History of Rocketry and Astronautics

Proceedings of the Twentieth and Twenty-First History Symposia of the International Academy of Astronautics

Innsbruck, Austria, 1986

Brighton, United Kingdom, 1987

Lloyd H. Cornett, Jr., Volume Editor

R. Cargill Hall, Series Editor

AAS History Series, Volume 15

A Supplement to Advances in the Astronautical Sciences

IAA History Symposia, Volume 9

AAS Publications Office
P.O. Box 28130
San Diego, California 92198

Affiliated with the American Association for the Advancement of Science
Member of the International Astronautical Federation

First Printing 1993

ISSN 0730-3564

ISBN 0-87703-376-5 (Hard Cover)
ISBN 0-87703-377-3 (Soft Cover)

Published for the American Astronautical Society
by Univelt, Incorporated, P.O. Box 28130, San Diego, California 92198

Printed and Bound in the U.S.A.

Chapter 8

SPECULATIVE SPACECRAFT, 1610-1957*

Ron Miller†

Astronautics is unique among the sciences in having its roots buried so deeply within the human imagination. It evolved from a desire to visit and explore worlds beyond our own. That there might be such places is a relatively modern concept. Before the time of Galileo, the Moon was thought of as a kind of ethereal place, not made of the base materials that formed the Earth, and the planets were only a peculiar kind of star—the notion that one could visit a point of light must have seemed absurd.

In 1610, when Galileo first turned a telescope toward the heavens (and what a great exercise of imagination that was; to even suspect that there might be something in the sky beyond the power of the human eye to see!), the known Earth was in a frenzy of exploration. The New World had been discovered by Columbus 118 years earlier, effectively doubling the size of the planet. There, across an ocean, whole new continents had lain unsuspected. Anyone who cared to do so could buy a ship, or sign aboard one, and go off to explore a wholly alien world. How frustrating it must have been to have had whole planets hanging in the sky where they could be seen by anyone, yet with no way of being reached!

EARLY DEVELOPMENT

Some of this wishful thinking was succinctly expressed by Bishop John Wilkins in 1638 [1]. While he had nothing to suggest as a *means* for leaving the Earth, he summed up, as far as it was then known, the specifications for a space-traveling vehicle. He believed "seriously, and upon good grounds [that it is] possible to make a flying-chariot. . ." and agreed with Kepler that as soon as such devices were available, the colonization of the Moon would not be far behind. Wilkins' criteria (in 1648, he listed the "four several ways" by which flight might be accomplished, the fourth being "by a flying chariot") [2] and enthusiasm influenced several generations of wishful spacecraft designers that followed.

* Presented at the Twenty-First History Symposium of the International Academy of Astronautics, Brighton, United Kingdom, 1987.

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In the same year that Bishop Wilkins was first taking the idea of space travel seriously, Francis Godwin—under the pseudonym "Domingo Gonzales"—wrote the first interplanetary novel in English literature: *The Man in the Moone.* Unfortunately, it was not the step forward that his compatriot's *A Discourse Concerning A New World and Another Planet* had been. His science, especially the descriptions of conditions in outer space, were very much behind the knowledge available in the time in which we wrote. On the other hand, Danish astronomer Johannes Kepler, who had his novel *Somnium* published posthumously in 1634, described the perils of interplanetary flight, and the hostile conditions on the surface of the Earth's Moon with an accuracy that was unshaken until relatively modern times. It is only that Kepler chose to make his flight from the Earth to the Moon by magical means that he has no place in this history. Godwin's method was only slightly less fantastical: a bevy of unusual swans called "ganzas" are attached to a light framework, from which hung suspended a trapeze-like seat. As the swans were of a species that periodically migrated to the Moon, they carried their passenger, at a rate of 175 miles an hour, to that satellite, arriving in just 12 days [sic].

Cyrano de Bergerac masterfully parodied these many inventive if ridiculous schemes in his *Histoire Comique* (1657). In it he described a number of highly imaginative methods for reaching the Moon. Serendipitously he stumbled upon the correct answer, and penned the first description of a manned rocket in literature.

Once the discoveries of Galileo and Copernicus transformed the planets from points of light in the sky into worlds in their own right, there began speculation concerning the possibility that these new worlds might be *inhabited.* This inspired a series of works by authors and philosophers throughout Europe, beginning with Bernard le Bouvier De Fontenelle's *Entretiens sur la Pluralite des Mondes* (1686). These were extremely popular works within those intellectually awakening times, and helped feed the burgeoning enthusiasm to discover a method by which these fabulous worlds might be visited—and perhaps colonized.

Still, there was no method known by which a man could leave the surface of the Earth. Before the year 1783, no one had ever left the Earth for any greater distance than he could jump. This didn't deter the imaginative authors of the time. Daniel Russen, whose *Iter Lunaire* (1703) proposed probably one of the most naive space-travel schemes in all of history: a giant leaf spring that has one end attached to the Earth and a car or seat attached to the other. The spring is bent double, the passenger takes his place, and the spring is released. When the free end reaches the Moon, the astronaut simply steps out onto the surface. it might be useful to point out that Russen took de Bergerac's work seriously!

In 1705 Daniel DeFoe described a winged flying machine powered by an internal combustion engine, and the use of hibernation during a long spaceflight [3]. Pier Jacopo Martello in 1707 [4] described a winged spacecraft lifted by means of the "magnetic" energy created by a pair of amber globes; experimentation with the mysterious wonders of static electricity was the vogue among scientists, amateur and professional, in Europe at the time. Like radium 150 years later, electricity was the vogue all-purpose answer when an otherwise unavailable force was needed. The anonymous "Samuel Brunt" in *A Voyage to Cacklogallina* (1727) described a stream-

lined, winged spaceship. His hero was systematically acclimated to the rigors of spaceflight, including the lack of oxygen and weightlessness. Murtagh McDermot in 1728 [5] described the method used by his hero to *return* from the Moon: he is blown back to the Earth by the detonation of 7,000 barrels of gunpowder. The final descent is cushioned by the wings he prudently carried with him. In 1751 Ralph Morris wrote of a winged spaceship in *John Daniel* and Louis Guillaume De La Folie described an electrical spacecraft in 1775 [6]. The latter, like Martello's, was modeled on many static electricity-generating machines which were being experimented with throughout Europe.

In 1783 came the revelation that the dreamers of spaceflight had been craving. For the first time in history, men were able to leave the surface of the Earth in a device of their own building. The Brothers Montgolfier had invented the hot air balloon. Immediately, almost any other possible method of space travel was abandoned. Publishers and popular magazines featured novels and stories of spacefaring balloonists well into the following century. Perhaps the first of these, combining two great, current scientific discoveries, was "Vivenaire," writing in 1784. He described a flight by balloon to the newly discovered planet, Uranus. The equally anonymous "Aratus" in *A Voyage to the Moon* (1793) wrote of a trip to the Moon, where a civilization of English-speaking snakes are discovered. In 1808 a "Mr. Nicholas Lunatic, FRS" wrote of another trip to the Moon via balloon [7].

Meanwhile, in the country that gave birth to the balloon, pyrotechnician Claude Ruggieri, as a kind of publicity stunt, managed to launch a live ram aloft in a giant rocket. The animal soared to an altitude of 600 feet, returning safely to Earth by means of a parachute. No one, least of all Ruggieri, apparently realized the significance of this event: the anonymous sheep was the first living creature to survive a flight in a rocket. Eventually, Ruggieri announced that he intended to build a huge "combination-rocket" in which he planned to send a "young man" aloft. When the young man proved to be instead a small boy, police forbade the experiment, thus denying Wilfried de Fonvielle—later a noted balloonist—a special place in astronautical history.

In 1815, Edward Francesca Burney, in *Q.Q. Esq.'s Journey to the Moon*, made what was probably the first suggestion for a "space gun." Four large cannons, operating in parallel, were used to launch a small, conical capsule to the Moon. Burney's astronaut was equipped with possibly the first spacesuit ever described. The conical spacecraft was made of a partially-furled umbrella, which, when opened, allowed the astronaut to descend safely to the lunar surface.

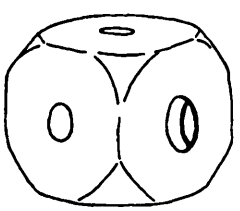

Figure 1 Tucker.

American George Tucker, writing in 1827 as "Joseph Atterley," described in *A Voyage to the Moon* what may be the first true spaceship (Figure 1) in literature, in that it made an attempt to deal with the known conditions of space in a realistic fashion. Although it is propelled by an imaginary anti-gravitational substance ("Lunarium"), the craft

itself is carefully thought out. It is made of copper in the form of a truncated cube, 6 feet on each side, reinforced with iron bars. It is tested by evacuating the air within it. A small, circular double sliding door is sealed and insulated with quilting. Air is carried compressed in a spherical tank. Tucker was a professor at the University of Virginia, and Edgar Allan Poe was one of his students for a year. It is entirely possible that Tucker influenced Poe in the writing of what was to become, in its turn, the single most realistic and influential space travel story written up to its time.

It is important to note that by the beginning of the 19th century, spaceflight, even in fiction, had to be accomplished by at least pseudoscientific means. Dreams, magic, and swans would no longer do.

THE FIRST SPACESHIPS

In 1835 Edgar Allan Poe published his novelette, *The Unparalleled Adventures of Hans Pfall.* Although written as a satire, it is one of the first attempts at scientific verisimilitude in space fiction. The story is crowded with minute, specific detail which, whether it is detail Poe made up from whole cloth or not, contributed toward an unprecedented sense of realism.

Poe's method of traveling to the Moon is by means of a balloon. It is strikingly reminiscent of the stratosphere balloons of the 1930s and 1950s. it is a vast bag, some 200 feet in diameter when fully inflated (with a mysterious gas "37.4 times lighter than hydrogen"). Flaccid and only partially inflated at the time of launch, it expands into a sphere when it ascends into the rarefied atmosphere high above the Earth. Suspended beneath the balloon is a standard wicker basket surrounded by an airtight rubber bag. This will also inflate into a sphere from internal pressure. It is filled with four round windows of thick glass. In the side of the sphere is an opening for an air compressor.

Poe's hero carries a full complement of scientific instruments and supplies, as well as food. His descriptions of the Earth as seen from space might have been written by an X-15 pilot or an astronaut.

What makes Poe's contribution to interplanetary literature so important is that for the first time it had become necessary to provide the trappings of known science. Poe realized that it was no longer sufficient to simply enable a character to reach the Moon or planets by *fiat.* The conditions at high altitudes were becoming well known, astronomers were becoming more assured about the nature of outer space, and the prevailing conditions on our own satellite. Any author who wished to write a story set beyond the Earth could no longer blithely ignore this knowledge, or make up conditions to suit himself. Poe established a *standard.*

The first author to make full use of Poe's example was the immortal Jules Verne—but the thirty years that separated *Hans Pfall* from Verne's novel saw an ever-increasing number of novels and stories about spaceflight. An anonymous *Adventures in the Moon and Other Worlds* (1856) described a trip in a mechanical spacecraft and Elbert Perce, in *Gulliver Joi* (1851), described a flight into space using a "variety of rocket." This may be the first suggestion of the use of rockets in

space travel, predating Jules Verne's better-known example by 15 years [8]. Miguel Estorch, writing in Spain in 1855, revived the idea of the space gun in his novel *Lunigrafia*. In it a 2-foot iron ball is shot to the Moon. Alexander Dumas *pere* wrote of an antigravity spacecraft in his *Voyage to the Moon* (1865). Dumas was a close friend of Verne, and it is not impossible that the idea for his novel was inspired by the book Verne was currently writing. Another antigravity spaceship was described in "Chrysostum Trueman's" novel, *A History of a Voyage to the Moon* (1865). Considerable thought is given to the construction of the spaceship: it is provided with air, food, water, and insulation. The outside is made of seasoned wood sealed with tar, the inside covered with sheet iron. A garden provides fresh oxygen—perhaps the first such suggestion for a sealed ecosystem.

Also in 1865 was published Camille Flammarion's nonfiction *Mondes imaginaires et mondes reels*. Flammarion was an extraordinarily popular writer about astronomical subjects, and this book added a great deal of fuel to the already smoldering desire to escape the Earth.

Also in 1865—a banner year for the publication of interplanetary fiction—was published Jules Verne's classic *From the Earth to the Moon*. Volumes can be—and indeed have been—written about this singular book. Since its first edition, it has never been out of print. Few other novels published 120 years ago have survived so well. As a result, it is probably unnecessary to recount the plot of the book. The list of prescient "predictions" that can be found in it is a long one. It would include such coincidental ones as the number of astronauts making the first journey to the Moon (3); the size, shape, and weight of the projectile, which closely approximated that of the Apollo command and service modules (Figure 2); the material the projectile was constructed of (aluminum); the blunt-end reentry into the Earth's atmosphere for an eventual ocean landing and recovery by a ship of the U.S. Navy; etc. More important, however, are Verne's virtual invention of astronautics, his awareness of many of the social effects of spaceflight, and the suggestion that rockets could be used to steer a spacecraft and that rockets would work in a vacuum. Verne also suggested the use of "light . . . as [a] mechanical agent" for rocket propulsion. Although it has become customary to sneer at the naiveté of Verne's method of launching his projectile—a 900-foot cannon sunk into the soil of Florida—internal evidence is strong that Verne knew exactly what he was doing. He was obviously aware of the giant cannon's weaknesses, but had little other choice. He was attempting to describe a spaceflight in the most believable possible terms, and the state of rocketry in the 1860s would have made the use of rockets impossible. Verne's readers simply would have thought the idea of launching a vehicle to the Moon by way of rocket power laughable.

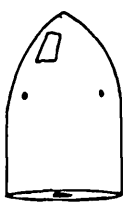

Figure 2 Verne.

Verne's novel has been enormously influential on the history and development of rocketry and spaceflight. The pioneers of astronautics who credit Verne with inspiring their careers include Goddard, Tsiolkovsky, and Oberth. Astronomer

Robert Richardson wrote that "There can be no doubt that Jules Verne's *Trip to the Moon* with all its faults has exerted a powerful effect on human thought in preparing our minds for this greatest of all adventures." [9].

From the Earth to the Moon was also the progenitor of a special kind of speculation concerning spaceflight, in which no materials, techniques or science are used that are not available at the time of writing. Verne could easily have opted for some variety of antigravity, as most other authors of his century were doing. But this would have violated the rule by which he was playing: to show how it would have been possible to travel to the Moon using the science and technology available in 1865.

In the same year that saw the Verne novel, also appeared what has been long considered a rival for the honor of having first suggested the use of rockets in navigating space, Achille Eyraud's *Voyage a Venus*. However, it is debatable that it appeared before Verne's book, which was serialized in magazine form before hardcover publication. Nevertheless, Eyraud's description of the operation of his rocket-propelled spacecraft is so erroneous—he obviously had no idea of *how* a rocket worked—that it is a moot point.

THE LATE VICTORIANS

Edward Everett Hale published his short, humorous novel, *The Brick Moon*, in 1869. In it he described, in meticulous detail, the construction, launch and eventual practical use of an artificial Earth satellite—the first such suggestion ever made. Intended to be used as a navigational aid, along with three others, the 200-foot, ceramic-coated sphere is accidentally launched with its workmen aboard. In the course of the story, Hale foresaw the navigation satellite, the use of satellites in geodesy, mapping, reconnaissance, communications, sea surveillance, bioscience, meteorology, and orbital rendezvous.

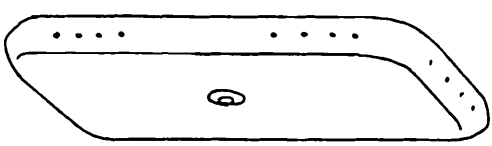

Figure 3 The Astronaut.

In 1871, the French scientist Tridon invented a high-altitude balloon gondola that bore more than a passing resemblance to that described in Poe's novelette [10].

In 1880 Percy Greg published his long novel, *Across the Zodiac*. In it he details the enormous spaceship *Astronaut*, Figure 3, (which was almost certainly the first use of this word, though not in its modern sense). This is a huge vessel 150-feet long, 50-feet wide and 20-feet high, with metal walls 3-feet thick. The top and bottom are flat. Glass windows are let into the sides, roof, and floor. In addition to rather luxurious Victorian furnishings, there is a waste-absorbing garden. It is propelled by a variety of antigravity called "apergy," a repulsive force.

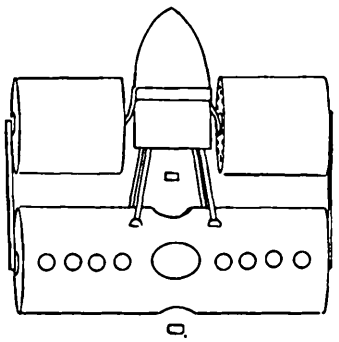

Figure 4 Ganswindt.

In the following year, Hermann Ganswindt, in a lecture given in Berlin's Philharmonic Hall, described his interplanetary rocket vehicle (Figure 4). This was the first serious proposal for a rocket-powered spaceship. He elaborated on his plans in 1891. As Ganswindt later described his spaceship, it operated by firing a series of steel projectiles from a central firing chamber, fed like a Gatling gun from a pair of cylindrical reservoirs. Half of the charge would be ejected from the nozzle, the other half striking the upper part of the chamber, transmitting its energy to the rocket. Ganswindt was convinced (as were a great many more knowledgeable scientists) that a rocket moved by virtue of the resistance of the atmosphere to its exhaust, and in order to allow his spaceship to operate in a vacuum, thought it was necessary to provide it with something to push against. The ship was given its initial start by being carried to a great altitude by balloons or, as he later improved it, by a helicopter. The entire ship could be made to spin along the axis of its acceleration, to provide artificial gravity for its passengers. Ganswindt did have the original idea of connecting two spacecraft by a long cable, and rotating them around their common center to create artificial gravity.

Andre Laurie (pseudonym for Paschal Grousset) deserves at least a brief mention for proposing what must be the most extravagantly impossible scheme for reaching the Moon since Davis Russen. Instead of traveling *to* the Moon, the heroes of *Conquest of the Moon* (1888) pull the Moon down to the Earth's surface by using a giant electromagnet!

In 1890, F. Gomez Arias developed the first serious spacesuit design. In the following year Robert Cromie's *A Plunge Into Space* described a 50-foot spherical spaceship propelled by antigravity. The novel boasted a preface by Jules Verne. In 1894 popular science writer Garrett P. Serviss published his first novel, *A Columbus of Space*. Although it, too, is lifted by antigravity, Serviss' spaceship is unique in that it is powered by nuclear energy. It operates by extracting "interatomic energy," converting it into the antigravity force. Even waste products from the air-conditioning system can be used in the atomic engine. The boiler-shaped vehicle was the first spacecraft ever to employ atomic power.

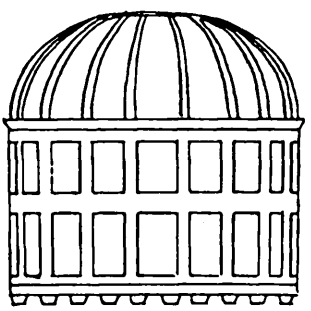

Figure 5 Callisto.

1894 saw a space travel novel by the most unlikely of authors: financier John Jacob Astor. In *A Journey in Other Worlds* he described the spaceship *Callisto* (Figure 5). Like the *Astronaut* it was propelled by "apergy." 1894 also saw publication of Fred T. Jane's *Guesses at Futurity*, a series of illustrated articles on life in the future. In

it appeared a number of spacecraft and, in one installment, a lunar colony. In 1897, Jane published the novel, *To Venus in 5 Seconds*, which contained what is probably the first description of a matter-transmitter. Jane was also the illustrator of many of H. G. Wells' novels, but is probably best known as the founder of the series of reference books that still bears his name.

By this time serious scientific studies had taken place, investigating the possibilities of spaceflight, and the use of the rocket. By the turn of the century, Wolfke, Federov, and Tsiolkovsky had all done much theoretical work. When this work was published, it influenced both theorists and writers.

John Munro, in his 1897 novel, *A Trip to Venus*, had the misfortune to dismiss the possibilities of both the mass driver and the rocket in favor of antigravity. Kurd Lasswitz' *On Two Planets*, of the same year, did not describe any actual spaceships, but nevertheless was enormously influential on the men who eventually founded the German Rocket Society (VfR).

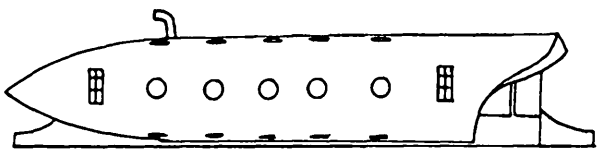

Figure 6 Serviss.

Garrett Serviss published his second interplanetary novel in 1898 [11], hot on the heels of the American serialization of H. G. Wells' sensational *War of the Worlds*. Serviss' novel was written to order for the New York *Evening News*. Though the story shows its hasty origins, it was the first to describe a massed armada of spacecraft (Figure 6), to describe a battle between spacecraft, and one of the earliest descriptions of a spacesuit and an Extra-Vehicular Activity (EVA).

Ellsworth Douglass and Edwin Pallander devised a novel scheme for propelling the spaceship in their story "The Wheels of Dr. Ginochio Gyves" (1899). Equipped with enormous flywheels that act as powerful gyroscopes, the ship stays still while the Earth moves out from underneath it! In another story, "The Pharaoh's Broker" (1899), Douglass describes a spaceship equipped with exercise apparatus to combat the effects of weightlessness.

This remarkable and unfortunately anonymous passage is from *Half Hours in Air and Sky* (1899):

> In the infancy of physical science it was hoped that some discovery should be made that would enable us . . . to pay a visit to our neighbor, the Moon. The only machine independent of the atmosphere, we can conceive of, would be one on the principle of the rocket. The rocket rises in the air, not from the resistance offered by the atmosphere on its fiery stream, but from internal reaction. The velocity would, indeed, be greater in a vacuum than in the atmosphere. . . .

The unknown author showed a grasp of the principles of rocketry that eluded even scientists as late as the 1930s.

G. Le Faure and H. DeGraffigny's four-volume novel of 1889, *Aventures extraordinaires d'un savant russe*, was a virtual catalog of imaginative spacecraft which ranged from a Vernesque cannon-launched projectile to a solar sail.

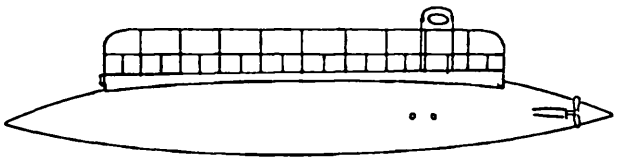

Figure 7 Astronef.

1900 saw the serialization of George Griffith's charming novel, *Stories of Other Worlds* (retitled more aptly *A Honeymoon in Space* for its books publication). The interplanetary adventures of the antigravity spaceship *Astronef* are described (Figure 7). The vessel is spindle-shaped, about 75 feet long, with a long, glass-enclosed gallery or observation deck running two-thirds of its length. Another large window is set into the floor of the interior cabin, making the *Astronef* the world's first glass-bottomed spaceship. A pair of propellers at the stern move the spaceship while within a planetary atmosphere. Griffith equipped his honeymooners with remarkably modern-sounding spacesuits. They carried tanks of liquid air, an air purifier, a pressure regulator, and telephones (wires connected the helmets).

THE EARLY 20TH CENTURY

The new century saw simultaneous explosions in the quantity of extraterrestrial fiction being published, and in the serious interest of science in rocketry and astronautics. Simultaneous with stories of rocket flight to the Moon and other planets were real-life experiments with rockets and liquid-fueled motors. Many of the scientists and experimenters working in this new field devised imaginative schemes for the future application of their ideas to spaceflight. Because of their connection with well-known names, many of these speculative spacecraft are fairly familiar. Therefore I will do little more than mention them in this paper. What will be described in more detail are spacecraft from popular literature—especially where these are prescient, extrapolating technology beyond that envisioned by the working researchers, or where they make "practical" use of contemporary developments in astronautics or rocketry. This latter function is a valuable one. Many lay people would never have heard of the work of Goddard, Oberth, Valier, and others, or what their work actually signified, were it not for their appearances in popular fiction.

H. G. Wells provided the first spaceship of the new century in his novel, *First Men in the Moon* (1901). Like many others of its time, Wells' spacecraft was antigravitational—in spite of the pseudoscientific explanation, just a modern version of propelling a spaceship by magic. Nevertheless, even an antigravity spaceship needs to deal with the very real conditions of outer space. So, even though their propulsion may be mythical, antigravity spaceships are still worth studying for their solutions to the problem of living in space and on other planets.

Wells' spacecraft was a globe of thick glass, broken only by a circular opening. Around this was a steel framework that supported a system of shutters. These were coated with the antigravitational substance, "Cavorite." Opening and closing the lou-

vers enabled the sphere to be controlled. Inside were supplies, including a water distillation apparatus, "solidified air," and chemicals for removing carbon dioxide.

In 1901, the Pan-America Exposition in Buffalo, New York, featured a simulated trip to the Moon as an attraction.

Georges Melies created the first depiction of spaceflight in motion pictures with his "Trip to the Moon" in 1902. Although it is a highly-fantasized combination of Verne's *From the Earth to the Moon* and Wells' *First Men in the Moon*, it is reported that the venerable Jules Verne paid a visit to the set during filming.

V. I. Kryzhavovskaya, in her novel, *On a Neighboring Planet* (1903), described a balloon-launched electrical spaceship carried along on waves of "universal vibration." Russian authors of the early 20th century were active in producing stories and novels about interplanetary flight. Many of them were directly influenced by the publications of Tsiolkovsky and, later, Tsander.

In a paper written in 1907, Robert Goddard pointed out the potential use of the pressure of sunlight as a means of propulsion—a possibility that had already occurred to some science fiction writers. In the same work, Goddard also suggested the possibility of gaining energy for rocket propulsion from atomic fission.

Although it was propelled by just one more variation of antigravity, A. Bogdanov's spaceship in his novel, *Red Star* (1908), is remarkable for its size and elaboration. It was a huge sphere, 66 feet wide, with a flattened base, made chiefly of aluminum and glass, and divided into four floors. On one was a hanger for an aircraft.

Fenton Ash, in *A Trip to Mars* (1909), described a Martian spaceship. it was egg-shaped and equipped with folding wings that extended for atmospheric flight.

"Roy Rockwood," the house name for the anonymous authors of a series of boys' adventure novels, published two interplanetary adventures, the first, *Through Space to Mars*, appearing in 1910. The *Annihilator* was a 200-foot-long torpedo powered by the waves of energy ejected from its rear. The *Annihilator* reappeared in the sequel, *Lost on the Moon*, in which it was revealed that the engine would not work when the ship was inverted!

In 1912, Robert Esnault-Pelterie suggested the use of atomic energy in spaceflight. He estimated that a Moon rocket would require 21 million foot-pounds of energy to make the trip. He thought that radium might provide the necessary energy.

B. Krasnogorskii, in his 1913 novel, *On the Waves of the Ether*, described the first solar sail in literature since LeFaure and Graffigny more than a quarter century earlier. The ship, called *The Victor of Outer Space*, was in the form of a small, bullet-shaped cabin suspended by gimbals in the center of a large circular "sail." Krasnogorskii made elaborate calculations, and his descriptions and explanations were detailed in the extreme. The ship's velocity was measured by a device that determined the Doppler shift of the spectrum. The sail was a disk 105 feet in diameter. Four opaque, black screens could cover quadrants at will, to control the pres-

sure of radiation upon it. The ship was launched by carrying it aloft on a special cradle supported by four balloons. At five miles Krasnogorskii supposed that the Sun's radiation would be sufficient to lift the ship from the cradle.

Between 1913 and 1916, French authors Masse, Drouet, and Graffigny published several schemes to launch a spacecraft by centrifugal means. At first it was suggested that a projectile could be flung into space from the rim of a large flywheel spinning at a rate of 40-50 mph. A variation had the projectile placed at the end of a counterweighted beam, which, in turn, was balanced at its center of gravity. Rotating the 150-foot beam at 44 mph would throw the spacecraft from the Earth at a speed of about nine miles a second. This plan was later revised to employ a beam 328 feet long powered by a 12,000 hp motor. Once in space, the projectile could be steered by rockets. This spaceship was to have been a 36-foot-tall cylinder with a domed top. Made of sheet aluminum, it was divided into five floors with a full compliment of life-supporting supplies and devices.

In 1917 *Cosmopolitan* magazine published a story, "The Moon Makers," in which appeared one of the most remarkable spacecraft yet described in fiction. Even more remarkable is that one of its two authors, Arthur Train (Robert Wood was his partner), was a lawyer best known as a writer on legal matters.

The spaceship *Flying Wheel* (Figure 8) was a torus 66-feet in diameter and 14-feet high, made of aluminum. It is equipped with an airlock and spacesuits, stabilizing gyroscopes, etc. Above the ring are three large girders, their lower ends resting on the torus 120 degrees apart, the upper ends converging, like a tripod. At the apex is a cylindrical chamber containing a cylinder of uranium. Its disintegration produces a beam of alpha-particles that propels the ship. The thrust chamber is gimbaled so the ship can be steered. The terrific blast from the atomic engine at takeoff is graphically described. At one point in the story the *Flying Wheel* makes a landing on the Moon, tail-first, using its rocket as a brake.

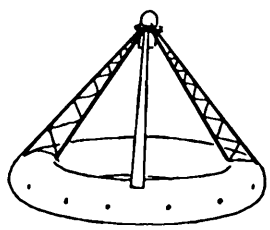

Figure 8 The Flying Wheel.

Danish author Sophus Michaelis' 1917 novel *Himmelskibet (Heavenship)* was the basis of an early space film, made that same year by Forest Holger-Madsen. It was eventually released in the United States, circa 1920, as *A Trip to Mars*. The spaceship depicted in the film was a large, enclosed cigar-shaped craft equipped with both wings and a propeller.

Robert Goddard, in a paper written in 1918, but not published until 1972, "The Ultimate Migration," proposed the idea of the space ark. At some far distant date when the Earth must be abandoned as an abode for humans, an asteroid or small moon may be converted into a vast spacecraft, powered by "intra-atomic energy." The passengers would be placed in a state of suspended animation, only the pilot being awakened every 10,000 years or so, as the nearer stars are reached—every million years for more distant targets. Unfortunately, like many of Goddard's ideas,

his habitual secrecy kept this prescient scheme from ever having any influence on the development of ideas in astronautics.

A story published in the German magazine *Der Luftweg*, "Die Geschichte Einer Mars-Expedition" (1921), described a giant, spindle-shaped spaceship. It tapered to an extremely finely-pointed tail, broken only by the exhaust of one of three rocket engines. Near the nose was a large propeller and amidship were a pair of short, broad wings. Another set of rockets projected at an angle from just behind the propeller. The spaceship took off vertically, aided by the propeller, which was also used within the Martian atmosphere.

F. A Tsander in 1921 suggested a composite "aerospace" vehicle that would take off as a propeller-driven aircraft, converting to rocket power at a high altitude. The metallic parts used in atmospheric flight would be fed into a furnace and converted into rocket fuel—this instead of jettisoning the parts as in a step rocket. The spaceship would be a "conventional" rocket, the aerodynamic features—wings, etc.—attached to its exterior. Once the disposable wings and propellers were converted into reaction mass, the rocket was left with a set of small wings for use in its eventual return to the Earth.

Rumors circulated in Europe between 1922 and 1926 that the Russians had a manned interplanetary rocket under construction at the Moscow airport, or at the Air Force Academy in that city. It was described as being of "an old-fashioned shape [sic]" and 351 feet long. It was reputedly intended for a manned trip to the Moon, where it would land by way of its retrorockets. The project was said to have been under the supervision of Tsander and Tsiolkovsky.

In the motion picture "The Sky Splitter" (1922), by J. A. Norling, the spaceship depicted was based on designs being published by Max Valier. It was launched by coasting it down a long, ski-jump-like ramp, which was supported at its highest end by an enormous pylon resembling the Eiffel Tower. The same production company also made "All Aboard for the Moon" in the same year, featuring a giant rocket launched from atop a mid-city building.

Figure 9 Maral-Vigee.

French author Maral-Vigee in his 1922 novel *L'Anneau des feu* based his spaceship (Figure 9) on the ideas of Esnault-Pelterie. The radium-powered rocket was 45-feet tall, 12-feet wide and made of nickel-steel. Half was painted black while the opposite half was polished metal, for thermal control. Four heavy legs were equipped with shock absorbers. Three small rockets, around the ship's waist, provided control while in flight.

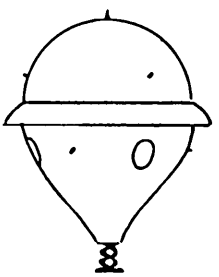

Figure 10 Tolstoy.

Alexei Tolstoy published his classic science fiction novel, *Aelita* (1923), which was later made into a silent film, still well-known today as an example of early Soviet film-making. A flight from Leningrad to Mars is

made in a light-bulb-shaped vehicle 26-feet tall and 18-feet in diameter (Figure 10). It was made of reinforced steel and was propelled by a rocket in the narrow neck at the spaceship's base. It was fueled by the imaginary powder, "ultralyddite," powerful enough to provide constant acceleration during the journey—which as a result only required 8 or 9 hours. The spaceship's landing was accomplished by using the thrust of its rocket, augmented by an airbrake.

The Italian authority on aviation, G. A. Crocco, presented a report in 1923 to the Italian Academy of Sciences on the possibilities of flight beyond the Earth. He concluded that it would be necessary to employ some sort of reaction-powered vehicle, but that no chemical fuels existed that contained sufficient energy. He proposed that only the controlled release of atomic energy would provide the power. He suggested two possibilities by which that might be accomplished: the uninterrupted ejection of a stream of alpha-particles (as in the Woods-Train *Flying Wheel* of 1917); or, the release of the energy in the form of heat, which could eject inert matter as the reaction mass. He would rotate his ship to provide artificial gravity, and suggested that a trip to the Moon would require only 4 hours, at trip to Venus only 8 days.

Clement Fezandie, in one of a series of stories published under the general title of "Doctor Hackensaw's Secrets" (1923), described the launch of a spacecraft from the rim of a massive flywheel. The wheel is spun by a powerful electric motor. The spacecraft is attached to the rim at the beginning, but as the speed of rotation builds up, the distance between the vehicle and the wheel is increased by freeing a heavy chain, attached to the spaceship, through the rim of the flywheel. When the maximum radius is reached, the ship is released.

Another Italian, Luigi Gussalli, published a scheme for a flight to the Moon in his 1923 book, *Si puo gia tentare un viaggio d'alla terra alla Luna*? He proposed a step-rocket of 27 stages, each fueled with 10.5 ounces of propellant. The stages are combined into four groups of 18, 6, 2 and 1 steps. The rocket was to have carried two passengers on a round trip. The rocket's initial impulse was to have been provided by a catapult.

1923 and 1924 saw publication of Hermann Oberth's *Die Rakete zu dem Planetenraum* and Max Valier's popularization of the Oberth book, *Der Verstoss in den Weltenraum* (the differences in titles are an accurate indication of the authors' very different approaches to the subject). Both books were immensely popular and fueled a whole new interest in space travel. Designs for speculative spacecraft begin from this point to greatly increase in number; even limiting consideration to those proposed with some degree of seriousness, between this data and World War II there appeared more spacecraft than can be conveniently listed in the space of this paper. As the century progresses, only the most interesting or unusual spaceships can be described.

At about the time of Oberth's and Valier's books, Antonio De Stefano calculated that a spaceship of 0.3 tons, carrying one person to the Moon, would require 150 tons of fuel for leaving the Moon, and would consequently need 75,000 tons of fuel for its takeoff from the Earth. The rocket itself would weigh 120 tons. Also in

1924, Mark P. Madden, writing in *Science & Invention*, suggested an unmanned rocket equipped with television apparatus for high-altitude observation of the Earth. In that same year F. A. Tsander published his design for an interplanetary rocket in which, he predicted, ". . . it will, in all probability, be possible within the next few years to fly to other planets." The spaceship he envisioned did not look outwardly very different from a conventional biplane airliner. It had a fuselage in the shape of a cylinder pointed at one end. At the opposite end were the rocket exhausts. There were a pair of wings—one set above and the other below the cylinder—and a cruciform tail. The wings carried four propellers, two pushing and two pulling. They were worked by an engine running on a hydrocarbon fuel and liquid oxygen. A substantial undercarriage allowed the ship to take off like a conventional aircraft. The entire ship was to have been made of aluminum.

Within the main body of the spaceship was a smaller aircraft. Its wings and tail surfaces protruded through the hull of the larger ship. It was to be used for the final descent to the Earth, and was propelled by a single propeller at its nose. The spaceship was to ascend to an altitude of just over 4 miles, as a normal aircraft. At this point it converted to rocket power. The wings and undercarriage are pulled into the ship and consumed as fuel, the pure aluminum being burned in oxygen. The metal is first melted in a special boiler, then ejected into the engine. Tsander had begun his studies in the possibilities of using the metal structural materials of a spaceship as fuel as early as 1909.

Tsander also proposed at about this time the use of solar sails. In his unusual version, the sails would be made of a mass of iron filings, held into a vast disk by a ring-shaped electromagnet. Since the sail is not solid, meteors would be of no danger to it. Tsander suggested that huge solar mirrors, either on Earth or in orbit, could focus light onto his sails, giving them velocities far in excess of that attainable by rockets. Tsander was also the first to suggest using a planet's gravity during a close flyby to increase the speed of a spacecraft.

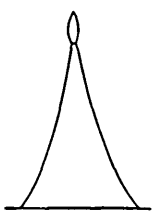

Figure 11 Hohmann.

In his 1924 book, *The Attainability of the Heavenly Bodies*, Walter Hohmann proposed a spaceship in the form of a cone-shaped tower over 105-feet tall and over 72-feet wide at its base (Figure 11). At the apex would be a small passenger capsule. This was shaped like a plumb bob 17.6-feet long and 5.25-feet wide. It would carry two astronauts and supplies for a journey of 30 days' duration. The capsule would weigh just over 8,800 pounds and was equipped with a braking surface for reentry, an inclined wing with a rudder, and a parachute for the final descent.

In 1927, the Moscow Association of Inventors held the First World Exhibition of Interplanetary Machines and Mechanisms. Displays were exhibited of dozens of plans and models relating to the work of Federov, Tsander, Kibalchich, Goddard, Oberth, Valier, and others. In that same year, Max Valier first pro-

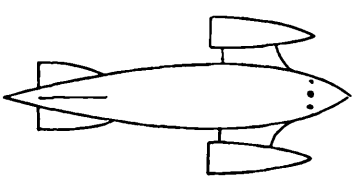

Figure 12 Valier.

posed his scheme to gradually evolve a working spaceship from a conventional aircraft (Figure 12). Once model rocket-propelled airplanes had been successfully tested, according to Valier's schedule, full-scale engines would be mounted in a trimotor Junkers G-23, directly behind the two wing-mounted piston engines. The aircraft would not switch to the rockets until a safe altitude had been reached. Once this had worked successfully, the aircraft would be converted to a rocket plane with an auxiliary piston engine. Four rocket motors would be installed in the wings, and the wings themselves would be shortened. Later, six motors would be placed within even shorter wings. Once enough flight experience had been gained, a pure rocket plane would be built and flown. This would have rudimentary wings, six rocket motors, and a pressurized cabin. It would be capable of intercontinental stratospheric flights. The penultimate step would be the rocket ship: wingless with fourteen rocket engines in a pair of outrigger pods. It would be launched vertically from a tower. Oberth and Valier joined forces to create the final objective of the evolutionary scheme: the spaceship.

Franz Ulinski proposed a number of spacecraft utilizing electrical propulsion about this time. There were two basic types: those that derived their power from solar energy; and, those that were atomic-powered. No matter their source of energy or size, Ulinski's spaceships consisted of a spherical passenger cabin surrounded by an equatorial ring of thrusters. The solar-powered ships had an additional Saturn-like ring of power cells surrounding them. All of his ships were propelled by the ejection of electrons from special cathodes. The largest of his proposed spaceships was a steel sphere 60 feet in diameter. Its six internal floors contained a full array of life-support equipment, and even a hanger for a small aircraft!

In 1928, movie producer Fritz Lang followed up the success of his *Metropolis* with *Die Frau im Mond*, the first serious motion picture about spaceflight. Lang hired Hermann Oberth as technical adviser, whose misadventures with the German "Hollywood" were as tragicomic as any film might have been. Oberth designed a three-stage Moonship for the movie, based upon the designs first proposed in his book (Figure 13). The still-convincing special effects of the film show the Moonship being constructed in a vertical assembly building, being carried to its launch site atop a crawler, and its takeoff after the first countdown in history!

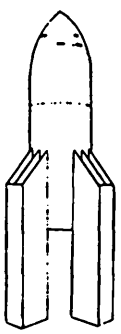

Figure 13 The Frau Im Mond Moonship.

Theorist Fritz von Hoefft developed, in 1928, an evolutionary scheme to develop staged winged and lifting-body spacecraft (Figure 14). There were to have been 8 spacecraft, beginning with the RH-I, a small (4-feet long) recording rocket launched from a balloon, to the RH-VIII, a three-stage manned rocket with a take-off weight of 12,000 tons. The RH-VIII would be a combination of three proven rockets. The first two stages would be manned for their return and eventual reuse; the final stage, an RH-V, would continue on into orbit. Hoefft's rockets were of a revolutionary design: relatively flat, broad shovel shapes with slightly curved upper surfaces and flat bottoms, they anticipated the

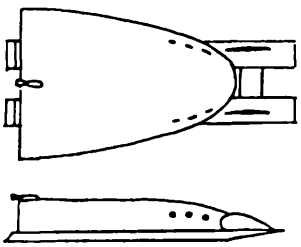

Figure 14 Von Hoefft.

lifting bodies of more recent years. In this same year Eugen Sänger submitted his doctoral thesis. In it, he investigated the problem of high-altitude rocket flights and outlined the basic principles of his "aerospace-plane." Also in 1928, James Randolph proposed a spaceship for a flight to Mars. It was to have been a 1000-foot step-rocket, with retrorockets for the landing on Mars and a cabin that rotated to provide artificial gravity.

1929 saw both the introduction of the comic strip "Buck Rogers" and Yuri Kondratyuk's techniques for planetary landings. The former, especially during its initial decades, was enormously popular. It's science was surprisingly accurate and "real" space scientists such as Robert Goddard and Max Valier made "guest" appearances under lightly disguised pseudonyms. Kondratyuk, meanwhile, was the first to describe the technique of landing on a planet using the combination of orbiter and landing module later employed by the Apollo program. He also proposed the use of lifting bodies for reentry, combined with atmospheric braking.

David Laser's book, the privately-published *The Conquest of Space* (1931), was the first book in the English language on the subject of astronautics. The latter half of the book is given over to a vividly-described flight into space aboard a manned rocket. The three-stage "Terra" (Figure 15) was 150 feet long and weighed 10,000 tons. It was constructed in a large hanger, from which extends the gently rising launching track. The first two stages of the rocket are destroyed after being jettisoned. The third stage eventually returns to Earth by parachute for an ocean landing.

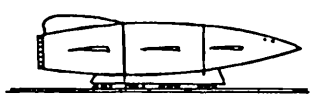

Figure 15 The Terra.

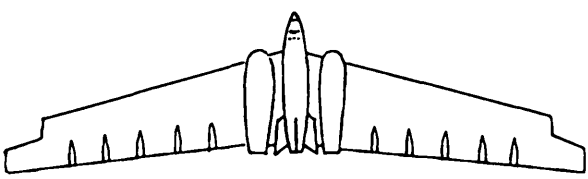

Figure 16 The Wieland.

Also in 1931 Otto Willi Gail published his novel, *Hans Hardt's Moon Flight*, the most popular of a series of spaceflight novels Gail had written. The Moonship *Wieland* (Figure 16) was based on the theories of Max Valier. The Moonship proper was a finned torpedo-shape. In its nose, ahead of the passenger compartment, was a spherical capsule attached to three parachutes. The internal details of the spaceship were described with great thoroughness and accuracy. The crew undergoes extensive training, including time in a high-speed centrifuge.

The *Wieland* is launched from the back of a flying wing booster, the entire assembly taking off horizontally from an inclined track 1.25 miles long. During the

course of the ship's flight to the Moon, an EVA is described in which a space telescope is constructed. The astronauts maneuver themselves by firing shots from revolvers.

In his 1931 novelette, *The Jameson Satellite*, Neil R. Jones placed the first Earth satellite launch in 1958. In that same year Professor Auguste Piccard ascended to an altitude of nearly 10 miles in an aluminum sphere suspended beneath a 100-foot balloon. Piccard's pressurized sphere is a strong contender for the title of the world's first spaceship. Some 90% of the Earth's atmosphere was below the balloon when it was at its highest, and the professor described the sky outside as "almost black . . . ." The 7-foot sphere filled all the qualifications of a spaceship, short of possessing a means of propulsion: it had all the necessary life-support equipment to sustain life in a near-vacuum, including the same bi-color, black-and-white paint job many spaceship designers had suggested for temperature control. Piccard had no illusions, however, as to where the future of high-altitude flight lay. As one who had built flying model rocket planes decades earlier, he predicted that "Three possibilities offered themselves: balloon, airplane and rocket. None of these three had ever risen ten miles. The rocket will do so one of these days. Eventually it will go far higher, even . . . ."

Piccard's flight was not exceeded until the National Geographic/U.S. Army Signal Corps balloon flight of 1935. Its 13.9-mile record was not challenged until the 1950s.

In 1931, Eugen Sänger began the long development of his spaceplane. Though not yet the "Silver Bird" it was to become, it was still the beginning of probably the single most influential speculative spacecraft in history. He did not publicly present the paper that resulted, the now-classic "Raketenflugtechnik," until 1933.

By this time, men had flown in rocket-powered aircraft, and rocket experimenters were clearly demonstrating the rockets' potential power as both a means of propulsion and as a weapon. In fiction, a corresponding change of emphasis has been taking place: spaceships are as commonplace as ever, but they are no longer central to the stories. They are taken as matter-of-factly as the horses in a western. Still, there are occasional original ideas, such as the spaceship *Red Peri* (Figure 17) in Stanley Weinbaum's 1935 story of the same name. It was a 100-foot tetrahedron of tubular girders supporting an atomic engine at the apex. Of special interest is the fact that this story contained the first suggestion that a brief exposure to the vacuum of space would not necessarily be fatal to a human being.

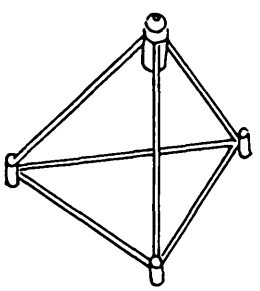

Figure 17 The Red Peri.

About this same time, an anonymous inventor suggested a manned, balloon-launched rocket. The solid-fuel rocket would detach from its balloon at an altitude of 11 miles, reaching a peak altitude of 43 miles, finally descending by parachute.

In 1937 Edward F. Northrup published his eccentric book, *Zero to Eighty* [12]. In it he described his experiments with what is known today as a mass driver. At the end of the book, Northrup suggested that the mass driver could be used *in lieu* of the first stage of a multi-stage rocket. He describes a slender, two-stage, liquid-fuel rocket 28 feet long and 3.25 feet wide. The upper, manned stage is 17 feet long and is provided with steering rockets and life support equipment, including a parachute for the eventual return to the Earth. The mass driver is enormous, so that the acceleration to which the two astronauts are subjected will not be excessive—still some 32 Gs, according to the author! The electromagnetic cannon proposed is 124-miles long, lying for most of its length horizontally on level ground. Only near its far end does it begin to gradually turn upwards, along the slope of a high mountain. At the summit, the muzzle of the gun points vertically. The gun's giant coils are hollow and water-cooled. Northrup's reason for using the monster mass driver is the lack of suitable fuels. "The Moon," he wrote, "will never be reached by a human being in a car propelled by rockets only, unless the dream of some scientists is realized, whereby we will be able to release and control the almost limitless energy stored in atoms."

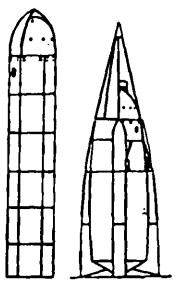

Figure 18 The 1939 BIS Moonship and the post-war atomic version.

Eugen Sänger and his assistant, Irene Bredt, tested a model of the advanced design of his rocket bomber beginning in 1938. Encouraged by the results, he applied for a patent on the design. The sleek spacecraft—which strongly resembles the famous PanAm "Clipper" in the movie *2001: A Space Odyssey*—was to have been accelerated along a horizontal track by a captive booster. In 1939, the youthful British Interplanetary Society completed its two-year study of a manned Moon landing. It proposed a monster solid-fuel rocket (Figure 18). Its lunar lander was a direct ancestor of the Apollo LEM.

The great Russian theorist, Konstantin Tsiolkovsky, designed a great number of speculative spacecraft during his long career, from Mooncars to space colonies. His spaceships, however, were generally variations on a single theme, although their sizes might change, or they might be combined. A typical Tsiolkovskian spaceship was an enormous teardrop, blunt end forward, the tapering tail-section ending in the opening of the rocket engine (Figure 19). Most of the rocket's volume was consumed by fuel tanks, and its length by the extremely long nozzles Tsiolkovsky expected his engines to have (at one time he trifled with the notion of twisting the long nozzle into a complex series of curves, thinking that the rushing gases might act to stabilize the spaceship, as the spinning flywheels of a gyroscope would). The passengers were equipped with immersion baths of water, as a cushion against the acceleration of takeoff. This latter was accomplished horizontally or on a gentle incline, on a ramp or rail, and assisted by a captive booster.

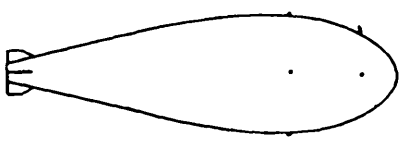

Figure 19 Tsiolkovsky.

WORLD WAR II AND AFTER

The period between the War and 1957 was literally deluged with spacecraft designs. With the development of the V2 and the subsequent experimentation by the United States with captured rockets, with serious plans for manned and unmanned spacecraft being proposed not only by industry but by the government itself, and the flights of real-life "spaceships" like the Bell X-1, it is little wonder that more spaceships were designed in this decade and a half than could possibly be listed in the space of this paper. It was a highly influential period. Now in their late thirties and forties, are the scientists and engineers creating our future space programs, who had their childhoods rooted deeply in that exciting time.

Robert Heinlein's short novel, *Universe* (1941), was the first fictional use of an idea suggested in 1929 by J. D. Bernal [13], the generation starship. This is a scheme for beating the limitations enforced on starflight by the speed of light. In a generation starship, the crew that leaves the Earth is not the crew that eventually arrives at the destination. Instead, they are the original crew's distant descendants—the intervening generations having been born, lived, and died aboard the starship, in transit.

In 1944 Sänger and Bredt describe the final form of the "Silver Bird" (Figure 20) in their report, *A Rocket Drive for Long-Range Bombers*. The Earth-orbiting single-stage aerospace plane (the first booster stage is captive, and does not leave the launching rail) was to have been 91 feet long and would have carried a payload of up to 4 tons to an orbit of 186 miles, or 30 tons of bombs to New York. One of Sänger's innovations was the concept of "skip gliding" for the ship's return to Earth, where the rocket would literally skip off the denser layers of the Earth's atmosphere like a stone skipping across a pond, losing energy with each bounce. Sänger's rocket bomber was the direct ancestor of today's space shuttles.

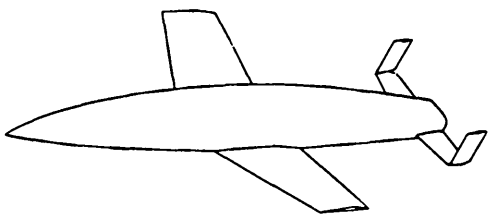

Figure 20 Sänger.

In 1944, Willy Ley suggested a Moon rocket consisting of three nested stages. The complete rocket would be about 1/3 the height of the Empire State Building.

1946 saw the completion of a RAND project, in association with several aircraft companies, in which a "world-circling spaceship" was designed. Although the goal was to develop a feasible unmanned satellite, a manned version of the four-stage rocket was designed as well. The manned fourth stage would have been winged, gliding back to Earth like a conventional aircraft.

The BIS' first post-war project was the "Megaroc," a manned adaptation of the V2. The finless, elongated German rocket would have carried a detachable capsule into a ballistic suborbital fight (only a year earlier, Willy Ley had suggested that a V2 could carry a man into space). Peak altitude would have been about 190 miles.

Artist Chesley Bonestell and Willy Ley co-designed an atomic Moonship for a magazine article published in 1947. Since the radioactive exhaust would be dangerous, the spaceship was to have been launched from the back of a large jet aircraft, at an altitude of 50,000 feet. From this point, the spacecraft would continue on to an 80-mile Earth orbit, before continuing on to the Moon. Also in 1947, the BIS published the results of Val Cleaver's and Les Shepherd's updating of the old 1939 Moon rocket project. In this new version, the landing craft remained virtually unchanged, but the booster was now a squat 40-foot atomic rocket. The next year, Cleaver and Shepherd developed the orbital rocket technique in which small rockets carry the fuel into orbit for a larger rocket. This will make the transit to the Moon or a planet, where another small rocket makes the actual landing. In 1949, Harry Ross of the BIS suggested a three-ship Moon-landing scheme that was later developed by Gatland, Kunesch, and Dixon. At the same time, the aviation company Curtiss-Wright announced its plans for a stratosphere "spaceship" that would orbit the Earth, and CIT professor, Chien Hsueh-Sen, proposed a boost-glide hypersonic aircraft with a 3,107-mile range. This transcontinental passenger carrier, 79-feet long and weighing 48 tons, would make the flight from New York to San Francisco in 45 minutes. Also in 1949, Walter Dornberger and Krafft Ehricke designed a passenger-carrying rocket consisting of two parallel stages, *BOMI*, a concept later employed by the Space Shuttle. This year (a boom year for space travel enthusiasts) saw publication of the seminal popular work by Ley and Bonestell, the classic *The Conquest of Space* as well as Wernher von Braun's *Das Marsprojekt*. "Captain Video," television's first space show, came on the air June 27, 1949. In the following year, two more long-running television "space operas" began broadcasting: "Space Patrol," the most successful of them; and "Tom Corbett," inspired by a Heinlein novel and boasting technical advice by Willy Ley. For all of their naivete and lack of production values (they were broadcast live), they served to inspire an entire generation of space-minded youngsters.

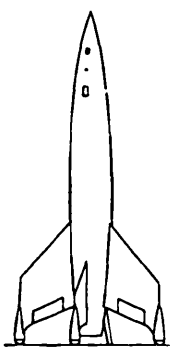

Figure 21 The Luna.

Two motion pictures in 1950 were the first post-war films about spaceflight. *Rocketship X-M*, made quickly to cash in on the advance publicity for the more carefully made *Destination Moon*, was the first to be released. The latter, however, is by far the better known. In documentary detail, scrupulous realism and accuracy, it details a manned flight to the Moon. It was the first film to deal realistically with the subject of spaceflight since *Frau im Mond*. It was also the first color film about spaceflight. The spaceship *Luna* (Figure 21), designed by Chesley Bonestell, has become almost the quintessential spaceship.

In 1951 began what was probably the single most influential speculative spaceship project ever published: the *Collier's* magazine space symposium. For two years the magazine published in serial form the results of a study by Wernher von Braun and a team of experts. Their goal was to show how it was possible to explore space with the technology and science available in the 1950s. Only the BIS had considered as many necessary steps, and in such meticulous de-

tail; but their plans had evolved over 15 years and had not, at this time, been collectively published as a coherent program.

The *Collier's* program began with the orbiting of an unmanned satellite carrying three rhesus monkeys, and finished with a large-scale expedition to Mars. Between were described the construction, testing and launch of manned shuttle rockets, a space station, space telescopes, manned lunar orbiters, and a lunar landing and manned base. Every detail was considered for the magazine's readers, including astronaut training and safety (the shuttles were equipped with ejection capsules).

It is difficult to overestimate the influence and inspiration von Braun's series had. The magazine, and the books in which the series was collected, reached literally millions of people, convincing them that spaceflight was not just a possibility for the future, with money and the proper will it could be done *now*.

In 1953, Eugen Sänger invented the concept of the anti-matter-propelled rocket. Also in 1953, Hubert Drake and L. Robert Carman developed their "phase IV research plane," in which an X-15-like rocketplane is launched from the back of a giant winged booster. NACA, when offered the project, rejected it as "too futuristic." Ernst Stuhlinger in the mid-1950s developed his ion-propelled spacecraft, which made an appearance in an episode of the *Collier's*-inspired series of television programs about space produced by Walt Disney.

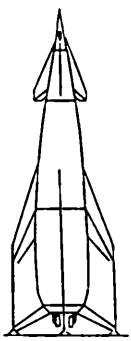

Figure 22 The BIS ferry.

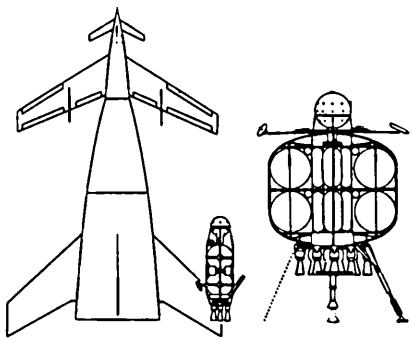

Figure 23 The Collier's ferry and Moonships.

The ideas at mid-century of the BIS were summed up in the 1954 book by Arthur C. Clarke and artist/engineer R. A. Smith, *The Exploration of the Moon*. As in the *Collier's* program, a coherent space program was illustrated, from unmanned satellites to a manned lunar base. The core vehicle was a three-stage winged ferry rocket (Figure 22).

The final outstanding speculative spacecraft proposed before the launch of Sputnik in 1957 were in the report presented by Darrell Romick to the 7th International Astronautical Congress in 1956, the result of ten years of research by Goodyear Aircraft. Two different spacecraft had evolved (Figure 23). The *Meteor*, a three-stage manned ferry rocket, each stage piloted and fully reusable, and the *Me-*

teor Jr., a Moon-lander developed from the *Meteor* third stage. The *Meteor* was to have been used to construct a massive space colony in Earth orbit. The 3000-foot-long colony with its 1500-foot-diameter rotating wheel—inhabited by 20,000 people—anticipated by 15 years or more the space colonies of Gerard O'Neill.

SUMMARY AND CONCLUSIONS

Speculative spacecraft have been and continue to be accurate mirrors of the technologies and science of their time, as well as gauges of the contemporary interest in spaceflight. They have provided sounding boards—flight tests on paper, if you will—for serious ideas and proposals. They have served a valuable propaganda role in helping to create and maintain the interest and support of the public in space travel. While it has been all-too-fashionable to frown at astronautics' connections with science fiction, the science should be proud of its effect on the human imagination, and grateful for the support and enthusiasm the fictioneers helped to create.

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