interception and deciphering.

The first of these vessels was constructed in 1943, and improved models were built in 1944. The first models could transport only approximately four truckloads worth of material, but eventually they could carry up to a dozen trucks or the equivalent thereof. Some subs have been modified to transport dozens of people.

They have shared their new transport designs with the Japanese, who needed a way to gain an upper hand in the Pacific. The Japanese, however, have not been as secretive in their operation of their underwater fleet, and Allied forces have intercepted enough transmissions to begun to suspect the presence of new underwater vessels. Other intelligence sources confirm this suspicion, and rumors are beginning to point to the Japanese having submersibles capable of launching aircraft. The Allies have collected several reports of Japanese planes flying far from any reported airfield or aircraft carrier.

HYDROFOIL WATERCRAFT

The first recorded patent for a hydrofoil craft was filed in 1869 by Emmanuel Denis Farcot. His design placed inclined plane foils along the sides of a traditional boat. When the boat moved forward, the foils lifted the boat up in the water, reducing the draft of the boat. The boat, with now significantly reduced drag in the water, could travel faster.

From these humble beginnings hydrofoils were a continual topic of research throughout the late 19th century up to the present. Early models of hydrofoils used pusher propeller drives for movement, rather than screw propellers in the water as the more traditional ships. They had varying ways to lift the boat out of the water, from outrigger foils to single foils mounted on the keel. Control was limited for the most part, and no practical designs had been produced until the dawn of World War II.

As Germany began its quest for power, German engineers were working on hydrofoil design amongst the myriad other vehicles they were developing. They found the military applications for hydrofoil design to be limited. They had solved most of the control problems using complex foil designs, but a boat on foils tended to be a poor platform from which to fire naval guns. Hydrofoils were fast, but that same speed made torpedo launches unreliable, and torpedoes launched to the front of the craft often had trouble clearing the boat after launch. Torpedoes launched to the side hit the water with too great a force and often broke into pieces on impact. Torpedoes launched the rear were effective, but firing a weapon while constantly running away from prey hardly appealed to the German sensibility.

What the hydrofoils were excellent at was quickly shuttling VIPs over water. Consequently, hydrofoil design was geared towards luxury vessels for the Reich officials. One design was remarkable in that it was submersible. This craft could not be made of a practical size to function as a U-boat, and was therefore useless to the Kriegsmaine. The single functional prototype was used by a high ranking member of Hitler's circle however, rumored to have been Himmler. Whoever it was, he used it to travel in the utmost of lavish comfort, incredible speed and underwater secrecy.

The Untervasser Train

The Germans used their submarine transports to shuttle supplies to and from Japanese bases, as well as to interests of their own. Before the occupation of Italy by Allied forces, hundreds of Italian miners were rounded up by SS troops and Ahnenerbe agents and taken to the Antarctic by these vessels, to exploit the mineral and metal deposits the Germans discovered there. Once Italy was 'liberated,' the labor force for Newschwabenland was cut off: to make matters worse, the need for labor in Antarctica had grown to a point where a solution was needed as quickly as possible. The labor force in Germany was already stretched to the limit, and the Nazis were deporting their slave labor to camps in occupied territories, in hopes of carrying out the most grisly mass murder in history.

The Germans decided that they needed labor too greatly for the bases in Antarctica, and that the plans for the Final Solution would have to be scaled down for the time being. They began to ship a number of Jews, Slavs, Gypsies and others from the various concentration camps to Newschwabenland, a few hundred at a time. The Third Reich had no idea how quickly the need for slave labor would increase, however, and available transportation was inadequate to ship all the camp residents to the frozen pole.

The Great Train Robbery

A special League of Nations Plenipotentiary team has been assembled in cooperation with the special service branches of Great Britain and the United States. Military and civilian operatives are thrown together for a mysterious mission. One month ago, a British warship answered a distress call out in the middle of international waters, off the eastern coast of Africa. When they arrived at the location of the call, they found an astonishing sight — a huge submarine filled with emaciated prisoners. Those people were from camps in Poland, bound for parts unknown; the entire crew had been killed when the prisoners took over the vessel. The teams are sent to investigate the origins of the vessel and try to track down where it was going. This is an obvious start to a long campaign to find Neuschwabenland: the complications can be many, and finding the truth will lead to the uppermost echelons of the Third Reich.

HIGGINS BOATS

Higgins brought his knowledge of shallow water boats into the design of the LCVP, or Landing Craft, Vehicle, Personnel boats. The flat reverse curve design of the ship would not only allow it to run aground without damage, but it also allowed for great maneuverability and speed. They were able to operate in as little as a foot and a half of water and were highly maneuverable. This was also due to the "headlong" — a solid block of pine at the bow — which was the strongest part of the boat, enabling it to run at full speed over floating obstacles, sandbars and right up on to the beach without damaging the hull. This also made the ship ideal for troop transport.

Higgins' LCVP boat was genius in design. Col. Joseph H. Alexander said "The Higgins boat broke the gridlock on the ship-to-shore movement. It is impossible to overstate the tactical advantages his craft gave U.S. amphibious commanders." It was slightly modified so that the front of the boat would drop open upon the beach to allow rapid deployment of its cargo. The original LCVP could carry a platoon of 36 men with equipment, or a jeep and 12 men as necessary. The boat could then perform a quick 180-degree turn without broaching in the surf and escape to transport more men and supplies. Because of this ability of the boat to quickly remove itself, new waves of Higgins boats could land on the beachhead and continue the wave of troops. This allowed commanders to attack less-defended coastline areas and move into the continent.

Perhaps the most exciting development for the Higgins boat occurred later in the war. Walkers were becoming more important in battle, yet their size and weight was a hindrance to transport. Many times they were required to be brought in later to a wharf that first had to be won from the enemy. Ships that brought in the walkers required the wharf for the large support crew required to unload, care and guard the machines. Higgins was once again called in, and created the LCW, or Landing Craft, Walker, variant of the LCVP. Essentially it was a larger version of the LCVP with more support, larger cargo area and more horsepower. While it did have a deeper draft than the original, with its elongated landing platform it could still beach itself far enough up that the walkers, already laden with crew, could step off the transport directly into action. This made the walkers more important, as they were crucial to securing the beachhead. Refueling and reloading teams for the walkers could be brought in later.

Andrew Jackson Higgins

Andrew Jackson Higgins was born in Columbus, Nebraska on August 28, 1886. As a youngster, he spent a lot of time along the Loup and Platte Rivers near Columbus. He was very interested in the shallow-draft boats that plied their trade along the rivers. He built his first boat in the basement of his home. The only way to remove the boat was to remove a wall of the basement, much to the dismay of those around him.

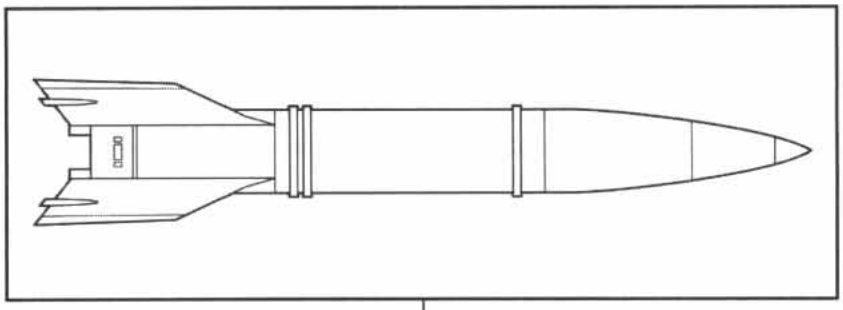
Higgins began his association with the military as an infantry officer in the National Guard. He then moved south and began a lumber business that had two lumber tracks in the swamp. In order to get to the trees and transport the lumber, he designed a shallow draft boat that did not sit very deep in the water yet could transport great weight.

Higgins began designing boats to be used in the shallow swamps and marshes of Louisiana. Simply calling his new venture Higgins Industries, he designed boats like the famous Eureka model that could operate in only a foot and a half of water without fouling the propeller. He would demonstrate the capabilities of his boats by running them up the Lake Ponchartrain seawall.

Higgins was not only a great designer of watercraft, but a forward thinker as well. As the war inched closer to America, Higgins traveled to the Philippines and purchased their stock of mahogany wood, a major material for his boats. He was among the few to hire women and men of all creeds and pay them all the same wages and was revered among his employees as a fair man. His boats were used in landing operations in the war, and he was held up as a hero to the Allied cause.

ROCKETRY

Rocketry is an old science, dating back to the ancient days of China. In previous centuries, it had been mostly used to further the use of fireworks. Fireworks, while very entertaining, were not highly useful other than as signal flares on either the battlefield or in advancing the position of humans in the field of travel. The age of superscience, along with the continuing human need to fight, changed all of that. Early work by the American scientist Goddard led to rockets designed as weapons as well as a means of travel. The Germans would further the science more than any other nation in the 1930s. They would build the first guided rockets, bombing England without a single pilot ever leaving German soil.



BIRTH OF THE SPACE RACE

The seeds of space travel can be found in the works of fiction authors such as H.G. Wells and Jules Verne. Their work inspired the formation of several 'space societies' in Germany and Russia in the late 19th century. These societies examined the practical issues involved in space travel. Although they didn't use rigorous scientific methods, they still helped to influence the minds of the next generation. The next generation *would* use scientific methods to work towards successful travel in space.

Taking the pioneering work of Goddard in liquid-fuelled rockets, the Germans designed and built the first practical inertial guided rockets. Their first designs were weapons of war, but the key scientists of the Reich all had aspirations to use rockets for more than destruction. They all had aspirations to design spacecraft, and their dreams were the first inklings of practical space travel.

Hermann Oberth

Hermann Oberth, born in 1894, was inspired to enter the field of rocketry by the works of Jules Verne. He was very interested in building spacecraft that would allow men to land on the moon. He wrote several books of his own, such as Rockets Into Interplanetary Space, Ways to Space Travel, Man in Space and more. Oberth was a brilliant scientist and nearly a prophetic visionary. He was without question one of the most influential figures of the space race, his works inspiring the fathers of rocketry. His teachings would educate and guide, among others, Werner von Braun. He would later join von Braun at the legendary lab at Peenemünde, where the Germans developed the V series of rockets.

Robert Goddard

Born in 1882, Robert Goddard showed an interest in rockets at a very young age. His love affair with rocketry would continue throughout his life, and he made many contributions to rocketry. In 1911 he had received his Ph.D. in physics from Clarks University, and was invited to become head of the physics department there, where he performed all of his early experiments. He worked with solid fuel rockets during World War I, but the Armistice Treaty prohibited further work on rockets for the military.

He successfully tested the first liquid propelled rocket in 1926. By now his work in the field of rocketry was drawing world-wide attention, influencing even noted scientists such as Wernher von Braun. His earlier researchs with solid fuel rockets helped bring about rocket weapons such as the bazooka. His work would also inspire the Germans to develop and use the V rocket series to terrorize Britain.

THE GERMAN TRIUMVIRATE

Three of the principle members of Germany's rocket and space programs were Willy Ley, Eugen Sänger and Walter Dornberger. All three worked with von Braun on the V series of rockets. Willy Ley was one of the scientists captured with von Braun after the American raid on Peenemünde. He agreed to help von Braun with American rocket research. More importantly, he started to write literature to help popularize space travel. His early efforts were not widely read, as the war effort tended to drown out fanciful ideas of space travel.

Walter Dornberger was one of the prominent researchers on the V rocket program, and made many contributions to it. He continued on at Peenemünde after von Braun was captured and assumed the leadership position now vacated from von Braun's absence. He would help the Germans take their first tentative steps sending rockets into space, both manned and unmanned.

Eugen Sänger helped early on developing the V rockets, but he had moved onto other projects by the time the V-2 and V-3 rockets were being built. He instead turned his efforts towards high-atmosphere rocket planes. His proposals were for planes that could fly to the outer reaches of the earth's atmosphere. He even mentioned working on a design that would be able to reach North America from the European continent.

V SERIES ROCKETS

The first fruits of the extensive German rocketry research were the series of guided missiles known as the V series. The V-1 was developed under the secretive name of the *Flakzeilgerat 76* or Flak Aiming Device 76. It was an 830kg bomb that could be sent 240km to hit a target. It used wings for lift and was powered by a pulse rocket engine mounted externally to the bomb. It was guided by a compass, and used a propeller to measure the distance it has traveled. Once it had traveled a preset distance on a set bearing, the missile would dive into the ground and explode. The missile was first used operationally in early 1943, and over 10,000 of the weapons were launched at England.

The V-1, while useful, was not as successful at the Germans had hoped. They continued to research improved designs, and their new design, the A-4/ Vergeltungswaffe-2 or V-2, replaced the V-1. The V-1 was a glider weapon, but the V-2 was a ballistic missile. It used a rocket engine to lift off and reach a certain height, cutting off its engine at a set point. It then allowed gravity to take over and guide it to its intended targets, where it would then explode. The missile was inertially guided with greater sophistication than the V-1. Complex gyroscopes augmented the internal compass, as well as basic computators. These instruments calculated the fuel burn and direction of the weapon, giving the V-2 an accuracy beyond the V-1. The V-2 was liquid fueled and could achieve a speed of up to 5,730 kph before engine cut-off. It carried a warhead of 975kg up to 330km away.

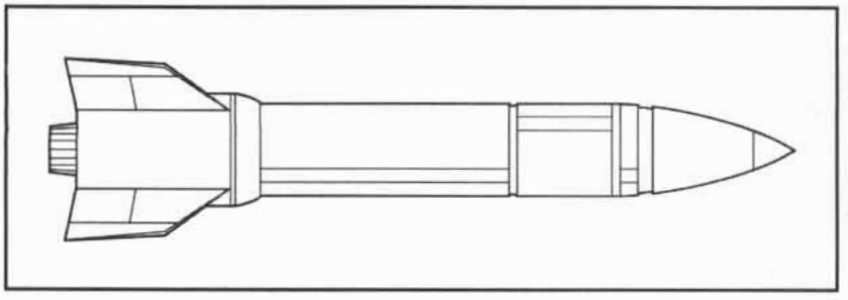
The V-2 was first launched at England in early 1944. Its development hit a snag once Wernher von Braun and other key scientists were captured. Despite the setback, the V-2 program was continued. Allied spies were able to confirm what captured scientists revealed during interrogation: research was moving forward in several disturbing and eye-opening areas. The Germans had apparently been working on manned versions of the V-2 as well as submarine-launched versions. New rockets, called "Projektil Amerika," were being contemplated with the ability to hit American cities from Europe. How far along the Germans have gotten in successfully building any of these weapons is unclear as of 1944.

R SERIES MISSILES

In addition to their ballistic missile research, the Germans worked extensively on guided weapons for use against small targets such as vehicles. These rocket-powered weapons are the R series of missiles, which use solid fuel rockets instead of the liquid-fueled rockets of the V series. The solid fuel wasn't as efficient, but it was safer by far and the effective ranges of the weapons were sufficient for battlefield use.

The first operational weapon of this series was the R-92, first used in 1943. Using the lessons learned from their cockroach walking bombs, the Germans designed a televisor guidance package for a rocket bomb. The controlling suite of electronics could only fit into a Tiger tank, the biggest tank they had available at the time. The system was integrated into a new fire control system for the main armament of the tank as well. The weapon would hit targets reliably out to 2km, but one problem with the new system was shock resistance. The heat build up in a tank, coupled with a less than silky smooth suspension, often created problems for the delicate guidance controls. Too many times the televisor picture would be lost, making guiding the weapon impossible.

Follow-up versions of the weapon system improved the electronics considerably. The R-94, first used in 1944, was basically the same weapon as far as destructive power was concerned. The guidance suite mounted on the vehicle was more reliable, however, and more compact to boot. The improvements were welcome additions to tank-mounted R-94s, and for the first time walker-mounted versions could be contemplated. Additional improvements in guidance are rumored to be in the works, including infrared versions as well as versions that can home in on a vehicle's heat signature and sound.



Wernher von Braun

Wernher von Braun was born in 1912. Like Hermann Oberth, he was inspired at an early age to study rocketry by the works of H.G. Wells and Jules Verne. He was a protégé of Oberth, learning rocketry as his knee and later standing along side his former teacher and Goddard as the fathers of space flight. Von Braun headed up the team at Peenemünde. His team included Oberth as well as the inventor of the rocketpack, von Vossler. They would develop the devastating V rockets, including the V-2 rocket.

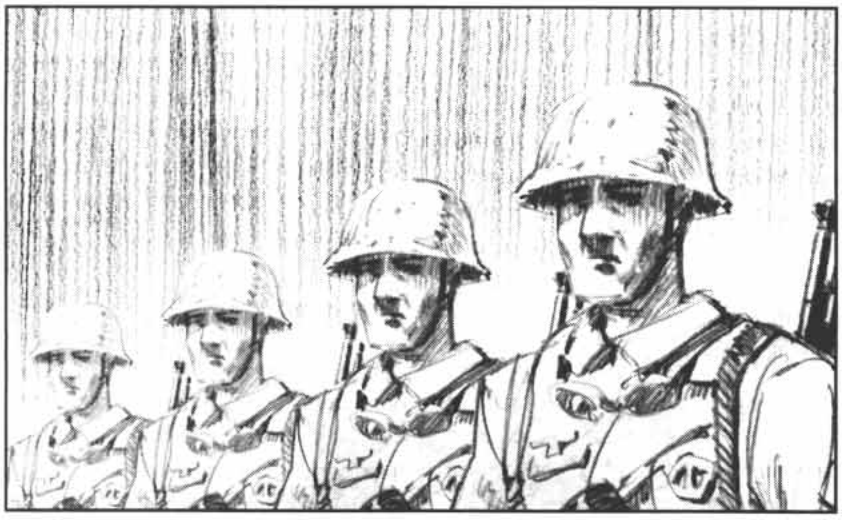
In addition to the secret work at Peenemünde on the world's first ballistic missiles, von Braun oversaw the first efforts of the German space program. He and all of this team wished to place a man on the moon, and if it was a German so much the better. Their work was cut short when Allied paraglider troops infiltrated Peenemünde in 1944 and captured von Braun and other key scientists working there. Von Braun, eager to continue his work in space exploration, decided to help the Americans jump start a space program of their own. He was now working against his former countrymen, including his mentor, Oberth.

Operation Thimble

Allied intelligence has finally pinpointed the location of the German rocket research facility. OSS agents have been selected to be trained by paraglider troops to accompany them in the drop on Peenemunde, an island in the Baltic Sea. The agents will be supported by the paraglider company in the raid on the facility. They are to capture as many scientists as possible; Wernher von Braun and Hermann Oberth are top on their list. They are then to gather as many documents regarding the German rocket programs as they can. Destroying the facility is a secondary mission goal. The raiders are to be picked up by a British submarine operating in the area. The camp is guarded by elite German troops. All sorts of problems can occur, from uncooperative scientists to a late British submarine. The commandoes could be in for the fight of their life if they take too long and Rockettruppen show up. Landing can be a tough problem, with broken, swampy marsh as the only terrain even barely suitable for the drop zone. A highly successful raid could thwart the German research for years to come. A botched mission could result in the American rocket program never starting before the end of World War II, relinquishing the race for space to the Germans before it even starts.

Chapter Five: Life Sciences

With the world engulfed in war, and the technology of the battlefield in every news report and magazine, people easily forget that some of the most astounding advances in science since the turn of the century have been in the areas of biology and medicine. Disease is finally starting to be fought effectively: the root causes of the unseen killers are being discovered, and cures are developed. Vitamins, valuable to human well-being, have been isolated and produced, and the standard of living (from a health point of view, at least) has increased dramatically. The understanding humankind has about the world in which it lives has increased by leaps and bounds.



HITLERJUNGEND RISING

The stadium was resplendent with color, the red, black and white banners of the Nazi Party flapping in the breeze in unison with those brilliant standards carried by the section leaders. They had all gathered to listen to one man speak — the Fuhrer. His speeches were legendary, inspiring all of Germany to greatness. Today his future party members filled the stadium beyond the rows of soldiers standing at attention. All of the Hitler Youth had been requested to attend. Including Claus Heinz.

He stood with his unit, proud and regal. He glanced from side to side, eying his compatriots, drinking in every detail of the event. He needed to remember all that he saw and heard here today. When he returned home, he would retire to his room and write all of the details down in his report. His eyes snapped to the distant podium as their leader and his retinue took the stage. The Youth waited in silence. Hitler approached the podium and began his speech. Claus listened intently to his opening remarks of praise for the young men gathered here.

Claus continued glancing around while keeping an ear to the speech. He noticed a lot of new faces in the ranks around him. To a man, they were all in leadership positions, and looked even more proud than normal Hitler Youth members. Odd. He concentrated on them, assessing them. They looked very fit, taller than most and even had an air of wisdom — some internal buttressing strength — in excess of their age. They had to be at the most 18 years old, but they a look about them that reminded Claus of the veterans he had seen returning from the front lines.

Hitler continued his speech, his clear and ringing voice proclaiming to the heavens the promise of those standing before him. He began to increase the pace and volume of his speech. Claus knew he would eventually build to a stunning crescendo by the end, emphasizing his points with the slam of a fist on the podium. Claus had seen him speak several times now, and Hitler's technique was masterful, his understanding of mass psychology complete. The crowd began to cheer at some of his statements, drawn into the magnetic power of Hitler's oratory.

Claus returned his full attention to the Fuhrer. "... through the strength of the Aryan people!" *Cheers.* "Your ranks have swelled into the millions, and the best of you will go on to fight for Germany's glory! Look to your leaders for guidance, especially the new faces who even now stride beside you as brothers in arms. These men have been chosen for their pure-blooded Aryan breeding, which has granted them the skills we need to protect and preserve the Fatherland. They will guide you all to the inevitable mastery of the Thousand Year Reich over all of the nations!"

More cheers.

Claus took renewed interest in the new face closest to him. Obviously Hitler was referring to this man, as well as those whom he so strongly resembled, scattered throughout the gathering. Claus had been chosen for this placement because he was an astute observer of human behavior. He used that talent to sift through the facts he was taking in now. What did the Reich have up its sleeve? Obviously the new young men were more physically capable than anyone he had seen before. They looked as though they had been through extensive training, and certainly they stood as proud as any elite soldier. There had to be something going on here; something more than met the eye.

Hitler finished his speech. His words went unheard by Claus, who had been lost in thought. The assembled youth was clapping and shouting praise for the Fuhrer. A wave of "Seig Heils" swept across the crowd. Claus joined in, extending his right arm in the customary salute. He started to construct his report in his head.

His British S.O.E. contact would be very interested in what Claus had to say.

ANTIBIOTICS AND OTHER DRUGS

Disease has long been an enemy of humankind, although the causes remained unknown for much of history. The dawn of the superscience age saw some great strides forward in the understanding and prevention of biological damage. The early 20th century in particular saw an explosion of research in the area of biology. Genetic theory was rediscovered, taking a page from Mendel, and scientists examined DNA, RNA, bacteria, genes, viruses and more. With the progress of biological understanding, scientists were able to conclusively determine the sources and causes of several debilitating diseases such as diphtheria, yellow fever and syphilis.

By discovering how diseases spread, researchers helped forge methods to combat the risk of infection and to prevent the conditions that were conductive to disease and epidemic. The quality of life of the average person soon increased by leaps and bounds. The way was forged for the next great discovery of superscience — effective medicines that could *cure* disease instead of simply trying to hold off infection.

PENICILLIN

In the late 19th century, scientists began researching the effect of harmful bacteria on healthy bacteria. This would be advanced by pure accident in 1928: Alexander Fleming discovered that one sample of harmful bacteria had been spoiled by bacteria from some penicilium mold. He decided to investigate further, and found that the mold had killed off many of the harmful bacteria in the petri dish. Further investigation proved that an extract of said mold, penicillin, could combat many disease-causing bacteria. The first highly effective antibiotic had been produced.

Penicillin was highly effective, but until World War II it was not produced in great quantities. The American drug company Pfizer changed all of that, developing a way to synthesize the drug. The new method required a substantial investment in the necessary equipment, but Pfizer's executives decided the financial risk was worth it. They started to produce large quantities of penicillin by 1941, and in 1942 the U.S. government offered funding to increase the production of penicillin even more.

Pfizer worked with the government to help many other drug companies set up facilities to manufacture the new wonder drug. None of the other companies, however, was able to meet the quality of Pfizer's product. Pfizer produced 90% of all of the penicillin used early on by the Allies, and continued to create a substantial percentage of the available drug supply thereafter.

SULFA POWDER

German scientist Gerhard Johannes Paul Domagk was researching antibacterial chemicals in the early 1930s when he discovered the most effective antibiotic used in World War II. He was working with the dye Prontosil, and found that in altered form it could effectively fight streptococcal infection in lab mice. His daughter had a similar infection at the same time: he tested the altered dye on her, and she made a full recovery.

Further research into his findings isolated the active agent *in the modified* dye. This agent was sulfanilamide, and it was first produced in 1936. It demonstrated its effectiveness during a meningitis outbreak in the French Foreign Legion in Nigeria, keeping the mortality rate to 11% until supplies ran out. Once supply of the drug was exhausted, the mortality rate subsequently increased to over 75%. The drug was found to be effective in treating pneumonia, meningitis and other bacterial diseases.

Sulfanilamide was used extensively throughout the war in the form of sulfa powder. The powder was sprinkled on wounds, preventing infection. Further research led to other sulfonamide drugs, and a total of four drugs in the sulfonamide family were discovered later during the conflict. These drugs helped to save many lives.

Drugs and Toxins

Name	Potency	Effects	Onset Time
Benzadrine	8	Stimulant/Analgesic	12 rounds (1 minute)
Adrenalazine	9	Stimulant/Analgesic	12 rounds (1 minute)
Yotoku/Banzai	10	Stimulant/Analgesic	6 rounds (30 seconds)
Opiates, injected (Morphine, Heroin)	10	Sed./Euph./Analgesic	1 round (5 seconds)
Opium, smoked/eaten	8	Sedative/Euphoric/Analgesic	5 minutes
Snuff	7	Euphoric/Stimulant	2 rounds (10 seconds)
Cocaine	12	Stimulant	2 rounds (10 seconds)
Chemical Agent	20	Fatal	6 rounds (30 seconds)
Peyote	6	Hallucinogen	15 minutes

COMBAT DRUGS

Improving soldier effectiveness is a constant goal of any nation preparing for war. The second of the World Wars saw the use and spread of a number of drugs intended to enhance the combat efficiency of individual troops. These drugs ran the gamut from stimulants like Benzedrine to the Japanese *Strength of Virtuous Spirit*, commonly referred to as "Banzai" by their Allied opponents. Combat drug users are variously referred to as berserkers, Supermen (*ubermenschen*) and kamikazes, depending on nationality.

Most combat drugs cause an increase in stamina and aggressiveness, although no one has yet been able to increase a trooper's learned skills with drugs. Disadvantages to these enhancements include increased fatigue (and in the case of some drugs, actual damage to the individual), an increased aggressiveness frequently crossing over into uncontrollable homicidal rages, and addictions to the drugs resulting in not only a black market for supply but increasingly violent encounters related to acquiring the drugs. See page 136 of **Gear Krieg: the Roleplaying Game** for more details.

DARK DAYS OF AXIS SCIENCE

Science has always been, in its purest form, an amoral discipline. It creates tools for the use of humankind, with no regard for the potential destructive or healing potential inherent in the concepts its servants explore. The scientific method was created to discover and prove new scientific theories, unlocking the laws of nature and unfurling them for consideration by the knowledgeable elite. Very little touched by human beings can remain in that amorphous amoral state for any length of time, however. As a result, the practice of scientific discovery is tied hand in hand with the ethics of human behavior. Scientists do try to work towards the benefit of all, and work with methods that do not harm other humans. There have always been, however, those scientists who pursue the fruition of their theories at all costs, including that of human lives.

In the entire course of human history, no seekers of knowledge were so callous towards the lives and mental stability of their fellow humans than the scientists of the Nazi regime. They had worked for years to convince themselves that certain classes of people — based on physical characteristics, race/religion, genetic twists of fate and behavioral patterns — were sub-human, and therefore perfect for experimentation just like any other animal. The acts they performed were almost indescribable in their villainy. They used human test subjects for poison research, euthanasia programs and far worse.

Their allies, the Imperial Japanese, were almost as bad — and perhaps worse in some respects. They regarded any persons of other Asian descent to be mere imitations of the true Japanese people; they viewed most occidentals with the same scorn, at least those who were part of the Allied nations. They used Chinese and other Asian mainland peoples for their research into reanimating the bodies of the dead. They didn't torture people in the name of science to same extent as their German allies, but they were more willing to torture purely for torture's sake. To further their scientific knowledge, they would turn to the Germans on a number of occasions.

The Axis took the promise of superscience and bent it to their evil desires in order to uncover the secrets of human biology. While their opponents grudgingly accepted the ingenuity of the Axis technical prowess used to create weapons of war, they could only gape in horror at the depths of inhumanity into which the Axis plunged in the name of science — once those secret depths were revealed, of course...

Heinrich Himmler

Heinrich Himmler was one of Hitler's most trusted men. He was appointed the ReichsFührer of the feared SS in 1929, and quickly expanded the role of Hitler's bodyguards in both size and function. By the time World War II was raging, the SS was a fighting force rivaling the Army in numbers and capability. Himmler was also personally chosen by Hitler to oversee the implementation of the concentration camps, as well as the VorfahrRückgewinnung Projekt. His involvement with the Ahnenerbe and his steadfast loyalty to the Führer made him a perfect choice for those tasks. He was devoted to the purification of the Reich through any means necessary.

Dr. Josef Mengeles

Dr. Josef Mengeles, a protégé of Professor von Verschuer, was the head researcher for genetic research with the Reich. He was a member of the SS, working under scientific grants offered through the Volksgesundheite und Wohlfahrt Programme. He worked primarily in the camp at Auschwitz, using subjects shipped there as his research subjects. He was particularly interested in the genetics of twins, but he also showed interest in cripples, dwarves, and other so-called "misfits of society."

He showed absolutely no compassion for his victims, performing what any civilized person would describe as evil acts of cruelty on human beings in the name of scientific advancement. His research was used to advance the goals of the VorfahrRückgewinnung Projekt, adding genetic tampering to the already extensive breeding practices in place. His findings were used in the first clumsy attempts at genetic engineering in Neuschwabenland.

The Allies had no idea of the full extent of his cruelty until much later in the war. What they found then horrified them to no end, only to discover that greater horrors of genetic research awaited them. Many died by his blood-soaked hands in the name of perverted science.

VOLKSGESUNDHEITE UND WOHLFAHRT PROGRAMME

The Volksgesundheite und Wohlfahrt Programme (VWP), or the People's Health and Welfare Program, was started in 1932 as part of Hitler's wish to help elevate the people of Germany. Dr. Paul Goebbels, Hitler's media mastermind, oversaw the popularization of the program. People were encouraged to participate in Germany's greatest health program. Sickness would soon be a thing of the past!

The program sponsored an extensive medical census of Germany between 1932 and 1938. Every citizen was asked to report for medical examinations. They dutifully came in droves, anxious to benefit from the state's good will. Nationwide campaigns for vaccinations were instituted with much fanfare. Blood samples were collected from every citizen. Every German was happy to help the Fatherland become a shining beacon of health to the world. The VWP also sponsored many social programs. The state took over full control of the orphanages in Germany. They educated, fed and provided medical care for the unfortunate children. The VWP offered grants to promising students of human genetics and medicine. Numerous youth athletic programs sprang up. All children enjoyed physical activity and teamwork playing community sports.

As the Nazi party became more entrenched in the mid-1930s, the VWP started to take on darker undertones. People began to disappear mysteriously. The Reich insisted the disappearances were routine emigration, and Nazi propaganda insisted that those people had simply decided that they must leave Germany for the good of all. Anti-Semitism also started to rear its ugly head, along with sentiments against other 'unworthy peoples.' Data collected during the medical census was used to start the deportation and concentration of "undesirable" elements.

The new directions of the VWP were skillfully presented to the masses by Goebbels. He used posters, movies, music, art and more to promote the benefits of the program. He eased Germany into a stunned complacence; once the full extent of what Hitler had planned for Germany was realized, its citizens were already fully in accordance with the ideas presented by their charismatic leadership. The deeds of the Nazi party were for the good of all of Germany, or so said the proponents of the VWP.

VORFAHRRÜCKGEWINNUNG PROJEKT

The VorfahrRückgewinnung Projekt (VRP), or Ancestral Reclamation Project, was the most secret project within the Third Reich. It was the true program for with the Volksgesundheite und Wohlfahrt Programme was but a cover. The VRP was Hitler's plan to genetically engineer the perfect Aryan race, to ensure the perpetuation of the "Thousand Year Reich." The VRP in its entirety was known only to a select few: the Führer and Himmler were the chief architects of the project. They wanted to select the most promising specimens of the Aryan ideal and encourage them to produce offspring with each other. The new generation would marry other perfect specimens, and eventually the families within the project would combine to produce the epitome of human perfection — a perfection defined, of course, by Hitler and his cronies.

Hitler and Himmler had read and admired the work of German philosopher scientists from the 20s and 30s. They found a kindred soul in the form of Otmar

von Verschuer: his writings spoke of German purity and how it might be achieved. He was an enthusiastic convert to the plans of Himmler and Hitler, and helped them map out the methodology for breeding a line of pure-blooded Aryans. Himmler was quick to point out that the VRP had to remain an absolute secret for at least the first twenty to thirty years. He knew that any tampering with the project before its first fruits had come into being would doom the entire endeavor to failure.

Von Verscheur provided the answers that Hitler needed. The VRP would be hidden behind a program to promote the health of all Germany. The Volksgesundheite und Wohlfahrt Programme was born. Using its medical and social initiatives, the VWP would allow the VRP to screen for promising genetic candidates. Medical examinations and blood samples were taken from everyone within the nation's borders, the unwitting subjects willingly participating in the collection process. Scientists, guided by von Verscheur, were able to examine the collected data, determining who the shapers of a new Germany would be.

Young married couples who qualified were encouraged to have children. Some couples were even told why they should have children, provided they were of sufficient status within the Nazi party and were deemed politically reliable. Other parents were told that their child had died shortly after birth; those children were taken in as wards of the state, trained and indoctrinated from birth to be active members of the master race that Hitler craved. Orphans were more easily folded into the program, and qualifying orphans were adopted by scientists posing as parents and schooled together with the children from known Aryan parents.

The children were carefully chosen. They had to be from a wide enough cross-section of the Aryan ideal to ensure a diverse breeding pool for future generations, as otherwise problems with inbreeding would unravel the carefully planned program. It took the VRP architects several years to achieve an adequate pool of first generation candidates, but by 1936 they felt they had succeeded in the crucial first step. Their candidates ranged in age from about four to ten years old, with more being born and weaned.

All of the children attended special schools. Their education was extremely rigorous, both mentally and physically. They learned the academic basics as well as politics, sociology, biology, ideology and any other pursuit that could be twisted to emphasize the glory of the Aryan race. Physical activity was encouraged, starting with sports early on and gradually moving towards more martial activities. At graduation, they were tested for certain aptitudes; from then on, they trained in the field in which they displayed the most developed talent. Some started training in military sciences, some in pure sciences and others in mechanical sciences. The young ladies of this generation were encouraged to marry at a young age — they were considered ready from the age of eighteen onwards — and bear the children of the next generation.

The first of the new breed graduated from the program in 1943. They are still unproven as the ubermenschen they were designed to be. The scientists involved in the program have been tasked with furthering the project, which has started to investigate the possibilities of direct genetic manipulation to improve the next generation of the master race. They are stumbling blind in this strange new field of science; however, they are very methodical and ready to deal with the failures of their uneducated tampering. Those products of the program with mechanical and engineering skills were placed in various wartime-critical businesses, tasked with designing the next wave of superscience weapons that would bring the glory of the Reich to the rest of the world. Military trainees were sent to become the next crop of leaders within the Hitler Youth, and from there went on to fight with the SS.

The VRP program accounts for nearly five percent of the German population under the age of twenty. Care has been taken to collect the seed of the first generation males to ensure that the females may be inseminated in the most effective combinations. One side effect of this practice of artificial insemination is to allow for preservation of genetic stock even if the military hopefuls are killed in service to the Fatherland. The next stages of the VERP call for wide-spread genetic tampering with the samples.

Professor Otmar von Verschuer

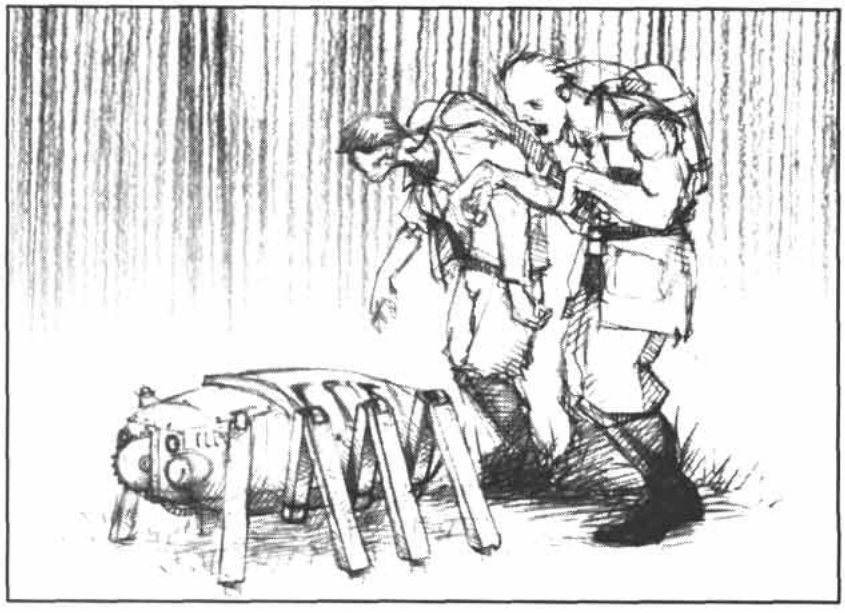
Otmar von Varschuer wrote many articles and books on the purification of the German people in the late 1920s and early 1930s. His theories were the genesis of one the most secretive and extensive programs the Third Reich ever undertook — the VorfahrRückgewinnung Projekt. He was involved with the ambitious program from the very beginnings, after being personally recruited by Himmler and Hitler (both doting fans of his writings). He created the original blueprints for breeding the perfect Aryan citizens, and later would be the first proponent of genetic manipulation to further the VRP's goals.

HITLER YOUTH

In 1925, the Hitler Youth was created to help spread the ideals of Nazism to the young boys and girls of Germany. The organization promoted Hitler and his beliefs to the young recruits, and those reaching the age of 18 became full members of the Nazi Party. By 1929, the Hitler Youth numbered 13,000 and was the only official youth group of the Nazi Party. Once Hitler took power in 1932, the group proved to be highly valuable. The Hitler Youth enthusiastically took charge of the new athletic programs of the VWP, and they were able to recruit many new members into their ranks from the other existing programs.

At this time, the organization is stratified from one large groups into several subgroups. There are now three separate programs under the same organizational umbrella, for boys ages 6 to 10, 10 to 14, and finally from 15 to 18; organizations for young girls were also created. Ironically, the purging of Jews from Germany as well as the recruiting of the remaining cream of the intellectuals for the VRP left the educational system of the Hitler Youth in tatters, and their promise have faded. Even so, as the young men become full adults they are taken into positions of power in the Gestapo, the SS and other organizations.

The Hitler Youth is used increasingly to help provide bodies for the Wehrmacht. They begin as assistants to defensive troops and help man flak cannons. By 1943, the numbers of boys from ages 15 to 18 are brimming. Hitler answered their pleas by forming the 12th SS-Panzer Division Hitlerjugend. By this time, the fruits of the VRP are beginning to ripen and they start showing up in the Hitlerjugend ranks as well. The VRP boys assumed a disproportionate number of the leadership positions, but they are proving to be capable leaders.



CHEMICAL AND BIOLOGICAL WARFARE

The Great War introduced the world to the most horrible form of warfare yet known. Although incidents of chemical or disease warfare had been documented as far back as five centuries before the common era, never had chemicals been employed on such a scale in mass warfare. Also included in this escalation was the development of flame weapons, particularly the portable flamethrower, and the large-scale use of battlefield smoke.

The eighteenth and nineteenth centuries saw renewed interest in the use of chemicals in warfare, concurrent with the development of European chemical industries. Fortunately, the intense ethical arguments on the topic precluded their use. Discussed as early as 1812, chemicals were considered for use in almost all the major conflicts of the later nineteenth century, including the Crimean War, the American Civil War and the Franco-Prussian War. An initial prohibition against using poisons in war was included in the 1874 Brussels Convention. The 1925 Geneva Convention only implied a prohibition on the first use of chemicals, but did not limit their possession and preserved the right to retaliate in-kind for a chemical attack.

Initially, the Great War saw the use of industrial chemicals, such as chlorine and phosgene, as relatively simple releases of clouds of chemicals from pressurized cylinders. The technology rapidly progressed to chemical compounds specifically developed or selected for their efficiency at killing or crippling those unfortunate enough to be caught in the burst. Soon artillery shells and bombs were fielded, allowing the projection of the chemical clouds away from friendly lines and providing some independence from wind effects on usage decisions. Defensive technology progressed just as rapidly, resulting in gas masks and chemical detectors recognizably similar to their descendants, if heavier and less capable.

CURRENT ERA

Most nations with chemical warfare programs focused on mustard agents as the most useful of battlefield chemicals and concentrated on refining and perfecting both their offensive and defensive capabilities. Italy provided the next example for the study of chemical warfare in the field when it employed mustard gas against unprepared and unprotected Ethiopian forces to devastating effect in the mid-1930s. Although the Japanese also used mustard gases in China in 1939, by then world attention was focusing back on events in Europe. During this period, the first mechanical collective protection systems were fielded providing overpressure environments to fortifications and other fixed installations. Advances continued in other areas of chemical defense as well, resulting in improved masks, detectors and, for the first time, decontaminating solutions and kits being made available for the next war. Unfortunately, German chemists, some of the best-regarded in the world at the time, also discovered nerve gasses in time to offer a potentially dire shock to other countries' chemical defense preparations.

Although the United States had no formal biological warfare program, relegating what study was done to the Army Medical Department's studies of diseases, many nations — including Germany, France, Britain and Canada — had active biological warfare programs, and Japan had perhaps the most notable of them all. Establishing a formal biological weapons program near the occupied town of Harbin in Manchuria, Unit 731 became one of the most infamous organizations the world has ever known, eclipsed only by the mass produced evil of the Nazi's Final Solution. Unconstrained by any recognizable human decency or morality, both the Nazis and the Japanese conducted extensive tests on human "subjects" immeasurably advancing their understanding of biological warfare and processes at a horrendous cost in human lives. Their results were often unanticipated, bizarre and horrible, such as the homicidal Nazi *ubermenschen* berserkers and both countries' zombie troops. Luckily for the world, biological warfare was still in its infancy, and most programs were researching the basic concepts and principles of fighting with organisms rather than engaging in the large-scale production and use of potentially world-shatteringly uncontrollable weapons.

THE JAPANESE "UNITS"

Unit 516 was built in Qiqihar, China as Japan's chemical warfare research production facility. It was established once the Japanese has invaded and taken over Manchuria in 1931. It was tasked with testing and producing a new generations of chemical agents, and was intended to replace Japan's first chemical production plant on Ohkumo Island. The Japanese used chemical munitions extensively during their takeover of mainland Asia, and hoped to use more effective agents in their planned invasion of Australia. They were unsuccessful in creating nastier agents before the invasion, but they did produce most of the munitions used in that action.

In 1932, the Japanese founded two new secret research bases near Harbin, China – Unit 713 and Unit 100 — to research biological weaponry. They worked with bubonic plague, anthrax, typhoid, cholera, syphilis and many other pathogens. In pursuit of plague bombs, the scientists at these two centers performed ghastly experiments on Chinese civilians. The subjects were exposed to pathogens with no regard for their life, and then vivisected while still alive to collect data. Other experiments to test the limits of human physiology were performed, all of them fatal to the unfortunate prisoners chosen as test subjects. Only the Germans' experimentation in their concentration camps were equal in brutality.

A byproduct of the biological research at Unit 731 and Unit 100 was the discovery of a pathogen that would produce a catatonic state in test subjects while leaving them open to commands and capable of performing mechanical actions under those commands. The Japanese quickly acted to conduct research on the effects of this unique pathogen, quickly dubbed the 'zombie' drug. The two facilities were reorganized, and Unit 100 became the center for zombie research in 1940. Unit 713 continued to research deadly biological weapons. Once the Japanese forces were in open warfare with Allied forces, the POWs the Japanese captured were used in increasing numbers in the experiments at Unit 100. This practice would change the entire tenor of the war in the Pacific, especially after the Japanese made liberal use of Zombie forces on the Australian front.

CHEMICAL TROOPERS

Perhaps the most horrifying opponents yet encountered on the battlefield are the Axis' chemical troopers. Whether Allied POWs infected with the infamous "Jungle Rot" by their Japanese captors or German concentration camp prisoners whose minds have been chemically destroyed, these walking atrocities prove challenging to neutralize, although their overall effectiveness is questionable. It is unknown to the Allies if the "zombie" process was discovered as the result of early combat drug experiments or through some natural pro-

cess, but they have proved some of the toughest "soldiers" fielded (or at least "directed" after a fashion) by the enemy. Rumors persist that zombies are almost as dangerous to their handlers as to the enemy, and that anyone wounded by a zombie is susceptible to the "disease" and may become one. Evidence collected in the field proves that zombies are not animated corpses, but most troops have no intention of confirming this for themselves.

• GERMAN ZOMBIES

Scientists performing gruesome experiments on concentration camp prisoners discovered a potentially useful side effect of failed combat drug tests. They found that certain chemical compounds, while ineffective at enhancing soldier performance, induced an odd mental state in research subjects. Subjects became aggressive, physically attacking anyone approaching them, as well as mentally arrested. They could be prodded to go a particular direction, attacking anyone in their path. Further testing indicated that the subjects were extremely resilient to pain, regularly ignored extreme physical damage and could continue their slow rampage well after normal men would be killed.

The clever Germans devised a small electronic device that would be worn like a backpack. Worn by a zombie, the pack would dispense doses of the zombie chemical agents at regular intervals. It kept the unfortunate wearer in the zombie state for long periods of time, longer than any expected combat. The Germans used it primarily on members of the 'sub races' they had rounded up, but they also used the process on some of their own troops as well as failed products of their eugenics programs.

• JAPANESE ZOMBIES

Unit 100, originally created to research general biological warfare, was converted over to exclusive study and perfection of the zombie process. Chinese prisoners were first infected with the biological agents in what the Japanese termed the *koumajutsu*, or demon invocation process. The drugs converted the victim into a cruel reflection of their former self. They became gnarled, aggressive and mentally stunted. Although the process was somewhat different, the end result was very similar to the German versions. The conversion process took much longer than the German process, but was permanent. There was no known cure for the biological agents used. Eventually, over the course of a few months, zombies would be consumed from within and die.

The Japanese would use their new discovery to horrifying effect. They used the process on thousands of Chinese and other mainland Asian peoples to create zombie fighting units. As hostilities with the Allies intensified, the Japanese started to use Allied POWs for zombie production as well. The effect was highly demoralizing, as Allied soldiers on patrol would be attacked out of the blue by mindless behemoths clad in the Allies' own uniforms! The 'zombie' troops were relentless killers, destroying any living thing in their path. They could only be stopped by being killed; no amount of reasoning could deter their approach or return their minds. Zombies were also used extensively in the invasion of Australia, providing helpful first wave 'human' walls to take fire and protect the Japanese forces landing behind them.

Zombie Stats

The process for creating a zombie are different for German and Japanese experiments, although the end results tend to be very similar. German zombies are created almost instantaneously, through injections of a chemical drug. The victim is transformed within minutes to their zombie state. The drugs defy the normal Drug and Toxin rules. They are so potent that successful use is guaranteed, and the Germans have carefully researched the dosages required to induce the effect. As a result, fatality from the drug is almost unheard of. Characters injected with the drug will become zombies within 5-10 minutes. Luckily though, once the drug is flushed from the victim's system, they will return to normal. The effects of a single dose of the drug lasts for approximately 1-2 hours.

Japanese zombies take longer to produce, but the biological agents used in creating them are far more resilient and damaging. Treat the Japanese process like a disease. The biological agent used has a Contagiousness rating of 20, an Onset time of two weeks and a Virulence of 20. Victims must make a Health test against the Contagiousness rating. Any margin of Failure means the agent takes effect, with the same modifications to the Onset time that drug potency rolls have. The agent then slowly eats the victims from within. After the onset time has expired, the victim makes a Health test against the Virulence rating. The agent causes death in the victim a number of weeks later equal to the Virulence minus the Margin of Failure of this roll. Fumbled rolls mean immediate death. There is currently no cure, though advanced medical procedures may delay the progression of the degeneration.

Zombies from both countries have the following attribute modifications: AGI -2, APP -2, CRE -2, FIT +2, PER -2, PSY -3, WIL +3, STR +2, HEA +2, STA +15, UD +3. All Skills receive a -2 to their levels, with a minimum level of 0.

ARTIFICIAL LIMBS & ORGANS

Development in artificial limb technology is an unfortunate result of the war and its associated casualties. Basic limbs are easily installed and allow the user to regain at least some of the functions lost to injuries. More recently, superscience limbs and organs that are implanted on and in the human body have started to appear in the more advanced hospitals, mostly as a result of inhuman experiments by Axis researchers. Allies laboratories are progressing as well but much more slowly, though their own inventions tend to be less traumatic and more reliable than their dark counterparts. Artificial limbs are immediately identified as such upon inspection, but can pass unnoticed under casual scrutiny, especially if the person is wearing clothes. Implants not designed to pass as human limbs (chrome-plated, exposed mechanisms, etc.) generally cost less than fully concealed ones and can be much more powerful. Arm and leg replacements are often roomy enough to conceal some small items such as a watch, miniature radio set or even weaponry. Power augmentations and built-in weaponry are possible as well but they are usually strictly forbidden by both law and ethics.

Arms and legs are probably the most common prosthetic replacement. Some limbs can even be designed to augment the physical performance of the wearer, though the body remains limited by its natural muscles and skeletal structure. With the most recent developments in televisor technology, eyes can be replaced and even augmented in many ways, such as an automatic shutoff to protect against blinding flashes of light. Even hearing can be salvaged with the help of a miniaturized sound processor attached to the side of the head — some even include a small short range radio set.

Other, more specialized replacements have been observed in Axis agents and veteran soldiers. The powerframe is one of these; it was first developed for people suffering from crippling back injuries. It consists of a hydraulically-enhanced spinal cord, reinforced vertebrae and back motors. Because of their bulk, powerframes cannot be hidden. Other implants include flesh pockets and skin armor. Flesh pockets are supple, sealable containment units hidden within a person's flesh to conceal items. Skin armor is the ultimate in personal protection: a fine layer of ballistic fiber attached to the wearer's skin.

BASIC FACTS

Many people are uncomfortable when around a person with visible artificial limbs, especially if they are grotesque-looking (apparent hydraulics, tubes, etc.). Limbs that can pass close visual investigation are possible, using flesh-like plastic; they cost ten times what the ordinary ones cost. A visual Notice check versus a Threshold of 6 is required to realize they are artificial when uncovered, unless one can touch them directly (the rubbery texture of the plastic flesh is a dead giveaway).

Maintenance is of the utmost importance for implanted artificial limbs, since they do not benefit from the body's natural healing capacity. They must be checked regularly for battery charges and fractures, and the stump must be carefully monitored to make sure that no trauma occurs. Once a year, the wearer must make a Health roll versus a Threshold of 3 (5 if not in a medical environment, +1 per check missed). If failed, a minor complication develops (roll randomly which prosthesis is affected): the item performs at -1 for all tasks until a medic looks at it. If the test is fumbled, a Flesh wound is immediately applied (infection or some such).

Crude limbs do not require any power source and will last indefinitely (although you do have to tighten the springs and screws once in a while). All other items are powered by one or more small batteries. Arms, eyes and ears require one battery to function. Legs and powerframes require two batteries each. Flesh Pockets and skin armor do not use any energy and thus do not require a power source. Batteries can be recharged by practically any energy source — it is easy to jury-rig an adapter, given time and a few pieces of assorted hardware (Tinker or Electronic Skill,

Threshold 3). Each battery lasts half a week, except for Basic limbs: because of their low energy requirement, their batteries last up to a full week. Past this time, a discrete indicator warns the wearer that the battery must be replaced as soon as possible. The battery will last for one more hour, after which the limb(s) will be at function with a -1 penalty. Additional hours will augment the penalty by one. Once the penalty reaches -5, the limb will become useless.

Each arm is considered to have free internal space equal to a small Flesh Pocket (see further), while the roomier leg has internal space equal to a large Flesh Pocket. Items (such as guns or radios) can be built directly into the prosthetic for twice their normal price (quadruple if the item is concealed). Alternatively, the space can be designed to be used as a standard flesh pocket.

ARMS

Arms are probably the most common limb replacement available. **Crude arms** are basic replacements, such as hooks or spikes, and impose a -3 penalty on all arm-related functions and Skill checks. **Basic arms** are a little better and often include very limited manipulation abilities (an articulated claw, for example); they impose a penalty of -2. Neither type can pass as a normal human limb (although Basic arms often go unnoticed underneath clothes), and must use specially adapted tools. A Crude or Basic arm is considered destroyed if it receives two Flesh wounds. A Deep wound counts as two Flesh wounds.

Prosthetic arms replicate many all movements of a normal arm and hand. They are limited in their fine motor control (-1 penalty). The limb is considered deactivated if it receives two Flesh wounds, and destroyed after three. A Deep wound counts as two Flesh wounds.

Power arms give a +1 bonus to AD and UD when specifically using the artificial arm. A pair of Advanced replacement arms gives the wearer a +1 to FIT; note that any increase in strength due to the FIT increase cancels the aforementioned damage bonus. Advanced arms have 15 points of armor; furthermore, any wound done specifically to an arm is considered a Flesh wound at worst. The arm is considered deactivated after two consecutive, targeted Flesh wounds, and destroyed after three. They cannot be hidden, are quite bulky and noisy and need recharging and repairs twice as often.

LEGS

Crude leg replacements are simple pegs and crutches and impose a -3 penalty on all movement-related functions and Skill checks. Jumping and jogging (or any faster movement) are impossible. **Basic legs** are somewhat more useful: they impose a penalty of -2 on all movement-related tests, but do permit painful jogging. Neither type can pass as a normal human limb, but Basic legs can go unnoticed underneath clothes. A Crude or Basic leg is considered destroyed if it receives three Flesh wounds. A Deep wound counts as two Flesh wounds for these types of legs.

Prosthetic legs simply replace a character's normal legs. These are limited in their fine motor control (-1 penalty to Skills only). A character can have just one artificial leg without any balance problem The limb is considered deactivated if it receives three Flesh wounds, and destroyed after four. Like the cruder leg models, one Deep wound counts as two Flesh wounds.

Power legs are only useful when used in pairs and give the wearer a +1 bonus to FIT; this bonus is added to that received from Advanced artificial arms only if the wearer also has a powerframe (see further). Whether the wearer receives the FIT bonus or not, he adds an additional 5 meters/round to his Sprinting speed. This is added to the other speed bonuses due to FIT increase. Advanced legs have 20 points of armor and take targeted damage like Advanced arms, but is deactivated after three Flesh wounds and destroyed after four. They cannot be hidden, are quite bulky and noisy and need recharging and repairs twice as often.

SENSORY ORGANS

Artificial eyes are bulky and cannot be concealed. Part of the hardware is mounted on an exterior plate; Appearance automatically suffers a -1 modifier. Fully artificial eyes include automatic shutoff to protect against blinding flashes of light but provide only crude vision (-2 to tests using the eye). A number of options are available for them, generally in the form of external add-ons. Telephoto lens add extra resolving power at the cost of a narrower field of vision. The character can see further than anyone else (as if looking through a x10 telescope) and gets a +1 bonus for all range attacks in which he takes at least one turn to aim (this may bring the total modifier above the usual maximum aiming modifier). Infrared modules enable the wearer to see into the infrared spectrum and detect sources of heat in complete darkness.

Artificial ears include an automatic cut-off system that immediately blocks the wearer's hearing when he is subjected to a sudden, very loud noise. Like eyes, the hardware is mostly external and lo-

cated on a plate attached to the side of the head. Radio Reception modules allow the user to receive short range radio broadcasts directly into the inner ear. They have a range of around 500 meters, depending on the emitter's power. High Sensitivity circuits, a somewhat uncommon module, give a +1 bonus to PER, but only for hearing tests; the external pickup looks like mechanical bat ears.

OTHER ITEMS

A powerframe is a set of external metal braces and plates to which actuators and motors are attached. The braces are connected to a series of pins set in the skeleton, making the frame a part of the wearer's body. It gives a +1 bonus to both FIT and BLD, though the FIT bonus is not added to those provided by any limb replacements (if present). The powerframe does, however, allow FIT bonuses from arms and legs to be cumulative. It gives the wearer 15 points of personal armor against rear attacks. Powerframes cannot be hidden and cause an automatic -1 to Appearance.

Flesh Pockets are supple, sealable containment units hidden within a person's flesh. Mini pockets can hold a volume of up to 8 cubic centimeters and can only be detected with a Notice skill roll against a Threshold of 5 (7 if the pocket is empty). Small flesh pockets can hold up to 250 cubic centimeters, enough to hide a small handgun, and can only be detected with a Notice roll against a Threshold of 4 (6 if the pocket is empty). Small and Mini pockets can be implanted anywhere except the head.

Skin armor is a layer of fine ballistic fiber that absorbs damage. This adds 5 to 10 points of armor to the body, depending on the selected grade. It has little or no effect on the wearer's movement, but is readily apparent, resembling reptilian scales (-2 to Appearance). It is as complicated to insert and repair, requiring four weeks in a specialized surgical center. Skin armor does not grow or shrink with the body, nor does it repair itself. If a character with skin armor is wounded or gains or loses weight, he will lose two points of Armor per Flesh wound (or per point of Build changed) and four points of Armor per Deep wound (in addition to the wound's effect). These lost Armor points will impair the healing process (double the healing time) and must be repaired by a qualified medic (Skill level 3+). Repairing one point of Armor costs 10% of the skin armor's original cost and takes one complete week at a properly equipped surgical center.

Artificial Limbs and Organs

Item	Mass	Cost	CP Cost	Recovery
Arm, Crude	7%	200	-4	1 days
Arm, Basic	9%	1500	-2	3 days
Arm, Prosthetic	12%	15,000*	0	7 days
Arm, Power	15%	30,000*	5	14 days
Leg, Crude	10%	300	-5	1 days
Leg, Basic	12%	1800	-3	4 days
Leg, Prosthetic	15%	18,000*	0	14 days
Leg, Power	20%	35,000*	7	21 days
Eye	0.3	15,000*	3	3 days
Eye, Telephoto	0.3	35,000*	8	4 days
Eye, Infrared	0.3	60,000*	7	4 days
Ear, Volume Control	0.2	11,000*	3	3 days
Ear, Radio Reception	0.2	40,000*	4	2 days
Ear, High Sensitivity	0.2	40,000*	5	3 days
Powerframe	10%	100,000*	16	30 days
Flesh Pocket, mini	0.01	1500*	1	1 day
Flesh Pocket, small	0.02	2000*	3	1 day
Skin Armor 5	5%	100,000*	6	4 days
Skin Armor 10	8%	250,000*	10	7 days
Battery (small)	0.3	100	n/a	n/a
Battery (large)	0.5	250	n/a	n/a

MASS *is the item's mass in kilograms. Mass of items marked in percentage varies according to the person's mass (percentage of BLD equivalent in kilograms).*

COST *is the item's cost in dollars. This is given for reference only for items marked *, which are available solely through governments and specialized labs.*

CP COST *gives the cost in Character Points for items added during character generation. Negative values give back CPs.*

RECOVERY *lists the usual hospitalized recovery time for the operations required to fit and install limbs (in days). A period of time equal to three times the recovery time is also needed for readaptation.*

Chapter Six: Paranormal Sciences

Science is a relatively young discipline compared to the study and practice of the supernatural. Long before the scientific method of proving Nature's laws was developed, people looked to magic, ESP and miracles to explain the world around them. While science has answered many questions people have had about how the universe works, it has not answered every question. Not that people have not tried to scientifically pursue the remaining unexplained phenomena. No one has found irrefutable proof of paranomal phenomena, but no has found proof that these phenomena do not exist, either...

MYSTICISM AND THE THIRD REICH

Two questions that are rarely asked due to the chaos that has been spread across the face of the world are 'why' and 'how.' Why and how did the Nazis take over so quickly and so easily, and turn a ruined nation into an industrial and military juggernaut? The answer will elude historians for decades to come.

The truth of it lies far back in the history of the land now known as Germany. The ethnic German people have not had a unified state since the dissolution of the Holy Roman Empire in 1806, when Francis II renounced his title. There had been attempts in 1815, after the defeat of Napoleon, and again in a series of revolutions in 1848, but both had produced limited results. It seemed the rest of Europe was not thrilled with the idea of a united Germany. At the same time, pastoral Germany, the rural setting that had always been promoted as the ideal by which the German people should live their lives, was being steadily destroyed by the rapid onslaught of industrialization and urbanization. German nationalists and purists were left frustrated, and in that frustration they sought answers.

SECRET SOCIETIES

In response to these events, many Germans strove to find a way to restore cultural, if not political, unity. An ideal was promoted, of an ancient utopic society that represented all that was noble and strong about ethnic Germans. The late 19th century was rife with secret societies and cults of all shapes and sizes, and the German provinces were no exception. Societies like the Ariosophists were formed as a reaction to a variety of factors common in that period of European history such as nationalism, cultural pessimism, Social Darwinism and racism. Such groups preached that the Germans had descended from a civilization that was pure racially and spiritually. An evil conspiracy of the non-Aryan races, they claimed, caused the downfall of this society by promoting egalitarianism with obviously inferior people. Their goals were to rediscover the ancient secrets that these god-like beings possessed and restore the German peoples to their rightful place as masters of a new Pangermanic Empire.

Occultism, grand conspiracies and mysticism were used by these groups to cloak their philosophy in an almost religious facade, and to provide it with an air of legitimacy in the face of concepts which average citizens might find suspect at best. In the case of the development of the Third Reich, some of these tenets proved to be frighteningly real. Figures like Hitler and Himmler were part of some of these organizations, like the ancient Thule Society. As they gained in power and influence, these societies prospered. It was a reciprocal relationship. Rumors abounded that the German elite was in contact with "ancient masters of the East," perhaps the last remnants of the Aryan civilization that had preserved itself with the coming of this new Reich in mind. This and other factors, such as the formation of the Ahnenerbe, convinced many inside Germany that the ideas presented in the late 1800's might not be that far from the truth. It was enough to sway the German people, for the most part, into following their new Fuhrer, and believing in the dreams and ideas presented by the Nazi Party. As the German nation arose like a phoenix from the embattled Weimar Republic and prosperity spread across all of Germany, even some people outside of Germany worriedly wondered, as well, if there was some truth to the mysticism of the Reich.

THE AHNENERBE

The Society for Research into the Spiritual Roots of Germany's Ancestral Heritage (Studiengesellschaft fur Geistesurgeschichte Deutsches Ahnenerbe) was founded in Berlin in July of 1935. One of its principle founders was Heinrich Himmler. Shortly after its founding, though, the leadership of the Ahnenerbe was given to Walther Wust. The society originally concerned itself with more pseudo-scientific pursuits, focusing on subjects that revolved around ancient myths and legends. Small expeditions were sent to various parts of the Middle East and Far East with a wide variety of missions. These groups were mostly concerned with information gathering, but they did come into conflict with some members of foreign intelligence agencies. At the time, the Russians, Americans, French and British were all very interested in where these German archeologists were working. It also was of consequence that some of the areas the interested Ahnenerbe went were controlled by these powers.

This early work consisted of researching ancient texts, meeting with locals, and searching and conducting digs on the sites of ancient civilizations in Persia, Egypt, China, Mongolia and India. Their sworn purpose was to find the origins of Aryan civilization. In the late 1930's and early 1940's, their missions became more aggressive. Agents were trained in espionage and counterintelli-

gence, mostly to combat the continued presence of foreign operatives competing with them for these ancient resources. There were studies of Indian medicines in South America, as well as an expedition dedicated to finding the lost continent of Atlantis. There was also an attempt to coordinate with Japanese agents operating in the Far East, especially given that Japan was engaged in combat operations in China. In that area of operations, it was almost an obsession among field agents to uncover any clues to the locations of alleged secret cities. To this end, they tapped the Buddhist spiritualists and lamas of Tibet, even sending a special detachment in 1939 to set up a vital radio link between an isolated group of lamas and Berlin.

A second branch of the Ahnenerbe was concerned with medical experimentation. Their goal was still discovering and probing the Aryan ideal and its differences from the "inferior races," but their hope was to find the biological, rather than anthropological, explanation for it. Their experiments tended towards the more gruesome. True sadists were among their ranks. Originally, they were involved with the Nazi programs to differentiate Aryans from non-Aryans, but as time passed, these individuals began a journey into the macabre. Their mandate was in the name of science, cloaked in a devotion to the mythology of the racial differences of humanity. Some of the darkest monsters of the Reich were born in this grasp.

As the clouds of war loomed in Europe, the Ahnenerbe were officially transferred to the office of Reichsfuhrer Heinrich Himmler. Hitler had followed the missions of the Ahnenerbe with great interest, and wanted a more personal degree of control in how they were assigned. The Ahnenerbe were considered a special branch of the SS, and its members were inducted and given military ranks. Himmler entrusted the day to day operations to Dr. Wolfram Sievers, who had been the Ahnenerbe's business manager under Wust. Wust stayed on as a figurehead, but Sievers ran the organization in all but name.

The Ahnenerbe, by order of Himmler, were operating out of the Castle Wewelsburg near the Teutoburg Forest. It was his vision that its agents act as the Teutonic Knights of old, questing for the lost treasures of an ancient Aryan past. His chief obsession was the Holy Grail, and he often fancied his "Knights" to be just like Arthur's Knights of the Round Table.

The medical branch began conducting experiments to help define human capabilities in dealing with the new technologies being developed by other scientific fields. The archeological branch took on more aggressive attempts to acquire some of the artifacts they had spent all those years researching. They had some experience with this already, accompanying Himmler to take possession of the Spear of Destiny in Austria when it was annexed into the greater Reich. The war between these operatives and foreign agents intensified just as much as the war between Germany and its enemies. Agents in the field, backed by an extremely gifted research staff back in Germany, waged a fierce campaign all across Eurasia collecting artifacts for a Nazi leadership that had become obsessed with the occult. They advanced practically behind the Germany Army into Southern Russia looking for artistic and archeological artifacts. Hitler firmly believed that possession of many of these treasures would help him win the war. The fledgling OSS and MI-6 found their greatest enemy outside of Fortress Europe to be the Ahnenerbe. Because their goals were so unconventional, yet still important to the war effort, the Allied intelligence services had to fight a battle just to catch up with them.

New divisions concerned with the occult and ancient religions were formed to counter the Germans. As with the war effort, this uphill struggle bore limited success early on. The Allies did have considerably more resources to bring to bear on this however, and were blessed with a much larger talent pool from which to draw. It wasn't long before the rather lopsided fight began to even out, and the Ahnenerbe found themselves hard pressed to so easily conduct operations on foreign soil. As the war ran on, they even found their units being used to defend their conquests on their own home territory, as Allied operatives sought to steal back the early gains of the Axis.

The VRP and the Ahnenerbe

The machinations of two of the Reich's most secret organizations were quite complementary. The Ahnenerbe, with its search for the source of the Aryan race, had a wealth of information that would prove useful to the VRP. Records the Ahnenerbe began to accumulate in 1935 were instrumental in helping Himmler choose the remaining promising couples and orphans in the later stages of the breeding project. As the Ahnenerbe began to investigate the medical experimentation, its new findings were incorporated into the next phases of the VRP. Once the first graduates of the VRP appeared, some of their ranks were recruited into the Ahnenerbe, increasing its fanatical zeal.

THULE SOCIETY

The Thule Society was founded in Germany in 1919, their ranks consisting of various individuals who would later figure prominently in the Nazi Party. These persons included Hans Frank, Rudolf Hess, Heinrich Himmler, and Adolph Hitler himself. Its stated purpose was as a group study and promote old German literature, but it acted as a blanket organization or several racist and anti-Semitic groups with occult origins. The name Thule had its origins in Nordic mythology as the legendary kingdom that was the original home of the German people.

The symbol of the Thule Society was a dagger over an encircled swastika, an eerie portent to the symbol that has come to symbolize Nazi Germany. Early "lodges" of the Thule Society were said to directly compete and come into conflict with Freemason lodges. It is assumed that this is the key reason Freemasons were targeted so quickly by the Nazis as enemies of the state. Although the Thule Society does not officially exist in Germany, it is rumored that its former members still meet and commune with "secret masters," possibly remnants of the long lost Aryan civilization. This rumor is fostered among the German public to bolster their faith that their leaders are the "chosen ones" to carry on the legacy of the Aryan race. As to the actual truth of the matter, only the highest Nazi Party officials know for sure.

KNIGHTS TEMPLAR

The Templars were founded in 1118 at the end of the First Crusade as a crusading military religious order. Their mission was to protect Christian pilgrims travelling to the Holy Land. They stayed in the Holy Land for over a century, finally being expelled by Muslim warlords in 1291. Members of the order were required to give all their land and property to the Templars. Consequently, the Templars became a very rich and powerful order in a short time. In the early 1300's, the King of France and Pope Clement conspired to destroy the Templars. The historical motivation for this was fear of the Templar's power and a desire to obtain their wealth. The last Grand Master of the Templars, Jacques de Molay, was burned at the stake in 1314. Not long after this, the Templars ceased to exist. One interesting fact was the story that the bulk of the Templars' wealth had gone missing. The Church and French were able to confiscate their land, but the riches King Phillip had hoped for were missing. This vanished treasure still haunts the dreams of many adventurers and it has gathered around it its own share of legends.

It was in Germany that the origins of the Templars became confused with the origins of Freemasons. The Templars were revived in 1755 by Baron Gotthelf von Hund, who claimed he had access to original Templar documents. These documents allegedly showed that the Templars had access to the secrets of the Temple of Solomon, believed by the newly emerging Masons to be the origin site of the Craft. More than one group sprang from these revelations. The Ordo Templi Orientis was one such group. The Templars became cloaked in a shroud of mysticism, and were credited with the possession of ancient and arcane knowledge. Noteworthy individuals of the time, like Guido von List, proposed theories that the Templars were actually in possession of ancient Aryan secrets, and were persecuted in an attempt to destroy a revival of Aryan religion. He even went as far as noting that the Maltese Cross, the sigil of the Knights Templar, was actually a clockwise and counter-clockwise swastika skewed and joined together.

Reborn Knights

Conflicting reports from agents placed deep in occupied Europe tell of elite troops bearing a small sigil that features a Maltese Cross. Could the Knights Templar, or at least a grotesque parody of the ancient group, have been reborn in the midst of the Nazi government? Some of these troops are impossibly perfect human specimens, and they are equipped with the most advanced weaponry available. Their numbers seem to be few, however, and they never appear in large groups. They have, however, been signaled across all the Axis territory and war fronts...

Masonic Temples

The lodges developed as a meeting place to do business and share ideas in an open environment. They grew out of the old trade houses of the 14th and 15th centuries. New members were inducted, and affairs of the order would be dealt with in these halls. As the societies grew and mystery surrounded them, it also surrounded the lodges. Stories of clandestine meetings brokering big business deals or deciding the course of action in political matters were quite common. In fact, before and during the war, higher placed officials did use them to conduct meetings on intelligence and important diplomatic matters. They took advantage of the secrecy already surrounding the lodges to conduct business that otherwise might be vulnerable to enemy agents.

ARTIFACTS

The symbolism of several revered artifacts made them prize possessions in the highly secret war of espionage between the Axis powers and the Allies. Hitler saw these as chess pieces in his war with the Allies: if he could control these artifacts, he could win the war through their mystical powers. The SS, particularly the Ahnenerbe, were the chief questing agents for Hitler. They carried in their hearts his insatiable desire to possess these mythical objects.

It is most interesting to note that their fascination was in a large part with objects of the Judeo-Christian faith. The belief among them was that many of the artifacts were actually Aryan relics that had been corrupted by the "lesser races" and incorporated into their "mythical" religions. Members of the Thule society did view Christ as a messianic figure of the Aryan people, citing his martyrdom at the hands of the Jews as yet further historical evidence of the conspiracy against the Aryan people.

SPEAR OF LONGINUS

The first artifact acquired by Hitler and the crown jewel of his collection was the Spear of Longinus, or Spear of Destiny as it was sometimes called. Heinrich Himmler and his SS were sent as a special detachment to retrieve the Spear upon the annexation of Austria. The Spear of Destiny was the weapon of the Roman legionnaire, Longinus, who was said to have been the soldier who pierced the side of Christ at the Crucifixion. Legend had it that whoever wielded the Spear would conquer the world. It figured prominently in a Wagner epic on the Grail quest. The struggles of the villains in that epic to achieve power through its possession were something that Hitler identified with in his conquest for world power. The Spear was kept at Wewelsburg Castle, the heart of SS operations. It also made it one of the first targets of the OSS's new Occult and Paranormal Division. One of its first missions was to find a way to steal the Spear for the Americans.

Operation: Spear of Destiny

An OSS team is assigned the mission to infiltrate Wewelsburg Castle and retrieve the Spear of Destiny from the heart of SS headquarters. They will leave from England and parachute into the heart of Germany. The group will rendezvous with an underground cell in Germany, acquire SS uniforms and papers, and proceed to infiltrate the castle. They will then have to penetrate several layers of security, acquire the Spear, possibly cause a diversion, and then escape with the Spear to the countryside. Extraction will be by a Lancaster bomber converted for troop carrying. This operation must be undertaken within a very strict time window. The team must perform the mission in the allotted time or risk being stuck in Germany, or worse, caught in a larger SS assembly in Wewelsburg Castle. Possible side plots and variants include exploring the SS keep for additional information on SS activities, Himmler himself being there during the raid, the bomber not showing up or being shot down, failure to rendezvous with the underground cell.

ARK OF THE COVENANT

Another equally famous artifact was the Ark of the Covenant. The Ark in history was a physical representation of the pact made between the Hebrews and Yahweh. It was a golden box allegedly holding the stone tablets on which were carved the Ten Commandments. It was a symbol of power in the Bible that kings bowed to and armies fell before. It was believed that whoever held the Ark before them would be invincible. Hitler's Ahnenerbe also believed, through their attempts to construct a replica Ark based on Bible directions, that the Ark represented some sort of transmitter/receiver unit. It was primitive by modern radio standards, but their theory was that the Aryan masters had constructed it so that early Teutonic peoples could speak with them. Although this made it an intriguing artifact, it was clear that Hitler also believed it would help make his Nazi Party an unstoppable power. He had more teams scouring for this than any other artifact. Missions were underway across the Middle East, and even in Europe to try to uncover its whereabouts. The Allies were equally involved in searching it out, and because of this, there arose some of the bloodiest clashes between these two groups.

HOLY GRAIL

The Holy Grail, the cup Christ drank from on the eve of his crucifixion and/or the one that caught his blood as his side was pierced, was quite literally that for the SS. Himmler was absolutely fascinated with the stories of the Arthurian Grail Quest, and viewed his SS, particularly the elite "Black Knights," as his own Knights of the Round Table. He sent many groups in search of this artifact, following leads as old as the Crusades. Special teams even operated under-

ground in Great Britain, in case the legend of Joseph of Arimathea was true. This was the one he put his greatest stock in: in this legend, Joseph traveled west with the Grail (and alternatively, the Holy Shroud), and landed in Roman Briton. There, he hid the Grail, which would eventually become the object of numerous quests and romantic stories. Why Himmler wanted it so badly other than the legitimacy it would give his "Knights" was not readily apparent. Supposedly it could also bring immortality to whoever drank from it. This was quite an intriguing possibility to the leaders of the Reich, and would make a strong case for its recovery.

BURIAL SHROUD

The Burial Shroud, or more popularly, the Shroud of Turin, was believed to be the cloth in which Christ was buried. Legends dating back to the 4th Century spoke of this artifact, as a cloth that alternately showed the face or full body of Christ outlined on the fabric. There are also legends that speak of this as the actual "Grail" item, not the cup. These legends say that Joseph of Arimathea took this item west through what is now Turkey, where it was moved around until it came to rest in Constantinople. Upon its sacking in 1204 by Crusaders, the Shroud disappeared. It was about this time that many of the Grail legends were written.

The Shroud surfaced again a few years latter and is now in the possession of the Vatican. Because of the precarious peace between Mussolini and the Pope, Hitler has not yet ordered a move to acquire the Shroud. The publicity either caused by an attempted retrieval or the Church's own propaganda machine could have dangerous consequences with the Catholic populations of Italy and Spain, and potentially even cause an uproar within the conquered Greek province.

Although Hitler fully intended to get it, he planned for it at a time after the conquest of the Allies, when he could devote more resources towards pacifying the populations of Europe not directly under Germany's control.

CROWN OF THORNS

The band of branches covered in thorns alleged to have been the crown placed on Christ by the Romans is a powerful artifact of Christian faith. What is known from various historical writings, is that the Crown of Thorns was held and revered in Jerusalem well into the 800's. It was allegedly delivered to Constantinople in 1063, although small portions of it were given as gifts to royalty before this.

Legends associated with it suggest that the thorns of the Crown, and perhaps the Crown itself, had the power to cure sickness and injuries. One such story states that the Emperor Justinian requested a piece of it to help cure the plague ravaging Constantinople at the time. This legend is backed up by stories of thorns from the Crown being given as gifts to royalty and religious leaders, presumably for the same purpose. It was eventually taken in the sacking of Constantinople back to France and resided in Sainte-Chapelle, where it stayed until the French Revolution. After that situation stabilized, it was put in permanent residency in the Cathedral of Notre-Dame.

With the German occupation of a good portion of France, the Crown was spirited away by a group of Catholic priests and hidden in the French countryside. Himmler has ordered special Ahnenerbe teams into France to hunt down this relic. The French underground has also been ordered by British Intelligence to attempt to discern its location. The possible propaganda value of the Crown falling into Nazi hands combined with more esoteric consequences has caused Allied Intelligence to put high priority on this item's recovery.

Operation: Alliance

An Allied unit operating in Egypt is ordered to investigate an archeological site that was active before the war. The dig was halted when Rommel's Afrika Korps began sparring with Monty's British 8th Army. History holds that this is one of the possible resting-places of the Ark of the Alliance, taken there by an Egyptian Pharaoh. A possible wrinkle would be that a team of Ahnenerbe has also decided to have a look over the site. This could result in a very pulp-style of adventure, with the Allied group attempting to secure the site and find clues to the whereabouts of the Ark while playing cat and mouse with the rival German group.

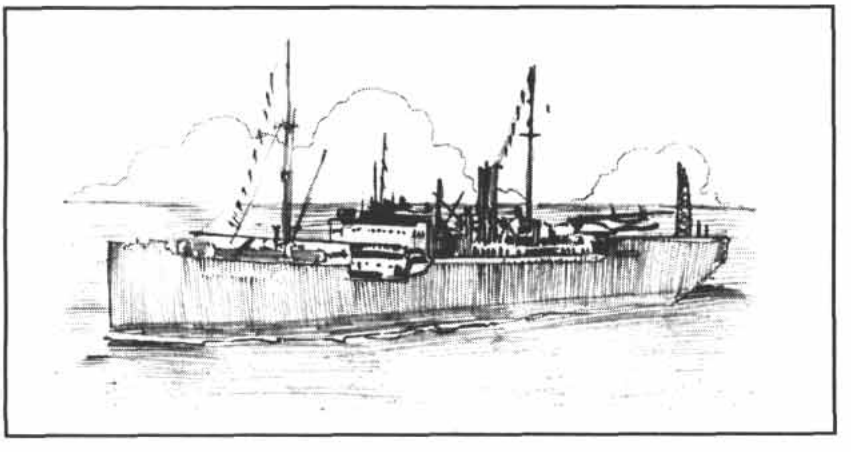
A battle could even erupt between German and British forces in the vicinity to make the situation even more chaotic. Alternate locations to make this adventure less archetypical would be an old ruined city in Persia (taken there by the Babylonians), the catacombs of Rome in Italy (hidden by Christians who stole it from the Roman emperor), or a classic site, Malta (hidden by knights of the Crusade). Each location would have a unique set of protagonists and antagonists, and could be a red herring or the actual location of the Ark.

NEUSCHWABENLAND

In the late 1930's, before war officially broke out, Hitler was looking to further expand his conquests. He also sought an area far away from his perceived enemies where research and development of new weapons and equipment could be undertaken. He chose Antartica for its remoteness and the huge propaganda victory it would provide him. It would stand as a triumph to National Socialism, and evidence that Germany was a burgeoning Superpower.

Significant research was done on a planned landing site and an expedition was prepared. The MS *Schwabenland*, an old mail ship and plane carrier, was outfitted at the cost of one million Reichsmarks and rechristened the *Neuschwabenland*. Its purpose was to survey as much of the Antartic coast and interior as it could and evaluate the site as a potential location for a new German base. The *Neuschwabenland* left Hamburg on December 17, 1938 and arrived on January 19, 1939. It immediately began surveying the coastline by sea and the inland by plane. Fragmented reports that eventually found their way to the Allies indicate that the planes found areas of liquid lakes and vegetation near the center of the continent. German geologists on the mission suggested these might be due to extensive cryptovolcanism (underground upwellings of magma). The validity of these reports has not yet been established by Allied intelligence, but estimates are that almost 600,000 square kilometers were mapped by sea and air. After the expedition had run its course, it returned with this data to Germany in February.

An immediate and massive expedition then left Germany for Antartica a few months later. This expedition seems to have been the one to open up a base somewhere along the Antartic coastline, possibly near the site of the initial exploration. The initial construction would have had to have been quick, as the long Antartic winter would soon descend and make almost any activity in that area impossible. From all accounts, the German engineers sent to build the base succeeded, but information on the exact location or the true purpose of the base eludes Allied planners to this day. The facility is most likely underground and operates on some special kind of power source. Speculation is that it could be geothermal, or perhaps some kind of rudimentary atomic source not using fission (such as radioisotope thermoelectric generators).



PURPOSES

Intelligence recovery missions from Germany indicate that the base at Neuschwabenland is being used to develop and test experimental weapons. Examples of these include new types of propulsion and power for U-boats, new all-weather fighter designs, advanced aircraft, and potential doomsday devices.

The remoteness of the base makes an Allied assault extremely difficult, if not impossible. This was undoubtedly one of the reasons the site was chosen. Possible ways to interdict the base have been postulated by Allied intelligence, though, as a way to minimize its effectiveness. It is known that U-boats make the majority of the supply runs to the base, but their exact route is unknown. It is assumed that they have found a deep channel route, or that the Germans are only using specially outfitted subs, so that they will not have to surface in regular sea lanes or as often. If these could be found and trailed, the exact location of the base could be pinpointed.

Other possibilities that have been hypothesized involve trying to board a sub while it is in a neutral port. It is well known that U-boats frequently stop in Argentina. A small team might be able to sneak aboard and either steal the pertinent information or capture and steal the U-boat. This would have to be a very quiet mission, as the violation of the neutrality of Argentina could have a very bad effect on the image of the Allies. Of course Germany would not only milk it for the propaganda value, but it could use it as a possible excuse to attack Allied shipping in neutral ports.

Expedition to the Far End of the Earth

Neuschwabenland is the Area 51 of the Third Reich, without the tourists. Finding it, interdicting it and eventually destroying it could be a campaign unto itself. The mission could begin either in Nazi-occupied Europe or in a neutral port of call, with the team trying to obtain information on the exact location of the base and the best channel approach to Antartica's relatively unknown shores. Remember that some exploration has been done of Antartica to date, but the accurate maps of the 50s do not yet exist. This information will not be lying about either. Such data would be carefully guarded, and not just left out on the mess table. Only the navigator, captain and first officer would have access to it, and even they may eventually have to commit it to memory.

Once the location and route to the German base is obtained, a decision will have to be made on how to assault the complex, or even if it can be assaulted. The Allies don't have the resources to mount an operation so far from any of their bases of supply. A small commando team would be best suited to infiltrate the base, and they would be on their own for supply and survival, perhaps with intermittent sub drops and pickups to communicate with higher command. Missions might include intelligence gathering, sabotage, or outright theft of advanced German technology. There is even the possibility of the group encountering one of the "hot spots" that have cropped up in intelligence reports. Such an area might serve as a base of operations, but would also be at risk of German patrols. This would be the ultimate wilderness adventure.

POWERS OF THE MIND

The belief in psychic phenomena is not a new thing. Travelling mystics, parlor magicians and authentic occultists say that such phenomena are as old as man. During the early 20th Century, psychics fell out of vogue, by and large, but the major governments kept tabs on them; monies were earmarked for the occasional experimentation as well. Even though most governments took no official position on psychic phenomena, there was still an interest in what sort of benefits they could offer if proven. The focus was on military and espionage applications. Despite public ridicule of all things psychic, the scientific community remained as open minded as governmental institutions on the subject.

NATIONAL RESEARCH PROGRAMS

Each major government took an interest in a different area of psychic phenomena. The United States were most interested in the idea of remote viewing: projects were started in two major universities to study and explore the idea. The British seemed most interested in clairvoyance or telepathy studies. They hoped that this could be used in their already extensive code breaking programs. The German government under the new Nazi regime took an interest in precognition, but Hitler quickly lost interest in the program when it did not yield immediate results. The Japanese, given their resource shortage problems, have focused mostly on alchemy and transmutation. As for the Soviets, they were equally interested in the idea of telepathy, and Stalin quietly ordered a maximum effort to unlock its secrets. The Soviets actually spread their research efforts over a wide range of psychic phenomena, including precognition, astral travel and psychokinetics.

THE FARSEERS

Programs were started in the 1930s at the University of Chicago and the University of California at Berkeley to study the phenomenon of remote viewing, with funding from the United States government as well as from several private organizations. President Roosevelt had become convinced, after a remote viewer helped the Secret Service locate Giuseppe Zangara, a man who had been making threats to kill the president. The Secret Service, desperate to find him, accepted the help of Arthur Cameron, a well-known psychic. He correctly predicted the warehouse Zangara was hiding in, and the Secret Service apprehended him the next day.

With Cameron's help, programs were begun at the two universities to recruit and train remote viewers. It took years just to get the basics of procedure down, as Cameron, the de facto head of the newly christened Farseer Project, insisted on a scientific approach to this paranormal phenomena.

Remote viewing has proved to be less quantifiable than he had originally hoped. Although some true talents have emerged, the bulk of the Farseers produce results only around 50% of the time. The truly gifted among the Farseer Project have even reported contacting other minds while out on their travels. They believe these are other countries attempting to mount similar efforts. The Farseer Project is currently under the jurisdiction of the Army.

Chapter Seven: Gamemastering Superscience

Tales full of action and pulp are the part and parcel of Gear Krieg role playing. World War II era is fertile ground for adventure ideas, and many of those will involve superscience elements. This chapter will provide Players and Gamemasters alike with guidelines and ideas for running adventures and campaigns centering on the problems and triumphs of superscience. Nearly all game sessions will have at least some aspect of superscience in them: it is such an integral part of the Modern Age society that it is almost impossible to run a game in the Gear Krieg universe without it. Technology is even more prevalent than in the world we know, and this will affect many aspects of the characters' lives.

SUPERSCIENCE IN A ROLEPLAYING CAMPAIGN

Superscience in a campaign can take many forms. It can take the form of a gadget or two or it can be the entire focus of a campaign. For example, the Characters could be part of an infantry squad fighting in the thick of it in Europe. Their equipment is mostly mundane: rifles, ammunition, rations. However, they might be wearing Bakelite armor or using fully encrypted radios. These pieces of equipment are very superscience, but they are just another tool used to get an infantryman's job done. The men may have a briefing from a scientist on how to work the new equipment. The equipment may be experimental. It may not even work properly.

On the other end of the spectrum is superscience that is the "be all and end all" of an adventure or campaign. The Players could be part of a group of mercenaries hired to find a rare material needed to make an invention work. Furthermore, they could be competing against another group hired to do the same thing. Perhaps the Players are part of a Plenipotentiary Team (see page 65 of the basic rulebook), required to investigate reports of a hideous new machine that is terrorizing a small town. They may find a new Nazi death machine that could be used to turn the tide against the forces of the free world. The Players could be special forces types whose mission is to get behind enemy lines and find a secret research and development area. The information to be gained could be priceless. Destroying the facility could be paramount.

In addition to the level of superscience in a campaign, the Gamemaster can tailor the level of scientist involvement. Not every invention or discovery needs to be made by a Nazi scientist or an entire group of people. Pulp is rife with evil masterminds bent on world domination. They might use a doomsday weapon to threaten to destroy the world should their demands not be met. They may just want to rob banks with a stolen walker prototype. A private dick may be hired to find a missing person, only to discover a dastardly plot of epic proportions.

DARK ASPECTS OF SUPERSCIENCE

One of the cold, hard facts of science is that it is amoral. Science may be pursued without regard to the ethical considerations, and many times science has been pursued that way. As a result, the pursuit of science in a manner that most of humanity would find repulsive makes for an excellent source of villainy in a campaign. Players should want to stop an evil experiment at all costs. Gamemasters should take care to not glorify dark science, but to use it as an effective part of a narrative. They should emphasize the horror of it all. Villainous science can take many forms, such as medical horrors, chemical warfare, atomic research or criminal behavior.

The Axis powers were particularly adept at performing evil experiments on human beings. Few that have seen the horrors the Nazi regime inflicted on fellow humans will ever forget those images. The Japanese were no better. Both powers went so far as to play with life itself when they researched and created zombie troops. Gamemasters would be wise to stick with the more pulp applications of medical experimentation rather than the mundane. Pulp experimentation should be horrible enough for any Players.

World War I saw the genesis of chemical use on the battlefield. That danger is still present in the World War II era. Additionally, Nazi scientists worked on deadly nerve agents in order to pursue the final solutions they sought. The threat of use of agents on Player Characters should scare the daylights out of them. Agents can be mild enough to be countered by gas masks or the threat can be so great that Players must stop the use of them at all costs.

The splitting of the atom is a pursuit that the Allied and Axis powers both engaged in. The effect of an atom bomb in enemy hands is dire enough for any party of adventurers to prevent if at all possible. Players may take part in sabotage in any number of elements of the design and manufacture of a nuclear device. For most of World War II, stopping the creation of "the Bomb" will involve preventing the mining of fissionable material, destroying a research facility, or killing an important scientist. All are perfect missions for a party of characters.

Not every aspect of superscience is devoted to world governments and their agents. Individuals with great skill and talent can create superscience gadgets and weapons of immense power. When used irresponsibly, those devices and their creators become criminal and must be defeated. This type of behavior is especially present in the years leading up to the outbreak of war, where characters are more likely to be civilians rather than military personnel. For example, a criminal mastermind could be using her new sonic ray to disable guards at prisons, allowing her to free her colleagues from their captivity. Or

perhaps she has a deadly poison with no known antidote she is threatening to release into the city's water supply... should her demands not be met.

ROLE OF HISTORICAL FIGURES

Gear Krieg features many prominent historical figures in alternate history universe. These people are people that had a great impact in both worlds, and most have had their inventions and research amplified for the purposes of creating pulp superscience in a world at war. Player Characters, being the better-than-normal individuals that they are, are certainly eligible to meet one or two of these historical figures in their adventures. They are the legends in the world around them: not many can equal the genius of Tesla or Turing. They exist and they should be acknowledged.

However, this does not mean that every Gamemaster must include them in their campaign. There is plenty of room for scientists, engineers, and inventors that no one has heard about before. They can be the people behind machines that no one has ever seen. The existence of Edison Labs in no way precludes a totally fictional research facility existing some where else in the United States where the Player Characters are based on or affiliated with.

ROLE OF VILLAINOUS SCIENTISTS

If a campaign needs an arch villain to pit the players against, scientists — or even better *mad* scientists — make great foils for the party characters. And while a despicable person is certainly very pulpy, an enemy scientist need not be dripping with evil. A person with a set of morals that are different from the heroes can be so much more effective. Such villains are stronger because not only are they committing acts of wrongdoing, they are doing it because they feel fully morally justified in doing so. A Nazi scientist furthering the goals of the Third Reich by working on a disease that somehow targets a particular creed or ethnic background is more malevolent than a scientist that just wants to kill people. The former has a purpose and drive that makes for good plots and character motivation. He's a villain that the players will remember. The latter is just a mad man with a cookie cutter need to kill people. No one is going to remember him.

ROLE OF CHARACTERS

In a campaign based around superscience, the characters can be any one of a myriad of archetypes, both civilian and military. Civilian roles such as scientist or inventor are obvious choices. Player characters may even be a heroic adventurer with a gift for invention. A character may be an archaeologist in search of a particular item of religious or material importance. Perhaps the character is even an assistant to a scientist, tasked with testing a new gadget, or who habitually ensures that prototypes get to the right people.

In addition to people with scientific skills, people who support the scientist are also very important. People to hunt down important components needed for a new invention, such as a rare element or a vacuum tube that only one company manufactures. Characters can be part of a team hired to procure such important items. Scientists also need protection at times, and characters would make ideal bodyguards hired to keep a scientist safe.

On the opposite side of the coin to helping scientists if thwarting them. Characters may be hired to stop a scientist from completing a new weapon. Perhaps they are just asked infiltrate an enemy research center and steal valuable blueprints and notes. Characters can uncover a plot to use a new device and need to stop it.

Civilian roles tend to emphasis a single scientist or private businesses. If characters are part of the military, these kinds of roles can be filled as well. In addition, military characters have sanction to work against governments in helping or thwarting research and development on a much larger scale. Securing fissionable material is a good example. Uranium is tough to find, and is a nationalized material, only available to the government. Civilian characters are unsuited for a mission to stop an enemy government from obtaining such material, but a military party is ideal.

Superscience Vocabulary

In this day and age, technology is a basic part of everyday life. Technology brings a whole multitude of new terms along with it. It has also brought with it additional sophistication to people's lives. As a result, the hand waving of science typical in the pulps of yore most likely will not work in the minds of the people of today. Using the vocabulary of science and technology can help any Gamemaster speak technobabble with the best of them, helping to make a campaign come more alive. As with slang in any Gear Krieg campaign, however, overuse of technical terms can just make the Players' eye glaze over. Of course, that may be the intent of a Gamemaster when playing an NPC superscientist...

CREATING SUPERSCIENCE

There is plenty of superscience to use as written within the **Gear Krieg** universe. However, most Gamemasters will want to exercise their creativity and fuel the adventure with ideas of their own. Who doesn't want to surprise Players with a new weapon that they have never seen before?

What follows is a set of guidelines for the Gamemaster to create new gadgets and machines for use in her campaign. In essence the Gamemaster will be writing down intended effects of the new item, and working from published items to determine in-game values. Most of the time, ratings such as a Threat Value will not be needed — roleplaying scenarios are not a contest between Gamemaster and Players, and a little imbalance in the force is easy to correct. The system below exists mostly to provide a basic narrative skeleton to the playing group; in reality, developing a new item would take months if not years of tedious research, an endeavor not very well suited to an exciting tabletop session.

ROLEPLAYING THE PROCESS

Even if the Gamemaster is working on an item just to have something new to throw at her Players, it is very helpful to roleplay out the process of its creation. If the Players will be working for or against the creation of the item, then playing out the various aspects of the development of the item is vital. Ideas do not just materialize into a finished item out of thin air. There are many steps along the way, and events can go wrong at any of those stages. But that's what pulp action is all about!

Every new superscience advance begins as an idea in at least one person's mind. That idea is most likely a simple one: a faster car, a color televisor or a even a magazine-fed rocket launcher. If that idea merits investigation, the inventor must research the idea, to determine if it is feasible. The process of research however, requires a design to determine the difficulty of the research process. Therefore the design must be planned out first, and then the research process is performed.

The design, both in a role-playing and game design sense is the most important part of the process. The Gamemaster creating the new item must spell out invention's statistics. The nature of a new invention will effect the subsequent questions the designer must ask himself to realize the item. New inventions tend to fall into three categories: vehicles, weapons, and equipment. In all cases **Gear Krieg** allows for simple conversion of most "real world" values into game statistics. The conversions of those values are discussed below for each type of invention.

Plot Devices

Gadgets and superscience inventions make excellent plot devices. By their very nature and presence they lend themselves well to furthering a plot or even being the subject of a story. Players can be tasked with finding an experimental weapon and stealing it. They could be issued a new gadget and asked to test it, all the while being attacked by some one else who wants it. They could even have an integral piece of equipment such as a walker break down, requiring the party to stay in a town for a night. Many a pulp mystery was started in such a contrived fashion.

EQUIPMENT

Equipment is the simplest type of new invention a Gamemaster can create. As long as there are no direct game effects, the Gamemaster has full control over the function of the item. Only a couple questions need to be asked. What does it cost? How much does it weigh? The GM is free to describe the item's purpose and effect without inhibition otherwise, as long as it doesn't have a game effect like damaging a Player character.

• MASS

The mass of a piece of equipment is simple. Compare the item to an item of similar mass, and adjust accordingly. **Gear Krieg** does use the metric system, so equipment has its mass listed in kilograms. Values in pounds can simply be converted by dividing the mass in pounds by 2.2 to calculate the mass in kilograms.

• COST

For the most part, cost is irrelevant to the adventurers. They are handling new inventions that tend to be a one-of-a-kind prototypes: the price is incalculable (or at least well-beyond the means of the average adventurer). Therefore, there is often no need to even determine a price, except for dramatic effect. Characters should be reminded that new gadgets are "worth hundreds of pounds, dear boy, so do try and be careful with it this time..."

This advice applies to both weapons and vehicles. Just the scale of price changes: instead of hundreds of the currency of choice, the prices climb into the tens and hundreds of thousands.

• EFFECTS

If a piece of equipment has game-mechanic effects, then those effects must be decided upon and defined. Devices used by villains can be as fantastical as desired. The more malevolent the better. If the device allows the villain to be all-powerful, then the Players will be forced to stop her all the more. Devices used by the Players should be more restrained. They should aid the characters to perform better, but they should not allow the characters to overcome all challenges with ease. If an item does have a powerful effect, flaws with the device are recommended to temper the abilities of it. A drug that gives a character a +2 Agility or Perception can potentially be destroy the balance of the game – but not if it causes an automatic Flesh Wound after ten game turns.

VEHICLES

Vehicles are next in order of complication. They demand many questions be answered, but those answers are easy to come by. How big is it? How fast does it go? How far can it go? How many crew does it have? What weapons does it carry? What kind of protections does it have? What equipment does it carry? What kind of advantages and disadvantages does it have? These questions, when answered, for the basic game statistics for the vehicle.

• MASS

Gear Krieg uses a statistic called Size to show the mass of a vehicle. This statistic is used to determine the damage to units colliding with one another and other physical attacks. The Size of a vehicle is determined by looking up its mass in kilograms on the Mass to Size Table and cross-referencing that value with the proper Size value.

SIZE TO MASS CHART

Size	Mass in Tons	Size	Mass in Tons	Size	Mass in Tons
1	0-0.08	34	1001-1100	67	7901-8300
2	0.09-0.3	35	1101-1210	68	8301-8700
3	0.4-1.1	36	1201-1300	69	8701-9100
4	1.2-2.4	37	1301-1400	70	9101-9500
5	2.5-4.4	38	1401-1500	71	9501-9900
6	4.5-7.3	39	1501-1700	72	9901-10300
7	7.4-10	40	1701-1800	73	10301-10700
8	11-16	41	1801-1900	74	10701-11200
9	17-22	42	1901-2100	75	11201-11600
10	23-30	43	2101-2200	76	11601-12100
11	31-40	44	2201-2400	77	12101-12600
12	41-52	45	2401-2500	78	12601-13100
13	53-65	46	2501-2700	79	13101-13600
14	66-81	47	2701-2900	80	13601-14100
15	82-100	48	2901-3100	81	14101-14600
16	101-120	49	3101-3300	82	14601-15200
17	121-145	50	3301-3500	83	15201-15700
18	146-170	51	3501-3700	84	15701-16300
19	171-200	52	3701-3900	85	16301-16900
20	201-230	53	3901-4100	86	16901-17500
21	231-270	54	4101-4400	87	17501-18100
22	271-310	55	4401-4600	88	18101-18700
23	311-350	56	4601-4900	89	18701-19400
24	351-400	57	4901-5100	90	19401-20000
25	401-450	58	5101-5400	91	20001-20700
26	451-500	59	5401-5700	92	20701-21400
27	501-560	60	5701-6000	93	21401-22100
28	561-630	61	6001-6300	94	22101-22800
29	631-690	62	6301-6600	95	22801-23500
30	691-770	63	6601-6900	96	23501-24100
31	771-840	64	6901-7200	97	24101-25000
32	841-930	65	7201-7600	98	25001-25800
33	931-1000	66	7601-7900	99	25801-26600

Maneuver Ratings

Maneuver	Typical Vehicle
+1	Motorcycle, Advanced Fighter Plane
0	Sports Car, Advanced Walker, Fighter Plane, Helodyne
-1	Walker, Car, Speedboat, Autogyro, Fighter Plane
-2	Large Walker, Armored Car
-3	Tank, Half-track, Truck, Submarine, Bomber
-4	Transport Plane

• CREW

The number of crew determines the total number of actions a vehicle has. This value is the number of people actually needed to operate the vehicle formally, and does not include passengers and personnel not directly involved in operating the vehicle or any weapons it bears.

• MANEUVER

The Maneuver rating of a vehicle indicates how nimble the vehicle is. The rating can be widely varied depending on the type of vehicle. Examples of Maneuver ratings are shown on the table below.

• FIRE CONTROL

The Fire Control rating shows the sophistication of the targeting systems in the vehicle. Sample ratings are shown on the table below.

• SENSORS

Sensors show how good the vehicle is a spotting things. The rating is listed as the Modifier/Range. Most vehicles in **Gear Krieg** rely solely on the Mark I Eyeball – the sight of their crews. As a result, most vehicles have no sensors. As computators become more prevalent, as well as Radar and other sensors, vehicles will have crude sensor values of no more than a kilometer or two in range, with ratings in the negatives.

• COMMUNICATION

The Communication rating shows the kind of radio the vehicle has. Published vehicles are good guidelines for establishing values, as are the stats for radios in the GK RPG book and the Wargaming Companion book. Vehicles intended for reconnaissance tend to have higher ratings than other vehicles (better radios). Many nations only include radios in command vehicles.

• ARMOR

The armor values reflect the amount of protection the vehicle has against weapons. To determine a good value for base armor value, compare the vehicle to other published vehicles in **Gear Krieg**, and use a comparable value.

Weaker side and rear armor is modeled by the Flank and Rear defensive penalties in **Gear Krieg**, and those values can be account in most cases by just using the base value. However, special considerations are needed to model a vehicle with varying amounts of armor in various locations. Vehicles with large amounts of armor to their front are given the Reinforced Armor Perk to show the additional protection to the front. Vehicles with heavy armor to all directions can be given Improved Rear Defense or Reinforced Armor perks to those directions.

• MOVEMENT

Every vehicle has at least one system of propulsion of some type to propel it. The exact method of propulsion is totally up to the Gamemaster and has no effect on game play. The effect of the propulsion is important however, and is indicated by one or more Movement values. Each Movement value is shown as Combat Speed/Top Speed. The Top Speed value is simply the fastest speed the vehicle can go in kilometers per hour, divided by six. The resulting value is rounded to the nearest whole number. The Combat speed is half of the Top Speed, rounded up. Speeds in miles per hour can be converted to kilometers per hour by multiplying the speed by 1.6.

There are many types of Movement available: Flight, Ground, Hover, Naval, Rail, Submarine and Walker. Vehicles with Flight movement type move through the air and include planes and helicopters. Ground vehicles have wheels or treads. Naval vehicles move over water, while Submarine vehicles move below it. Hover vehicles travel on a cushion of air. Walker vehicles move on legs.

Some movement types have additional game statistics that warrant consideration. Vehicles that have Flight movement have a Stall Speed, which indicates the minimum speed at which they can maintain flight and not crash. Ground vehicles have a movement bonus on roads. They can travel 150% of their Top Speed. For those converting real world vehicles into GK statistics, this means that any maximum speeds given for road speeds must be reduced by a third before converting the values into Movement Points.

Fire Control Ratings

Fire Control	Typical System
+1	Highly Advanced Walker Computator and Gyrostabilization
0	Advanced Walker Computator and Gyrostabilization
-1	Basic Walker Sights, Advanced Computator and Gyrostabilization
-2	Optical Sights
-3	Basic Iron Sights

• DEPLOYMENT RANGE

This value indicates how far the vehicle can travel before requiring more fuel. It is listed simply in kilometers. Ranges in miles are multiplied by 1.6 to compute the range in kilometers.

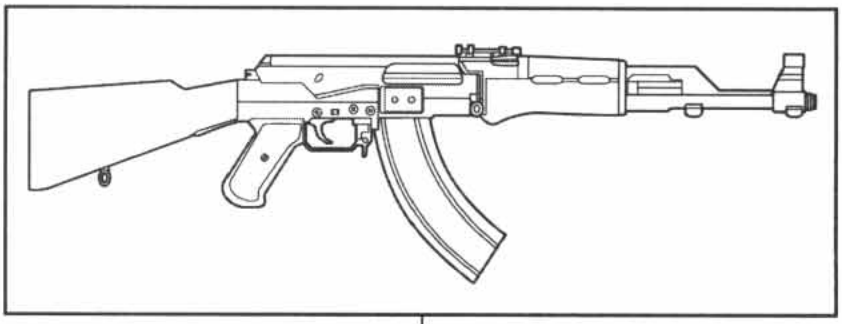
• VEHICULAR WEAPONRY

Vehicles intended for combat tend to mount weapons of various types. Weapons from vehicles already published can be used or custom weapons designed by the Gamemaster may be mounted. Each weapon is given a firing arc and an amount of ammunition.

Each shot in the **Gear Krieg** game engine is one cartridge in the real world, so no conversions are necessary in showing the amount of shots a weapon has. If the Gamemaster determines that a particular weapon is large for a particular vehicle, he can add the Stabilizer Mount Perk to the vehicle to show that it needs to be stopped in order the fire the weapon.

• PERKS & FLAWS

Perks and Flaws give a vehicle its distinct flavor, distinguishing it from other similar vehicles. The descriptions of Perks and Flaws give the best indication of their use. Prototype vehicles should have more flaws than the production models, and a vehicle that is an improvement on an earlier model can have even fewer flaws. Additionally, a vehicle with many Perks can be rather unbalancing for play, and a few additional Flaws can help keep the vehicle playable. See page 151 of the basic roleplaying rulebook for a list of official Perks and Flaws; the ones found in the various **Gear Krieg** wargame books are also acceptable.



NEW WEAPON SYSTEMS

Weapons are the most complex new items to design. They have questions to answer that are more complicated to answer than those for vehicle designs. How much does it weigh? How far can it shoot? How much damage does it do? How accurate is it? What kind of effects does it have?

• RANGE

Every weapon has four range bands: Short, Medium, Long, and Extreme. Some weapons also have an Artillery Range value. The Extreme Range value (and for those that have it, the Artillery Range value) indicates the maximum effective range for a weapon. Effective ranges are somewhat subjective, but if a weapon loses any significant penetration ability at a certain range, this range if the effective range.

Ranges for personal weapons are given in meters, and vehicular weapon ranges are shown in 50 meter increments. The Extreme Range is halved in turn to calculate the Long, Medium and Short Ranges. Artillery Ranges are halved to get the Extreme Range, and the process continues as normal. If a fractional Short Range is calculated for a weapon, round the value to the nearest whole number and double that value for the Medium range and so on to recalculate whole values for all ranges.

• ACCURACY

The Accuracy of a weapon indicates how well the weapon can hit a target. It depends on the design of the weapon, the type of sights the weapon has and even how the weapon works. Most weapons have an Accuracy of 0. Weapons with a +1 are exceptional weapons, with tight tolerances or excellent balance or precision guidance. Weapons with -1 accuracy are poorly made or poorly designed or fire *unpredictable* munitions. Prototype weapons are excellent candidates for poor Accuracy ratings. Sniper weapons are good examples of weapons with high Accuracy ratings.

• DAMAGE MULTIPLIER

The Damage Multiplier, or DM, shows how effective a weapon is as penetrating armor and causing damage. The best way to determine a DM value for a weapon is to compare it to a published weapon with a similar design and performance. Projectile weapons that can penetrate a similar amount of armor should have the same DM. Explosive weapons that have a similar mass should have the same DM. Projectile weapons that rely on kinetic energy to do damage are tricky since they tend to lose ability to do damage over range. These weapons can be given an Attenuating Damage characteristic, but for published weapons their DM is a averaged over range for simplicity.

• RATE OF FIRE

Some weapons fire their munitions very quickly. Some weapons are fired in groups to mass fire. These weapons are given a Rate of Fire (ROF) value. The amount of munitions warranting a ROF value different for rockets than for other weapons. Rocket weapons are more efficient in ammo usage, and can get a ROF bonus for firing only a few rockets at a time. The number of rockets a weapon can fire at once determines the maximum ROF rating. That is, if a weapon can fire up to two rockets per turn, is has an ROF of +1. If it can fire up to four rockets, it gets an ROF of +2, and so on. Other weapons are trickier, and conversion from real world firing rates to a system that supports turns of varying length (5 second and 30 second turns) can be tough. A good rule of thumb though is that for every 500 rounds a minute a weapon can fire sustained, the weapon should receive a +1 ROF value.

• SPECIAL CHARACTERISTICS

Like Perks and Flaws for Vehicles, weapon Characteristics personalize weapons to give them distinct abilities from one another. Rifles work differently from machine guns, tanks guns work differently from flamethrowers. Experimental weapons should have characteristics that make the weapon tough to use in some way. A chance to jam or one-shot wonders are good prototypical characteristics. See the Appendix for Weapon Characteristics.

• MASS

The mass for weapons intended for vehicular use is not necessary to calculate. However, weapons for personal use have a mass value for purposes of determining what a Player character can carry. Use other publishes weapons as a guide for assigning the mass to a new weapon. If the weapon is cutting edge, like say a laser rifle or a guided rocket launcher, the mass should definitely be higher due to the bulkiness new technologies tend to have before they are refined and miniaturized.

RESEARCH

Once the blueprints for the new invention have been plotted out the research process begins. The inventor must now conquer the obstacle of forging a new frontier in science. For each statistic that describes the invention there is a Research Pool (RP) that must be filled by Skill Rolls performed by the inventor. Equipment has an RP for the mass and each distinct effect it has.

Vehicles have one Pool for each of the following: Size, Crew, Maneuver, Fire Control, Sensors, Communications, Armor, each Movement System, Deployment Range and each individual Perk.

Weapons have their own research processes. Flaws add no RPs when added, but they do add one to the RP for each Flaw removed in an improvement to an existing design. Perks and Weapons do not add RPs if they are removed.

Weapons have one RP for each of the following: Short Range, Accuracy, Damage Multiplier, Rate of Fire and each Special Characteristic. Removing a Special Characteristic requires no additional RPs.

If an invention does not have a statistic, there is to RP (such as No Communications). The size of the Pool depends on the extent of the innovation in the new design, expressed as a Change Multiplier of the percentage of change. New inventions, not based on previous work, automatically default to a Change Multiplier of 1.

The Research Pool is filled by a series of Skill Rolls performed by the inventor. Mechanical Design or Electronic Design is the Skill used for the Skill Rolls, depending on the nature of the invention. Other Skills may be appropriate, at the discretion of the Gamemaster. The inventor makes one Skill Roll for each day, week, or month as decided by the GM. The result of this roll is added to the accumulated point filling the RP. Once the accumulated points equal or exceed the Research Pool requirement, that part of the research has been completed.

Once all of the individuals pools are complete, a single additional RP must be filled, representing the integration of all elements of the design into a working whole. The RP size for this roll is equal to the single largest individual RP. Once this RP is filled, the research process is complete. Additional personnel may help research. The single highest Skill level us used for the Skill Roll, and all of the appropriate Attribute values are pooled together and added to the Skill roll. Separate individuals or teams may make research separate pools concurrently. The inventor is now ready to move onto building the prototype.

Research Pool

Change Multiplier (CM) =	New Statistic / Old Statistic – 1*
Research Pool (RP) =	20 x Change Multiplier

** for positive statistics only.*

Sidebar: Prototypes in a Word at War

Normally the design of a new invention takes years of research and design. The trial and error of refinement consumes months of time, a lot of money, and many prototypes. The public never uses these prototypes, and only gets to buy the final masterpiece.

All of this process changes drastically in a world where open warfare is raging. Any new idea that can help the war effort in a significant way is pursued with gusto and immediacy. Any safety protocols that are followed are relaxed. Obviously no one will field a deathtrap vehicle, but if a risk in a design is deemed acceptable, the design will be manufactured as soon as it possibly can.

As a result, Gamemasters can easily justify giving to their Players vehicles and weapons that don't perform as expected. Some may be down right hazardous to use! Such are the breaks of fielding the latest superscience gadgets in a world at war.

THE PROTOTYPE

Every new invention goes through that first incarnation that proves the concept of the invention. That incarnation rarely works to the full intent of the design. It has many rough edges that required smoothing before it can be mass produced for general use. That version of the invention is the prototype, and it's the first time anyone gets to use the invention the see what it can do.

Given that a prototype is rarely perfect, and can be downright dangerous at times, it is a marvelous role-playing device to get the Players involved in a game. If a Gamemaster needs some comic relief or a way to keep the Players humble, a prototype perfect for the job. The more problems it has, the more opportunities the payers have for weaving a compelling and entertaining story.

For Players with inventors for characters, fielding a prototype can be an exciting time. It's the first time they get to see their idea in action. Using it in an adventure is more than enough for most Players' excitement. Adventuring with the prototype leads to valuable feedback and data for future refinements, which lead to the finished product.

Prototypes do not materialize out of thin air from research and design. They must be built, and their construction takes time. The amount of time taken depends on the size of the object in Material Points and making a series of Skill Rolls. The base amount of Material Points needed is calculated from the formula below. Ignore Armor Rating for Equipment and Weapons.

To know how much time the technician(s) will need, separate Skill tests are required: one for each major group of item components. The Skill and type of item linked to each group is listed in the Scratchbuilding Table below. Each test must succeed in order to get a functional invention. Note that only components that have changed factor into the rolls.

If a test is failed, the result if the test is added together with the result of the next roll and so on until the total of all rolls equals or exceed the total Threshold. Some time is also lost: the MoF times 10, in hours, is added to the final count. On a fumble, the same thing occurs, except that an embarrassing mistake is also made - spilled the oil drum, broke the best wrench, etc.

Scratchbuilding Table

Component Group	Design Skill	Item Type	Threshold
Structure	Mechanical	Vehicle, Weapon, Equipment	Size^2
Fire Control	Mechanical or Electronic*	Vehicle	FC + # of Weapons
Crew	Mechanical	Vehicle	# of Actions^2
Movement	Mechanical	Vehicle	Sum of MP of all systems
Auxiliary Systems	Mechanical or Electronic*	Vehicle	Number of Perks x 5
Accuracy	Mechanical or Electronic*	Weapon	Acc + 10
Damage	Mechanical or Electronic*	Weapon	DM + ROF
Auxiliary Systems	Mechanical or Electronic*	Weapon	Number of Characteristics x 5
Auxiliary Systems	Mechanical or Electronic*	Equipment	Number of Effects x 5

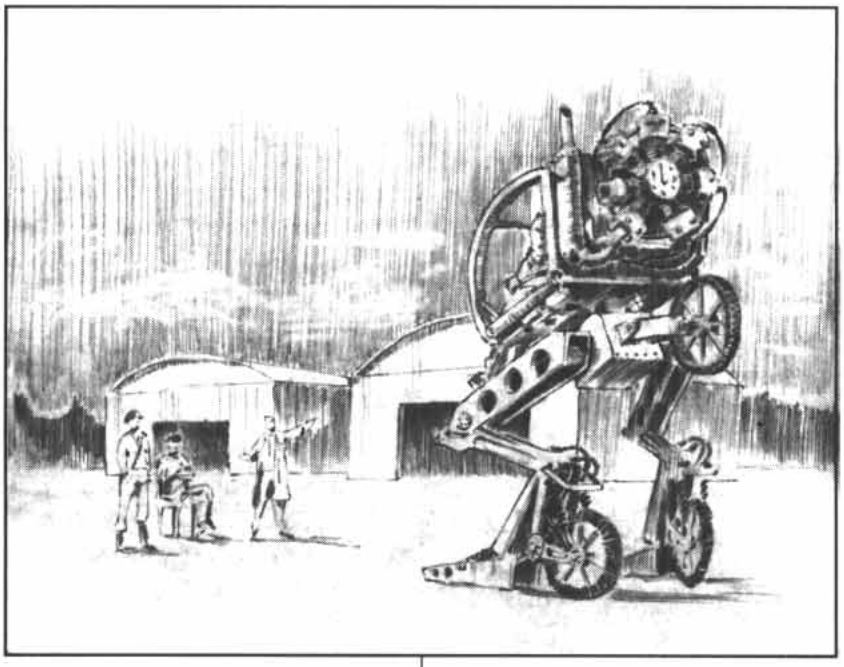
**Whichever is more appropriate*

The time required to build the new vehicle is equal to the total Material Points used times 4, divided by the best technician's skill level. Add one to the tech's skill for each assistant working with him, up to a maximum equal to the donor items Size rating. The resulting number is the total time of the operation in hours, not counting lunch breaks or other unavoidable pauses (even techs have to go to the bathroom sometimes).

Improvements to the prototype are made in the same way as the initial design. The entire process is much easier though. Only the changed statistics will require new research and building rolls. The base amount of Material Points required is not multiplied by 4 when calculating the total amount of time required to make the change.

THE FINISHED PRODUCT

Once various prototypes have been adequately field-tested, the data collected is used to construct the finished version of the invention. This version is the template to produce copies on a mass scale for public or military consumption. The flaws of the design have either been ironed out completely or accepted as part of the operation of the item. Highly dangerous problems should have been corrected by this point, unless those problems are a good plot element in the campaign. A villain that insists on using a new form of entertainment, despite the fact that it causes one in three people to go clinically insane, is a dangerous person. Time to save the world again...



DEVELOPMENT OF THE CHRISTIE WALKER

The development of the first Christie Walker is a good example illustrating the process of making a new invention a reality. As the first of its kind, this walker was a totally new invention, requiring new technology never before seen. An awful lot of tie and skill was required to get the first prototypes operational. The final prototype that was sold to Germany still necessitated further research and design to produce the first practical walking machines for battlefield use.

• THE DESIGN

The invention needed to have the following questions answered in the design of a vehicle. It massed approximately 1600lbs, or 730kg. The resulting Size for the vehicle was therefore 3. It had 1 Crew, just the pilot. The Maneuver was -2 — the vehicle didn't have any of the benefit of computator control. The walker had no weapons, and thus no Fire Control, making the rating -5. Likewise, the vehicle had no Communications or Sensor ratings. The walker was just a basic framework, and therefor had Armor equal to its Size (3). It was designed to both walk and travel by wheels, and consequently has two Movement modes: Ground and Walker. The Walker movement was highly experimental and the vehicle could only move 8mph or 13kph cross-country. It's Walker movement values were 1/2. The Ground movement mod faired better, and the vehicle could move at around 15mph or 24kph cross-country. The Ground values were 2/4. The vehicle could not travel very far at all, with a Deployment Range of merely 10km.

The vehicle had no weapons, but a plethora of Flaws. It was Unstable, prone to Random Shutdown (rating 3), had Inefficient Controls, Exposed Crew, Ex-

Material Requirements

Mechanical Material Points required = (Item's Size)^2 x (Armor Rating)

posed Movement System, No Sensors, No Communications, Overheating, Decreased Maneuver (Walker -1), and if all that weren't enough, it also had Hazardous Fuel Storage. That's a lot of Flaws to work out of the design!

Military Procurement

New military weapons, vehicles, and other items tend to follow a different path than those designed for civilian use. Civilian conveniences are designed to fill a perceived need. They are designed in the hope that they will sell on a mass scale. Military contracts fill a need that is carefully spelled out ahead of time. In effect the market need is pre-determined. The money paid for the new weapon has been set aside already - the manufacturer already knows how much they will make upon delivery of the item.

Gamemasters should keep this in mind when designing items intended for military use. If Player characters are involved with the design and manufacture of the new weapon, they should have more stringent requirements. Instead of them saying to themselves, "Wouldn't it be neat to put this feature on this?" they should be asking for the requirements up front and sticking to them.

There certainly are instances of new weapons that were designed by private individuals that were presented to the military and subsequently adopted for use. However, the more complicated the new invention, the more likely the chance there is that the military asked for its development and provided necessary funding. Few individuals can afford to design and build a new tank or walker without some government funding and technology.

In order to complete the design for the vehicle, Christie had to research it completely from the ground up. His Change Multiplier for each Research Pool was 1, since his walker was an entirely new invention, not based on a previous vehicle. Christie had to fill a Research Pool for Size, Crew, Maneuver, Armor, each of the two Movement Systems and Deployment Range. There are no Perks, no weapons, and the Flaws don't require any RPs.

Each Pool is 20 points, making it 8 RPs (seven for each of the stats and one for the integration of them all) that Christie must fill. His length of time between each roll was a week — he's making history here. His average roll was a 5, needing four succesful rolls to fill each Research Pool, or a full month. His grand total of research time was eight months. After all that work, he was ready to move onto building the prototype.

In order to build the walker he needed a total of $3^2 \times 3 = 27$ Material Points (Size 3, Armor 3). His Mechanical Design Skill level was 4, and his Electronics Design skill was irrelevant to the building the walker. The total base amount of time required to build the walker was (27 x 4) / 4 = 27 hours. He needed to pass the Thresholds for Structure, Crew and Movement. The Threshold for Structure was $3^2 = 9$. He rolled a 7 and a 4 to pass the Structure Threshold. The first roll had an MoF of 2, adding 2 hours to the total time needed to build the machine. The Crew Threshold was 1, and Christie rolled 3, passing the Threshold with ease. He needed beat a 2 + 4 = 6 for the Movement Threshold. He rolled a 4 and a 6 to surpass 6. The MoF for the first roll was 2, adding another 2 hours to the total build time. The total amount of time required to assemble the walker was 27 + 2 + 2 = 31 hours.

• IMPROVING THE PROTOTYPE

As one can see from the myriad Flaws, the first prototype was hardly ready for mass production. It was lucky to have walked any distance at all! Christie set about removing and reducing the effect of the Flaws of the vehicle. The first change was to improve the maneuverability. Christie decided to improve the walker ability of the vehicle, which would remove the Decreased Maneuver Flaw. He also decided to have an assistant work on the Overheating problems of the machine. The research required three RPs with varying CMs. The Maneuver change from –2 to –1 has a CM of –1/-2 = .5, making its RP 10. Removing the two Flaws are CM 1 changes, making their RPs 20 each. Christie once again averaged 5 for each Skill Roll. Since he was only modifying the walker, he got to make one roll per day. He needed 6 days to complete his research. His assistant was not a capable, and averaged 4 for his Skill Rolls, needing 5 days to complete his research. However, since he was working separately from Christie, their work was concurrent, making for a total time of 6 days for all research – for the individuals sections. A final RP of 20 had to be filled to complete the research. Christie, working with the assistant, was able to average 7 on his rolls, completing the final research in 3 days. The final total is 9 days for research.

In order to build the new prototype Christie had to modify the old one. He needed a base of 27 / (4 + 1) = 5.2 hours. None of the values indicated on the the Scratchbuilding Table changed, so no skill rolls were required. The total time to modify the machine was therefore 5.2 hours.

THE FUTURE OF SUPERSCIENCE

Phil sat in the dark theatre, watching the pre-show shorts. He couldn't wait for the main feature to show, but the new reels were so important these says. He did like the ones that showed the new stuff people invented. With the war an all, there was lots of stuff to hear about. He watched with anticipation of seeing a science news reel. He was wish was answered as the reel faded to the Movietone logo and the text 'The Future of War'appeared over it.

"...and in science news, British scientists are claiming to have created a weapon that uses light!" Phil didn't know where they got some this stuff, but it was always entertaining. The reel cut to an older gentleman standing next to what looked like a tank turret. Instead of a long protruding gun barrel however, there where only a couple of slits visible on the outside. "Mister Harry Grindell-Mathews is seen here showing off his latest creation! He called reporters to visit him in his Wales workshop to tell them about his amazing Death Beam! Let's hear him tell us about it in his own words!"

The audio switched to Grindell-Mathews voice. It sounded very soft and Phil had to srtain to hear him. "This weapon I've devised will help teach those Jerries a lesson! It works by amplifying normal light to the point that it can hit steel plate with enough force to burn through it! By using ruby crystals to trap the normal light, it bounces around inside until the light wave is pure and powerful enough to escape the crystal. The resulting beam of light can kill a Hun at over 100 meters!" The man beamed in black and white glory.

"Thank you, Harry! We'll surely be able to defeat the Nazis with your Death Beam! And now..." The image changed to show a group of scientists standing around a table. On the table was a trunk-sized collection of vacuum tubes, wiring, and metal. A walker loomed in the background, positioned to look as menacing as possible. "...we bring to you the latest in walker technology. Here we see very latest in walker and computator technology! Tesla's boys from Menlo Park have built a new computator that can help control walkers better than ever! Dr. Von Neuman heads up the team that made this new advance possible! According to him, this computator is half the size of earlier models, and has at least twice the computing power."

The picture faded to a test pilot climbing into the walker. "Dr. von Neumann was kind enough to show us a demonstration." The walker started up and began walking. It walked more smoothly than Phil had ever seen any walker move before. "He says we will soon see walkers capable of moving at over 35 miles per hour! That should be something, Dr. von Neumann!"

The picture cut to Dr. von Neumann, who filled the screen. It then pulled back to show him standing next to the computator on the table. "This machine is capable of operating for days at a time, even under adverse conditions. It can still operate at full capacity even if up to 25% of its tubes are rendered inoperable. We're quite proud of it. We are making great advances each day, and I predict we'll see computators within 10 years that will be able to perform useful math functions and will fit in your hand."

The narrator chuckled. "Now Doctor, let's not get ahead of ourselves! You've got a war to help win first!" The image of the scientist joined the disembodied narrator in the laughter. "And that will bring us to the end of another 'Future of War', brought to you by Movietone!" The picture faded to black as the reel ended. Phil hunkered down in his seat, preparing to enjoy the main feature.

Images of swiftly striding walkers lancing German tanks with ruby red death beams danced in his head.

Dr. John von Neumann

Dr. von Neumann was born in Budapest Hungary on December 28, 1903. He was a mathematical prodigy, showing talent for science at a young age. He studied chemistry in Budapest, Berlin and Zurich, receiving a degree in 1925, and subsequently worked toward a doctoral degree in mathematics in 1928. He was invited to Princeton in 1930, where he wound up teaching periodically for the remainder of his life.

As events turned for the worse in Europe, von Neumann, along with other expatriated scientists, was offered U.S. citizenship. This tapped the talents of many scientists during wartime, and their contributions were invaluable. Von Neumann worked with Alan Turing during his stay at Princeton, and he was quite taken with Turing's work. His talent for math and his interest in computing machines led to his work on computator architecture.

In addition to his computator work, von Neumann assisted the war effort in many ways. His abilities in hydrodynamics, ballistics, meteorology, game theory and statistics were utilized on a great many projects, particularly in the use of computators to help aim artillery.

COMPUTATORS

The computators of Turing, Atanasoff, Berry and Zuring are but the beginning of a whole new era in human achievement. The computators have thus far been fairly specialized in their function. They perform one or two specific tasks like calculate a specific mathematical family of equations, quickly try several possible encryption keys, or help control a walker. They are programmable, but the kinds of programs they can handle are still fairly primitive and not very flexible.

There are new computators being designed however that will expand their capabilities to allow for more flexible programs. Experiments with paper tapes and punch cards are leading to designs that will allow for note only data input but program input as well. One machine will be able to perform the work of many older models. Scientists are searching for better methods of storage as well such as magnetic wire tape.

One particulalry promising avenue of research is in the very architecture of the machines themselves. Dr. John von Neumann of the United States has been lending his mathematical and game theory talents to the design of computators. Rumor has it that he has some revolutionary ideas on how to allow the various sub-parts be designed to communicate with each other while at the same being more flexible in their programming. Computators will be able to perform tasks beyond anyone's wildest dreams should he succeed.

RADIO GUNS

As man works to tame the electromagnetc spectrum, he is finding new and destructive ways to harness its energy. The work of Tesla has ushered in a new era of using seemingly harmless energies for great destructive purposes. One of the new areas of research is in the field of stimulating microwave radio energy in such a way as to give it coherency and the ability to theoretically damage objects. Pioneering work in this field is being done by Charles Townes. He is working on what he calls a Maser, or Microwave Amplification by Stimulated Emission of Radiation. His work is independent of those working on the rumored lasers, which are supposed to be the same principle but with normal visible light. His theory involves exciting the molecules of certain substances and then allowing them to return to their normal state. The return to normal state causes the molecule to emit microwave energy, which in turn excites more molecules. The resulting wave of energy multiplies in amplitude, eventually producing a beam of energy that can damage other objects.

DEATH RAYS

Lasers, or Light Amplification by Stimulated Emission of Radiation, is a sister technology to Masers. The chief researcher in this field is Harry Grindell-Mathews. He is a protoge of Nikola Tesla, of who it is said also worked at one time or another on laser research. Grindell-Mathews was part of the groups of citizens that presented te original Canal Defense Light system to British government. He continued work on the system, refining it with ideas from people such as Townes. He has not fielded a working laser system on a tank yet, but he is reported to be close to doing so.

GUIDED MISSILES

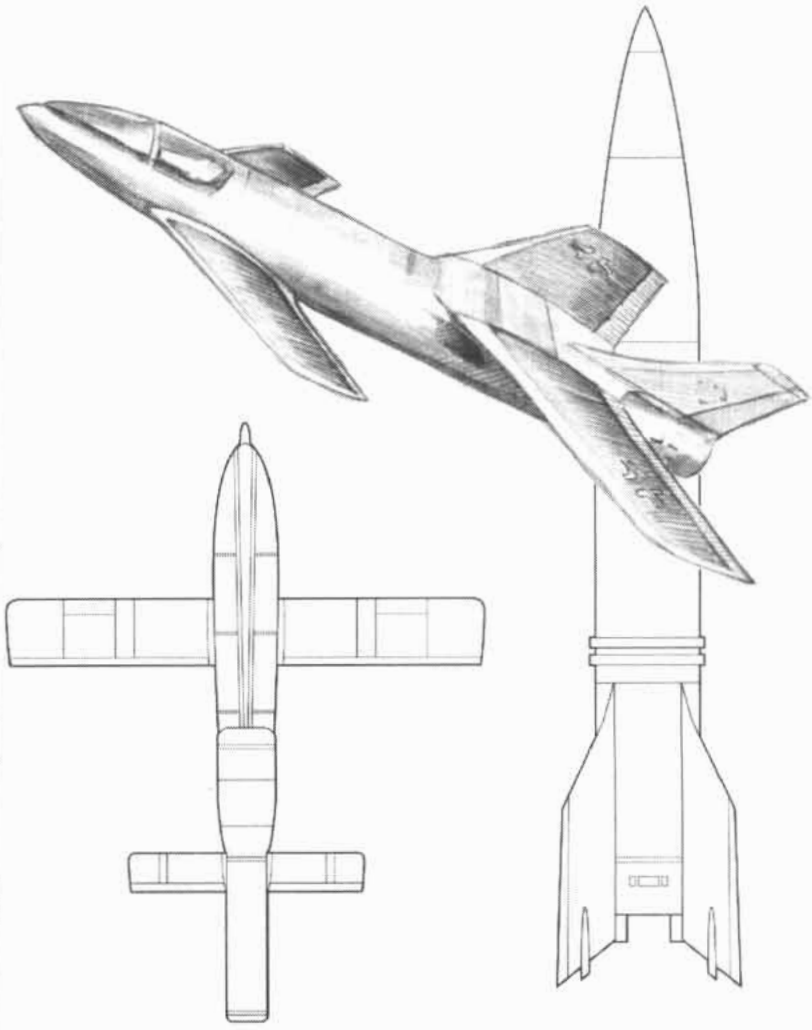
The United States and Germany have both designed and built crude guided weaponry. The German V series of rockets, the first guided ballistic missiles, have been terrorizing England. Guided by simple gyroscopes, the weapons are able to travel unheard of distances unaided by human hands. The Americans have been working on guided bombs, homing on sound and light. Both are said to be working on technoliges that marry both families of weapons - rockets and small, accurate guidance packages to construct weapons that can hit targets beyond visual ranges with decent accuracy. Thus far the greatest

successes have been with weapons that work from air-launched systems. Weapon prototypes working from the ground have had a great deal of trouble with the large amount of cluttering signals. These signals confuse the guidance system too much, rendering the weapons useless for precision strikes. As a result, the first weapons will most likely be used by and against the air forces of the world.

SPACE

The last great unexplored vista for humankind is space. People have fantasized about traveling space since ancient times, but only recently has the power of scientific though been wielded to make travel a reality. Since the formation in the second half of the 1800s of societies dedicated to space travel,humankind has made phenomenal strides towards escaping the trapping of Earth. Rocketry, computational science and material science are but a few of the superscience disciplines that will be combined to allow people to travel in space.

While designing new weapons to wage war, the nations fighting in World War II are keeping their eye on the new frontier of space. Like all other obstacles before them, these nations seek to dominate the new territory space presents. Like land, sea, and air before it, space will belong to the power than can tame it first and best. As aircraft design is pushed to its limits, new designs that can go past the atmosphere are now being contemplated. While war wages in Europe and the Pacific, the Allies and Axis powers are working to conduct war in yet another theatre. This war will be a war without sound, defeaning only in its silence.



Heinlein, Clarke, and Asimov: Science Fiction and Science Fact

The works of authors in the late 19th century help give rise to superscience as an accepted part of life. The new genre of literature, know as science fiction, is still in it's infancy during World War II. The wonders of the Modern Age will fuel the imaginations for future authors, sprouting new ideas and machines fantastic even for a populace raised on superscience.

The future authors of this new wave of fiction can be found working in the heart of the war effort. Isaac Asimov is teaching as Boston University, helping to train the scientists of tomorrow. Arthur C. Clarke is an officer in the Royal Air Force, working with the use of Radar to help guide planes to safe landings in even the most adverse of conditions. Robert A. Heinlein is an officer in the U.S. Navy, serving in the Pacific. The experiences these men are accumulating will no doubt fuel their writing careers once the war is over.

VISIONARY SCIENTIST

A Visionary Scientist is not just a remarkably talented academic: he sees things in a different way. His leaps of logic astound others with their seemingly ethereal inspiration, and he remains baffled by the inability of others to see what to him is just plain common sense. Often without money, he is searching for the funding that would allow him to make his next discovery. He is certain he can solve all the great mysteries of the universe, if only he could find his notes! Visionary Scientists are found in labs writing away on chalkboards or arguing scientific minutiae with colleagues at conferences. They are also often found arguing with government officials who do not understand their vision. Nikolai Tesla is a good example of Visionary Scientist.

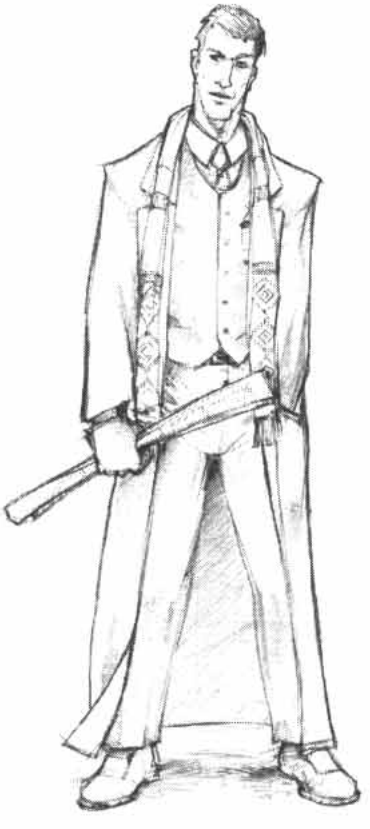
Attributes

AGI	-1	APP	0	BUI	-1	CRE	+2	FIT	-1
INF	-1	KNO	+2	PER	+2	PSY	0	WIL	-1
STR	-1	HEA	0	STA	20	UD	1	AD	1

Skills

Skill	Level	Attribute	Specialization
Electronics	2	+2	Communications
Electronics Design	3	+2	Communications
Mechanic	1	+2	None
Physical Science	3	+2	Electromagnetism

Equipment: Numerous notebooks, stacks of paper with indecipherable notes, rumpled clothes, bad hair cut, shoes on the wrong feet.



VISIONARY INVENTOR

Inventors come from all walk of life until they come upon some concept, solution or idea. They then become consumed by it, spending years in the pursuit of their vision. They tend to be found trying to 'sell' their new invention to someone; unfortunately, Visionary Inventors are usually ahead of their time, so most people are unaware of how revolutionary their work are. Inventors tend to be more grounded in the world than their scientist counterparts, but not by much. They can be found in labs, secret bases, hangars, arguing with government officials, at field trials, or asking for assistance to get their invention on a truck (due to some problem with a recent test, no doubt). Walther J. Christie is a good example of Visionary Inventor.

Attributes

AGI	0	APP	0	BUI	0	CRE	+2	FIT	0
INF	-1	KNO	+1	PER	+1	PSY	0	WIL	0
STR	0	HEA	0	STA	25	UD	3	AD	3

Skills

Skill	Level	Attribute	Specialization
Mechanics	3	+1	Walkers & Tanks
Mechanical Design	3	+1	None
Theatrics	2	-1	Demonstration
Tinker	3	+2	Walkers & Tanks
Visual Arts	2	+2	Airbrush Photos

Equipment: Numerous notebooks, stacks of paper with indecipherable notes, rumpled work clothes, precision tools, schematics, prototypes or concept mach-ups.

MATHEMATICIAN

Mathematicians are the architects of the new age of computators: they use the complex devices to perform calculations never before possible. If they can't finish an equation, then they just modify the machine to do it. Mathematicians are also the leaders in cryptology, seeing patterns in numbers and letters where ordinary people cannot. A Mathematician can be found in the halls of universities, much like any other scientist; they are also found in secret government locations, cracking codes and devising new computing machines. Alan Turing is a good example of Mathematician.

Attributes

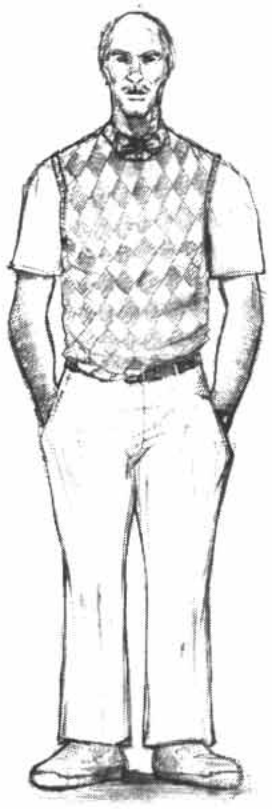
AGI	-1	APP	-1	BUI	-1	CRE	+1	FIT	-1
INF	-1	KNO	+2	PER	0	PSY	-1	WIL	+1
STR	-1	HEA	0	STA	20	UD	1	AD	1

Skills

Skill	Level	Attribute	Specialization
Communications	3	+2	Decryption
Computator	2	+2	Design & Programming
Electronics	3	+2	Computators
Electronics Design	2	+2	Computators
Physical Science	3	+2	Mathematics
Tinker	3	+1	Computators

Equipment: Today's crossword, slide rule, pencil behind the ear, computator cards.

ENGINEER/TEST PILOT



When an Engineer designs a new vehicle, he does not always have the luxury of finding someone willing to try it out at first. When no one is willing, the Engineer dons his second cap and becomes the Test Pilot. Forging the way to new frontiers of travel, the Engineer/Test Pilot is happiest when tinkering with a new design and getting to be the first to try it out. Even when a test pilot can be found, he often prefers to be the first guinea pig. Engineer/Test Pilots are most often found in their workshops or just outside of them, where they madly tinker away or sit chin in hand over a drafting table contemplating the geometry of a gear or wing. They can be seen bouncing around in their new car or flying obstacle courses in their latest jet; sometimes they are even showing off their creation to adoring fans and prospective buyers on the sidelines. Igor Sikorsky is a good example of Engineer/Test Pilot.

Attributes

AGI	+1	APP	0	BUI	0	CRE	+2	FIT	0
INF	0	KNO	+1	PER	+1	PSY	0	WIL	+1
STR	0	HEA	0	STA	25	UD	3	AD	3

Skills

Skill	Level	Attribute	Specialization
Aircraft Pilot	2	+1	Autogyro & Helicopter
Mechanics	3	+1	Rotary Aircraft
Mechanical Design	3	+1	None
Tinker	3	+2	Rotary Aircraft

Equipment: Slide rule, flight goggles, overcoat, drafting tools.

MECHANICAL GENIUS

Mechanical Geniuses seek how to make machine work better. Often years ahead of their time, they build machines with capabilities far beyond the norm: their vehicles have features no other vehicle has; their televisors have color, where all others are only in black and white; their engine runs on clean types of fuel. Mechanical Genius are easy to find — they will be in their shop, fiddling with a new revolutionary modification. They have the courage to make sweeping changes, eschewing the cost (monetary and personal). When their new wonder is finished, they will proudly present it to the world in a grand spectacle. Once they've spent all of their venture money, though, they can be hard to find... Tucker is a good example of Mechanical Genius.

Attributes

AGI	+1	APP	0	BUI	0	CRE	+2	FIT	0
INF	0	KNO	+1	PER	+1	PSY	0	WIL	0
STR	0	HEA	0	STA	25	UD	3	AD	3

Skills

Skill	Level	Attribute	Specialization
Drive	2	+1	Race Cars & Prototypes
Electronics	3	+1	Motor Controls
Mechanics	3	+1	Race cars & Walkers
Theatrics	2	0	Salesmanship
Tinker	3	+2	Race cars & Walkers

Equipment: Tool box, latest mechanical doohickey, scale models.

PHILANTHROPIST

When he becomes interested in a new idea, the rich Philanthropist commits all of his being and assets to realizing it. If it fails, he runs the risk of losing it all; if it bears fruit, he will be even more wealthy than before. The shrewdest philanthropists hedge their bets, keeping some of their wealth in reserve — for the next big idea to come along. Philanthropists can be found all over the place, enjoying media coverage wherever they go. They race cars, horses and planes, and rub elbows with well-known movie stars. They even appear before Congress, using their extensive political connections to demand fair business rules for their latest endeavor or support for a secret mission or project. Howard Hughes is a good example of Philanthropist.

Attributes

AGI	+1	APP	+1	BUI	0	CRE	+1	FIT	0
INF	+2	KNO	+1	PER	+1	PSY	-1	WIL	+2
STR	0	HEA	0	STA	25	UD	3	AD	3

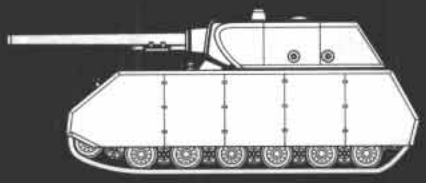
Skills

Skill	Level	Attribute	Specialization
Aircraft Pilot	2	+1	Autogyro & Amphibious
Bureaucracy	3	+1	Government & Military
Business	3	+1	None
Human Perception	3	+2	Business Deals
Psychology	2	+1	Behavior Perception

Equipment: Luxury cars, planes, movie star's address book, money, cigarette case, lighter, tuxedo, escorts.

GEAR KRIEG™

PKKPFW VIII "MAUS"



Year In Service:	1943	Maneuver:	-3	Armor:	26/52/78
Threat Value:	276	Fire Control:	-1	Movement:	Ground 2/3
Size:	19	Sensors:	None	Deployment Range:	100km
Crew:	6	Communications:	-1/5km		

PERKS & FLAWS

Buttoned Up, Defective FC (R1), Inefficient Controls, Large Sensor Profile (R3), Reinforced Armor (R4, Front)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
17cm KwK 44	T	9	18	36	72	0	x16	1	68	-
7.5cm KwK 44L/36.5	T	5	10	20	40	0	x10	1	200	-
7.92mm LMG	T	1	2	4	8	0	x2	1	1200	ROF2, AI, Coax
7.92mm LMG	T	1	2	4	8	0	x2	1	1200	ROF2, AI, Coax

VARIANTS Protoype, TV: 254 Year In Service: 1943 (Spring)

Remove: 17cm KwK 44

Add: 15cm KwK 44, Random Shutdown (R1)

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
15cm KwK 44	T	7	14	28	56	0	x15	1	68	-

Change: Movement: Ground 1/2

BY DREAM POD 9

PkKpfw VIII "Maus" VARIANTS

Ausf C, TV: 302 Year In Service: 1943

Remove: 7.5cm KwK 44

Add: 1 x Flamethrower, Hazardous Ammo/Fuel Supply

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Flamethrower	T	0	0	1	2	+1	x7	1	300	ROF1, SB

Ausf E, TV: 276 Year In Service: 1943

Remove: Turret Weapons

Add: 2 x 8.8cm KwK 43 L71, Sensors: -2/1km

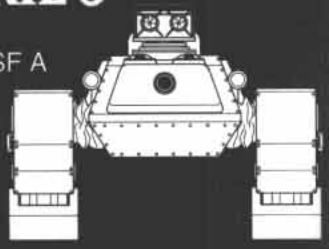
Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
8.8cm KwK 43 L/71	T	7	14	28	56	0	x14	2	236	-

Change: Communications: -1/8km

BY DREAM POD 9

GEAR KRIEG™

PZKF VII "JUTAN" AUSF A



Year In Service:	1944	Maneuver:	-1	Armor:	14/28/42
Threat Value:	210	Fire Control:	0	Move.:	Walker 2/3, Ground 2/4
Size:	9	Sensors:	-2/2km	Deployment Range:	100km
Crew:	3	Communications:	-2/4km		

PERKS & FLAWS

Defective FC (R1), Inefficient Controls, Overheating, Reinforced Armor (R1, Front), Reinforced Crew

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
8.8cm KwK 43 L/71	FF	7	14	28	56	0	x14	1	10	-
7.92mm LMG	F	1	2	4	8	0	x2	1	300	ROF2, AI
R-92 Missile	T	5	10	20	40	+1	x14	2	-	-
Grenades	F	-	-	-	-	-1	x10	-	4	AI
Smoke	FF	-	-	-	-	0	-	1	4	Obsc:2
Frag Dischargers	FF	-	-	-	-	-1	x3	-	8	AI, AEO

BY DREAM POD 9

PzKf VII "Jutan" Ausf A VARIANTS

Ausf B, TV: 205 Year In Service: 1944

Remove: 8.8cm KwK 43

Add: 1 x Flamethrower

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Flamethrower	FF	0	0	1	2	+1	x7	1	30	ROF1, SB

Ausf C, TV: 213 Year In Service: 1944

Change: Movement: Walker 2/3, Rail 5/10

Ausf D, TV: 475 Year In Service: 1944

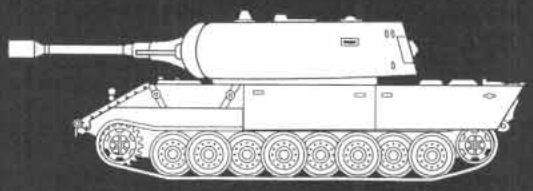
Remove: 8.8cm KwK 43, R-92s

Add: Quad 40mm AA Guns, Anti-Air

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Heavy AA	DT	2	4	8	16	0	x10	4	60 each	Link, AE: 3

GEAR KRIEG™

PZKPFW E-100



Year In Service:	1945	Maneuver:	-3	Armor:	26/52/78
Threat Value:	299	Fire Control:	-1	Movement:	Ground 2/4
Size:	17	Sensors:	-2/1km	Deployment Range:	120km
Crew:	8	Communications:	-1/8km		

PERKS & FLAWS

Buttoned Up, Defective FC (R1), Easy To Modify, Large Sensor Profile (R3), Reinforced Armor (R4, Front)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
17cm KwK 44	T	9	18	36	72	0	x16	1	68	-
7.5cm KwK 44L/36.5T	T	5	10	20	40	0	x10	1	200	-
7.92mm LMG	T	1	2	4	8	0	x2	1	1200	ROF2, AI, Coax
7.92mm LMG	T	1	2	4	8	0	x2	1	1200	ROF2, AI, Coax

VARIANTS: Ausf B, TV: 485 Year In Service: 1945

Remove: Turret Weapons

Add: 2 x 8.8cm KwK 43 L71, Sensors: -2/1km

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
8.8cm KwK 43 L/71T	7	14	28	56	0	x14	2	236	-	

Change: Fire Control: 0

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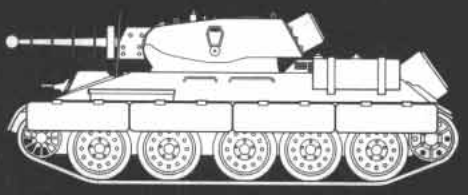
T-44/E43



Year In Service:	1944	Maneuver:	-3	Armor:	18/36/54
Threat Value:	81	Fire Control:	-2	Movement:	Ground 3/6
Size:	11	Sensors:	None	Deployment Range:	300km
Crew:	4	Communications:	None		

PERKS & FLAWS

Buttoned Up, HEP: Cold Weather, Improved Off-Road, Inefficient Controls, Large Sensor Profile (R1), Reduced Armor (R2, Rear)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Tesla Model 43	T	2	4	8	16	0	x10	1	35	Haywire, AD1, PH2
7.62mm LMG	T	1	2	4	8	0	x2	1	-	ROF2, AI, Coax
7.62mm LMG	FF	1	2	4	8	0	x2	1	-	ROF2, AI
LMG Ammo Bin									1890	-

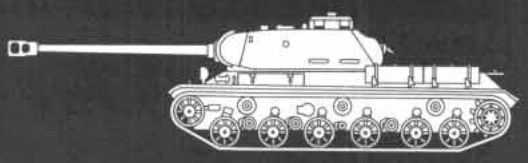
VARIANTS: Command, TV: 81 Year In Service: 1944

Add: Communications: -1/3km

Change: LMG Ammo 1570

GEAR KRIEG™

IS-II "IOSEF STALIN"



Year In Service:	1943	Maneuver:	-3	Armor:	20/40/60
Threat Value:	104	Fire Control:	-2	Movement:	Ground 2/5
Size:	12	Sensors:	None	Deployment Range:	250km
Crew:	4	Communications:	-1/3km		

PERKS & FLAWS

Buttoned Up, HEP: Cold Weather, Improved Off-Road, Inefficient Controls, Large Sensor Profile (R2), Reinforced Armor (R4, Front)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
122mm D-25	T	6	12	24	48	0	x13	1	28	-
7.62mm LMG	T	1	2	4	8	0	x2	1	-	ROF2, AI, Coax
7.62mm LMG	FF	1	2	4	8	0	x2	1	-	ROF2, AI
7.62mm LMG	FR	1	2	4	8	0	x2	1	-	ROF2, AI
LMG Ammo Bin									2330	-

VARIANTS: IS-III, TV:115 Year In Service: 1944 (late)

Remove: 122mm D-25

Add: 1 x 152mm D-35

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
152mm D-35	T	7	14	28	56	0	x15	1	25	-

Change: Deployment Range: 190km, LMG Ammo 1000

IS-II "Iosef Stalin" VARIANTS

IS-IV, TV: 127 Year In Service: 1945

Remove: 122mm D-25

Add: 1 x EUEA Tesla Model 44

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Tesla Model 44	T	3	6	12	24	0	x15	1	35	Haywire, AD1, PH2

Change: Deployment Range: 190km, LMG Ammo 1000

GEAR KRIEG™

SHIKI 42 "ONI"

Year In Service:	1942	Maneuver:	-1	Armor:	9/18/27
Threat Value:	48	Fire Control:	-1	Movement:	W 3/6, N 2/4, S 1/2
Size:	7	Sensors:	None	Deployment Range:	75km
Crew:	2	Communications:	None		

PERKS & FLAWS

Amphibious, Buttoned Up, Inefficient Controls, Limited Life Support, 2 x Manipulator Arms (R5, Punch), Reinforced Armor (R1, Front)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Anti-Ship Mine	F	-	-	-	-	0	x12	-	1	-
7.7mm LMG	F	1	2	4	8	0	x2	1	150	ROF2, AI
7.7mm LMG	Rr	1	2	4	8	0	x2	1	150	ROF2, AI
Grenades	F	-	-	-	-	-2	x9	-	3	AI

VARIANTS "Ryujin", TV: 83 Year In Service: 1942

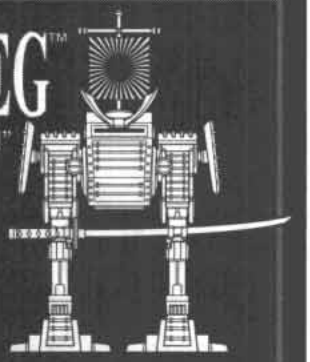
Remove: LMGs

Add: 1 x Flamethrower, Hazardous Ammo/Fuel Supply

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Flamethrower	T	0	0	1	2	+1	x7	1	50	ROF1, SB

GEAR KRIEG™

SHIKI 43 "SAMURAI" PROTOTYPE



Year In Service:	1943	Maneuver:	-1	Armor:	11/22/33
Threat Value:	49	Fire Control:	-1	Movement:	Walker 3/6
Size:	7	Sensors:	None	Deployment Range:	125km
Crew:	1	Communications:	None		

PERKS & FLAWS

Buttoned Up, Camouflage Netting, Improved Off-Road, 2 x Manipulator Arms (R6, Punch), Reinforced Armor (R1, Front)

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Katana 42	F	-	-	-	-	0	x6	1	-	-
Grenades	F	-	-	-	-	-2	x9	-	3	AI

VARIANTS Shiki 43, TV: 53 Year In Service: 1943 (late)

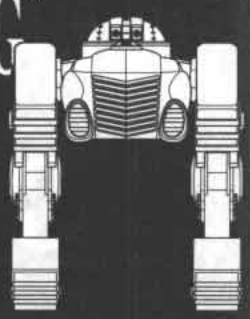
Remove: Katana 42

Add: 1x Katana 43

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
Katana 43	F	-	-	-	-	0	x8	1	-	-

GEAR KRIEG™

TUCKER HERMES PROTOTYPE



Year In Service:	1944	Maneuver:	0	Armor:	10/20/30
Threat Value:	100	Fire Control:	-1	Movement:	Ground 2/4
Size:	7	Sensors:	None	Deployment Range:	100km
Crew:	2	Communications:	-1/5km		

PERKS & FLAWS

Inefficient Controls, Manipulator Arms (R2, Punch), Reinforced Armor (R1, Front), Reinforced Crew Compartment

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
.50 T1 HMG	T	1	2	4	8	+1	x4	2	350 each	ROF1, AI

GEAR KRIEG™

Year In Service:		Maneuver:		Armor:	
Threat Value:		Fire Control:		Movement:	
Size:		Sensors:		Deployment Range:	
Crew:		Communications:			

PERKS & FLAWS

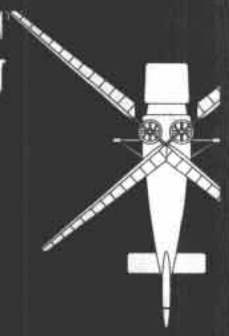
WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec

VARIANTS:

GEAR KRIEG

FL 282 "KOLIBRI" HELODYNE



Year In Service:	1942	Maneuver:	0	Armor:	3/6/9
Threat Value:	20	Fire Control:	None	Movement:	Air 13/25, VTOL
Size:	3	Sensors:	None	Deployment Range:	300km
Crew:	1	Communications:	-2/60km		

PERKS & FLAWS

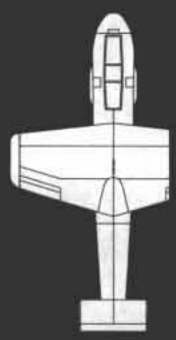
Maximum Ceiling (R8), Cannot Glide, Difficult to Bail, Exposed Movement System, Exposed Crew, VTOL

WEAPONS

None

GEAR KRIEG™

HEINKEL P.1077 "JULIA" PROTOYPE



Year In Service:	1942	Maneuver:	-2 (-3*)	Armor:	3/6/9
Threat Value:	88	Fire Control:	-2	Movement:	Air 15/30, VTO
Size:	4	Sensors:	None	Deployment Range:	64km
Crew:	1	Communications:	-2/60km	Stall Speed:	8

Rocket penalty included vis-à-vis Turn Radius

PERKS & FLAWS

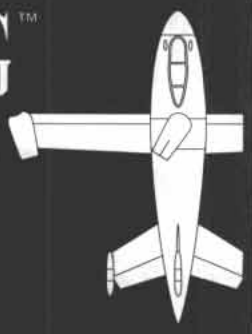
Fragile, Hazardous Ammo/Fuel Storage, Rocket Powered

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
30mm Mk108	FF	3	6	12	24	0	x6	2	60 each	Linked, ROF1

GEAR KRIEG™

FOCKE WULFE TRIEBFLÜGLE PROTO.



Year In Service:	1943	Maneuver:	-1	Armor:	4/8/12
Threat Value:	87	Fire Control:	-2	Movement:	Air 16/31, VTOL
Size:	4	Sensors:	None	Deployment Range:	1200km
Crew:	1	Communications:	-2/60km	Stall Speed:	0

PERKS & FLAWS

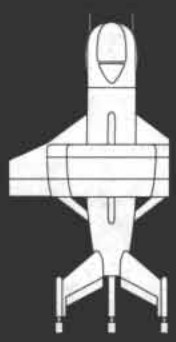
Cannot Glide, Difficult to Bail

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
30mm Mk108	FF	3	6	12	24	0	x6	2	60 each	Linked, ROF1
20mm MG151	FF	2	4	8	16	0	x6	2	120 each	Linked, ROF2

GEAR KRIEG™

HEINKEL WESPE PROTOTYPE



Year In Service:	1943	Maneuver:	-1	Armor:	6/12/18
Threat Value:	63	Fire Control:	-2	Movement:	Air 14/27, VTOL
Size:	4	Sensors:	None	Deployment Range:	950km
Crew:	1	Communications:	-2/60km	Stall Speed:	0

PERKS & FLAWS

Cannot Glide

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec
30mm Mk108	FF	3	6	12	24	0	x6	2	60 each	Linked, ROF1

GEAR KRIEG™

SIKORSKY VS-300
HELODYNE PROTOTYPE

BY DREAM POD 9

Year In Service:	1941	Maneuver:	0	Armor:	1/2/3
Threat Value:	3	Fire Control:	None	Movement:	Air 7/13, VTOL
Size:	3	Sensors:	None	Deployment Range:	100km
Crew:	1	Communications:	None		

PERKS & FLAWS

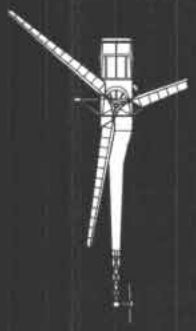
Maximum Ceiling (R11), Cannot Glide, Difficult to Bail, Exposed Movement System, Exposed Crew, VTOL

WEAPONS

None

GEAR KRIEG™

SIKORSKY R-1
HELODYNE



BY DREAM POD 9

Year In Service:	1943	Maneuver:	0	Armor:	2/4/6
Threat Value:	7	Fire Control:	None	Movement:	Air 9/17, VTOL
Size:	4	Sensors:	None	Deployment Range:	210km
Crew:	2	Communications:	-2/90km		

PERKS & FLAWS

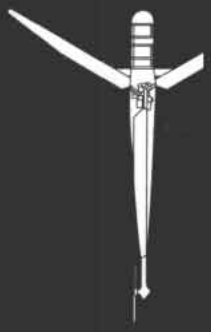
Maximum Ceiling (R8), Cannot Glide, Difficult to Bail, Exposed Movement System, VTOL

WEAPONS

None

GEAR KRIEG™

SIKORSKY R-5
HELODYNE



BY DREAM POD 9

Year In Service:	1944	Maneuver:	0	Armor:	3/6/9
Threat Value:	30	Fire Control:	None	Movement:	Air 15/29, VTOL
Size:	4	Sensors:	None	Deployment Range:	580km
Crew:	2	Communications:	-2/90km		

PERKS & FLAWS

Maximum Ceiling (R8), Cannot Glide, Difficult to Bail, Double Towing Capacity, Exposed Movement System, VTOL

WEAPONS

None

GEAR KRIEG™

BY DREAM POD 9

Year In Service:		Maneuver:		Armor:	
Threat Value:		Fire Control:		Movement:	
Size:		Sensors:		Deployment Range:	
Crew:		Communications:			

PERKS & FLAWS

WEAPONS

Name	Arc	S	M	L	Ex	Acc	DM	#	Ammo	Spec

VARIANTS: