I. What Is Science?

The Anthropology of Astronautics

by Krafft A. Ehricke

Astronautics, *a publication of the American Rocket Society, originally published "The Anthropology of Astronautics" by Krafft A. Ehricke, in its November 1957 issue.* Astronautics *described Ehricke's article as "A searching examination by one of the leading thinkers in our field of the implications of space flight and its challenge to human destiny." Ehricke's article was later republished in a book,* Krafft Ehricke's Extraterrestrial Imperative, *authored by Marsha Freeman, which was published by Apogee Books in 2008.*

From 1957: Krafft A. Ehricke is assistant to the Technical Director of the Astronautics Division of Convair in San Diego. After graduating as an aeronautical engineer in Berlin, Germany, he worked at Peenemünde on the V-2 project. In 1945 he obtained a contract from the Dept. of the Army. He worked from 1947 to 1950 as research engineer on ramjet and rocket systems at Ft. Bliss, Tex., and from 1950 to 1952 was at Redstone Arsenal, Ala., where he headed the Gasdynamics Section. From 1952 to 1954 he was with Bell Aircraft Corp. in Buffalo, N.Y., as preliminary design engineer. In 1954 he joined Convair, San Diego, as Design Specialist. Prior to his present position, he built up the Preliminary Design and Systems Analysis Group of the newly established Astronautics Div., and headed it for some time.

Altogether, in the United States and other countries, billions of dollars are now being spent on the development of a technology which gives every indication of being or becoming an astronautical technology. This is extremely gratifying to all those who, during the first part of this century, fought for recognition of space travel as a serious, practical and worthwhile effort—not at some future time, but right now, in this century and in this age of ours.

The campaign for technical and scientific recognition of space flight is won. However, the fight for recognition of astronautics as a vital part of man's future, rather than as just an accepted technical or scientific specialty, has hardly begun. Astronautics is the science of operating in space and traveling to other worlds. The implications are such that it now becomes increasingly important to develop the philosophy, as well as the utilitarian aspects, of this new science.

Since space travel has been recognized by its protagonists as one of the most fundamental and outstanding concepts in the history of man, it is not surprising that a good deal of thinking has already been done on this subject, beginning with Konstantin Ziolkowsky, whose ardent belief in the cosmic mission of mankind heralded the dawn of astronautic pioneering some 60 years ago, and continuing with Hermann Oberth, Willy Ley, A.C. Clarke, A.V. Cleaver, Wernher von Braun and Eugen Saenger. A certain mutual overlapping of thoughts and arguments advanced by these pioneers and others, is unavoidable, in view of the principal agreement among all concerned over the promotion of space travel.

However, the philosophy of astronautics is young and fertile. Its countless implications are far from exhausted. For this reason, the author, concerned for some 20 years with the study and the advocacy of astronautics as a technical, as well as a cultural, mission, submits a few additional thoughts on this subject.

The concept of space travel carries with it enormous impact, because it challenges man on practically all fronts of his physical and spiritual existence. The idea of traveling to other celestial bodies reflects to the highest degree the inde-

The Three Fundamental Laws Of Astronautics

First Law

Nobody and nothing under the natural laws of this universe impose any limitations on man except man himself.

Second Law

Not only the Earth, but the entire Solar system, and as much of the universe as he can reach under the laws of nature, are man's rightful field of activity.

Third Law

By expanding through the Universe, man fulfills his destiny as an element of life, endowed with the power of reason and the wisdom of the moral law within himself.

pendence and agility of the human mind. It lends ultimate dignity to man's technical and scientific endeavors. Above all, it touches on the philosophy of his very existence. As a result, the concept of space travel disregards national borders, refuses to recognize differences of historical or ethnological origin, and penetrates the fiber of one sociological or political creed as fast as that of the next.

As a technical concept, astronautics is all-embracing, and more revolutionary than anything conceived so far, including even atomic technology. As a scientific concept, it is bound to stimulate and rejuvenate practically all fields from astronomy to zoology. Its sociological and political implications are such that future generations may well describe as "cautious" even the boldest predictions of our time.

A Moving Spirit

Because of this, space travel holds perhaps the greatest general appeal for our complex and divided world. It seems to promise less immediate material gain than atomic technology. Yet, or perhaps therefore, its spiritual appeal is extremely powerful, symbolizing as it does that man, after all, has not yet lost his capability of cutting the Gordian knot, of exploding old notions which retard his development and of overcoming seemingly invincible physical obstacles.

If it can be done here, it can eventually also be done in other segments of our life today, where man seems to be hopelessly and perpetually deadlocked. A feeling of enthusiasm and genuine interest seems to prevail among all those who deal with space flight and astronautics—school children learning about it, Congressmen allotting money for it, political leaders of the East and West praising their nation's contributions to its progress, and last, but not least, scientists and engineers blazing the trail toward its eventual accomplishment.

Nevertheless, we must face the question: "Why space flight?" As an implication of a waste of time and money on a hopeless venture, this question is rarely asked today. Few people still doubt that we can, for instance, establish satellites which will serve useful purposes. As a request for philosophical justification of the vastly greater long-range implications of astronautics, an answer must be given, and given as firmly, conclusively and decisively as possible. It has already been recognized that a good deal of thinking is needed to provide this kind of answer, and we are just beginning to deal with the problem. We should not, however, let ourselves be stampeded into frantic attempts to "prove" a need for rushing to Venus or Mars, because, to put it bluntly, there really is none *today.*

Acceptance of Space Vehicle

The important point is to understand why we should gradually accept the space vehicle just as our ancestors finally got around to accepting the wheel and the boat. There was a time—the *Odyssey* proves it—when it was almost inconceivable for the ordinary man to leave his peninsula or island and sail beyond the horizon into the unknown. We still haven't changed much in principle, because it is still inconceivable for many of us to consider our Earth as an island from which one day many men may leave for distant places, unknown to us, except in a general way, or which one day may be visited by people from far away, as an American citizen today visits the country of his extraction.

As a contribution toward answering this famous question, I propose to establish a broad perspective by formulating three fundamental laws of astronautics [see box, this page], and examining their implications. These laws are the basic tenets in the pioneering of

space flight, in the development of modern missile technology (as well as other technologies, notably the atomic), and in our ambitious plans and hopes regarding the future of astronautics.

The first law is astronautics' challenge to man to write his declaration of independence from *a priori* thinking, from uncritically accepted conditions, in other words, from a past and principally different pretechnological world clinging to him. This can be done. The Declaration of Independence and the Constitution of this country prove it. Implementation may take a long time, but the first breakthrough to its formulation is of decisive importance. These documents would probably never have been written in Europe, although the French Revolution is credited with stimulating much of the thought that went into them. A new world, mental distance emphasized by physical distance, and a fresh sociological start were necessary for their formulation.

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"It is part of our heritage as children of this planet to seek out other worlds, to grow and to mature with our expanded capabilities into degrees of freedom and independence which would make present-day societies appear like the incredible confinements of medieval communities . . ." During the Gemini 4 mission on June 3, 1965, Ed White became the first American to conduct a spacewalk.

Contains Many Variables

Europe and America (not only the United States), though related, are two separate differentiations of the integral of human civilizational capacity, like the Chinese, the Indian, the Roman, Hellenistic, Hebrew and many other civilizations before them. This integral contains innumerable variables, and the number of possible differentiations in time and space is therefore equally large, provided man's spirit is not snuffed out in the confinements of a too narrow cosmic environment.

Here we find an important trend: The gigantic scope of astronautics is doubtless one of the more immediate reasons for its fascinating challenge. It offers to take man where he has never been before, and therefore compellingly appeals to his inborn curiosity, love for adventure and dedication to research. However, beyond this, the most fundamental reason may be deeply hidden in a past so distant that it exceeds by far even the lifespan of his own species. A characteristic of life on this planet, including man, is the desire to expand, to spread, to instinctively respond in an aggressive manner to the unknown, and to regard the seemingly unattainable as a provocation which must not remain unanswered.

The first great response of this type came with the expansion of life from the oceans to the land. Amphibia and reptiles reproduced the original conditions existing in the primeval oceans in their eggs, which were then hatched by the sun in a friendly, warm climate, the only climate in which they could exist. With a few exceptions, they remained crawling animals. Their bodies were in close contact with the ground, resulting in extensive heat exchange. Hence, their blood temperature followed, and today still follows, that of ground temperature. It cannot be kept at a constant moderate level like that of the mammals.

The development of the mammal, the most versatile

and perfect land animal, was a brilliant biotechnical achievement. Divorcing the body from the ground by means of legs freed the body from slavishly following the temperature cycle of the soil, permitted the development of insulating furs, and allowed the maintenance of a fairly constant temperature around 98°F, about the same as that of the primeval ocean waters. Now it was no longer necessary to lay eggs and depend on the sun for hatching. The brood could be developed in the motherbody itself. Therewith, life became almost independent of climatic conditions. The conquest of the land could be completed. Also, the lower atmosphere could be occupied in time by follow-on developments of the reptiles, which showed a better growth potential for this environment than mammals.

Found Itself Stymied

Then life found itself stymied on the borders of space. There are no biological means where direct application would permit living beings to enter, and cross space. It is intriguing to think that life may have answered this challenge by producing a new amphibian—man—whose restless mind reaches beyond the confinements of his biological world. The human brain alone is capable of utilizing certain superior qualities of inorganic matter for entering space.

And now begins the next act in the gigantic drama, with man holding a key role. Surrounded by protective shells, life sets out to spread to other worlds. Possibly it does so from several nuclei in space, many light years apart. In this perspective, it appears more difficult than not to assume that our response to the challenge of space flight should be limited to building earth satellites, unless we choose to impose this limit on ourselves. It is part of our heritage as children of this planet to seek out other worlds, to grow and to mature with our expanded capabilities into degrees of freedom and independence which would make present-day societies appear like the incredible confinements of medieval communities or African tribal regulations. It is a historical fact that man's mind and spirit grow with the space in which he is allowed to operate.

The importance of the second law can be measured by the effect which the expansion of European man all over the Earth had on the development of civilization. Medieval European civilization, frozen in the narrowness of its small, rigidly controlled communities and tightly bound to an all-powerful religious dogma, was in the 12th and 13th Centuries dangerously close to becoming another static civilization, like those of ancient China, Japan, India or the Incas on this continent. Before it stretched a dreary succession of generations unchangingly channeled through a rigid, if not tyrannical, social and philosophical system for whose maintenance alone they were permitted to exist. The sudden recognition that here was the wide and beautiful Earth waiting to be taken by man, overwhelmed and emboldened the great thinkers of that time, notably Giordano Bruno, Nicolaus Copernicus, Galileo Galilei and Johannes Kepler. This was the crowning achievement of the Renaissance, and forever shattered the world of dogmatic scholasticism.

Now we begin to realize that the Solar system, and probably even part of this Galaxy, can be ours. The consequences, for all phases of human existence, of the practical application of the second law of astronautics during the coming centuries almost defies our imagination, just as the world of today would be almost inconceivable to the Renaissance pioneers. We today are merely the shipbuilders for the men and women who will enter a new era of discoveries and lay the foundations for those who will come after them, those who will develop planetary technologies and create cosmic civilizations.

The Third Law

The third law specifies this anthropological character of space operations as we humans can conceive it. It does not imply as desirable the brutal conquest of other worlds, such as happened frequently in the colonization of this world of ours. It does, however, proclaim man's natural right to explore and attempt to fertilize with human skill and wisdom all those parts of the universe which he can reach, whether or not they are inhabited by intelligent beings. This right is equally at the disposal of other civilizations in the universe if they can reach us first, or, if, in the course of their expansion, they reach other worlds before us.

The results of man's contact with another civilization in space, if and when this ever happens, can only be speculated upon. Of basic importance right now is the fact that man is the only source of intelligent life known to us, which gives him the right to expand, to develop and to enrich the foundations of his existence to the limits of his capability. In the light of this perspective, expeditions to other planets, i.e., the age of discovery, is

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"Man's natural right to explore and attempt to fertilize with human skill and wisdom all those parts of the universe which he can reach . . ." Hubble Space Telescope view of Galaxy Messier 94.

again just a beginning, no matter how advanced it may appear to us.

If all the evidence is in, future generations may find solutions to the problem of living elsewhere in the Solar system, or even in interstellar space, thereby giving space flight its ultimate anthropological meaning. It is not very important that we cannot yet specify in more than a general way the utility of living elsewhere in space, because we are about as competent to judge this as Democritus was to judge the utility of atomic knowledge which he so diligently pursued.

This does not mean that consideration of utility should be overlooked. On the contrary. However, astronautics, like all endeavors of large scope, has both an immediate, utilitarian aspect, and a long-range, fundamental aspect. It is not only sensible, but imperative, to establish the utility of a particular project such as an artificial satellite, a lunar probe or an artificial comet. We can also define the utility of a manned exploratory flight to Venus or Mars. Yet all these utilities are limited to special scientific or technical considerations, or to arguments based on military or political expediency. They constitute a professional challenge to a limited group of people, as does a supersonic airplane, the Mt. Palomar telescope, an unconquered mountain peak or a sandstorm observed on Mars.

If this were all, one could well take space flight or leave it alone. The anthropological challenge of space flight, however, goes much deeper. Its perspective and meaning, which alone lend magnetic appeal, can be derived only from the long-range aspects, which align it alongside the highlights of life on this planet.

Realism of Vision Needed

We must be realistic, but there is a wrong kind of realism, timid and static, which tells man to live for his existence alone and not to rock the boat. The kind of realism we need is the realism of vision—the realism of a Columbus, of our Constitution, of a Benjamin Franklin, of an Albert Einstein, of a Konstantin Ziolkowsky and of a Hermann Oberth.

This is the realism which lives by our first law, the very foundation of man's development—the law that states that we are free to grow in this grand universe of ours unless we put the yoke around our own necks. In this spirit, it will not be too difficult to deal with the immediate utilities which rightfully provide the formal justification for each subsequent phase of astronautical development.

However we look at astronautics, it is impossible not to feel its challenge to human destiny. For this reason, space travel needs, and will find, the support of all civilized nations as we gradually and painfully move into the cosmic age of man.