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FRANK J. MALINA: ASTRONAUTICAL PIONEER DEDICATED TO INTERNATIONAL COOPERATION AND THE PEACEFUL USES OF OUTER SPACE

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Abstract

The story begins in Brenham Texas in 1912 where Frank Malina was born of Czech immigrants. He credits the reading of Jules Verne as a child in the town library with inspiring him with a desire to become a space explorer. After attending Texas A and M, he attended the California Institute Technology and earned a PhD under Theodore Von Karman, later to be the founder of the IAF and IAA. Malina together with fellow students Jack Forman, Apollo Smith, Ed Forman and Tsien Hsue-shen went on to develop one of the most successful lineages of rocket concepts, including the JATO units and the Sergeant missile, as well as providing a number of fundamental patents of American rocketry; their first rocket firings took place in October 1936. On October 11, 1945 Malina led the team that launched the WAC Corporal to an altitude of 43.5 Miles, setting a new world record and was the first man made object to escaper Earth's atmosphere. Malina co-founded Aerojet General Corporation and JPL, serving as the second Director. After the end of the War, Malina went on to become the Deputy Science Director of the new organization UNESCO, dedicating himself to mobilizing international cooperation. He was one of the founders of the IAA during the 1959 Barcelona congress and served as its second Director. When Malina died in 1981; the IAF instituted the Frank J Malina Astronautics Medal, with the support of Aerojet General Corporation, for demonstrated excellence by an educator in promoting astronautics and related sciences. The young students who in 1935 began experimenting with rocket motors had lived to see their dreams for the peaceful exploration of outer space begin to be realized. This Highlight Lecture will describe the life and times of one of the true pioneers in space rocketry and his work in support of international cooperation in the peaceful uses of Space.

INTRODUCTION

On October 31 1936, 70 years ago, the first rocket motor tests were carried out at Caltech by a group of graduate students and rocketeers under the leadership of my father, Frank.J.Malina. Just nine years later, on Oct 11, 1945, the group launched the WAC-Corporal from the White Sands Missile Range to an altitude of 235,000 feet, the first man made object to reach outer space. Subsequently the WAC-Corporal was launched as the second stage on a captured V2 rocket and reached an altitude of 244 miles.

In this International Academy of Astronautics Plenary Lecture, I would like to celebrate the work of one of the key pioneers of the space age through the personal testimonial of a second-generation space explorer. My own career is in space astronomy, and when I was a graduate student, the rocket carrying my telescope for my Ph.D. in astronomy was launched from the White Sands Missile Range where my father's group had launched the WAC-Corporal thirty years before. I grew up in a home whose garden fence was at least as far as the edge of the solar system. A frequent visitor to our home was Theodore Von Karman, my fathers's Ph.D. advisor,

and one of the foremost applied mathematicians of the twentieth century. During the 1950s and 1960s, as the International Astronautical Federation and the International Academy of Astronautics were founded, many current IAA and IAF members were friends and colleagues of my parents, Frank and Marjorie.

My father embarked on research in rocket propulsion fired by an unreasonable desire to launch rockets into outer space for the purposes of exploration. Overtaken by events during the second world war, he and his colleagues put all their energy into the war effort. In the closing years of the war they were able in nine months to design, build and launch the WAC-Corporal, realising their student dreams. After the war was over, Frank Malina decided that his place was in Europe helping to create new structures for peace, and was one of the founders of UNESCO and the IAA. He then went on to a career as a professional artist, as a pioneer of what became known as Kinetic Art, and then as the editor of the first international journal dealing with the interaction of the arts, sciences and technology, the Leonardo Journal.

The subtitle that I would like to give my talk is ”New Leonardos, New Medicis ”for indeed making things happen requires not only the teamwork of individuals with overlapping passions and different talents, but also the confluence of historical circumstances and sponsors that allows new ideas to be sustained by individuals and organisations in the societies we live in.

This paper will be a personal testimonial that overviews my father’s many faceted career. My father among other things left behind copious archives now at the Caltech, JPL and the Library of Congress as well as several ”memoirs” which documented in detail his recollection of the rocket work during the 1930s and 1940s (1). Von Karman’s autobiography (2) as well as some more recent books (3) and articles (4) provide other views of my father’s work in astronautics. In this paper I would like to balance a description of his work as a rocket pioneer, which are well documented in the astronautical history literature, with details of his work in international collaboration and also in the art-world. In my view, my father’s lasting legacy are in these three areas of rocketry and astronautics, international collaboration in both the science and art world, and his own work as a pioneer the new technological art forms of the new century.

TEXAS

Frank Joseph Malina was born in Brenham, Texas, U.S.A. on October 2, 1912. His parents were Frank Malina, a Czech immigrant, and Caroline Marek, also of Czech origin (5). He had one sister, Caroline Mercer who worked as an industrial psychologist in Texas. In 1920, the Malina family returned to the new republic of Czechoslovakia, where they ran a hotel and restaurant. The travels through the devastation of post WWI Central Europe were important events in Malina’s childhood.

In 1925 the family returned to Texas because the social and economic situation in Czechoslovakia was discouraging; in addition Malina was showing exceptional academic abilities; The family felt that they should return to the U.S.A. where suitable schooling could be found. He completed High School in Brenham, Texas. He obtained a Bachelor of Science from the Texas Agricultural and Mechanical College which was then a small land grant college run on military lines. Already in 1933 he wrote for his technical English course he wrote that now that man had conquered air travel his imagination had turned to interplanetary travel. The perceptive English professor encouraged him to continue his education by attending the California Institute of Technology, and made this possible by loaning travel funds to the young Malina.

CALIFORNIA

Arriving At Caltech in 1934, he started with a scholarship in Mechanical Engineering and obtained his Masters degrees in Mechanical (1935) an Aeronautical Engineering (1936), and a PhD in Aeronautics in 1940. Malina quickly gravitated to one of the Guggenheim Aeronautical Laboratory (GALCIT) faculty members, Theodore von Karman. Initially working as a graphical illustrator for the textbooks Von Karman was writing, Malina proposed to him to carry out a Ph.D. on rocket propulsion. Karman became his mentor and PhD advisor and subsequently his close colleague and friend for the almost the next 30 years.

The origins of the rocket research group at Caltech are well documented in my father's memoirs and oral histories as well as the work of a number of historians. The trigger was a seminar given by William Bollay reviewing the publications by Eugene Sanger in Vienna on the possibilities of rocket powered aircraft. Stimulated by the seminar at Caltech, two rocket enthusiasts, John W. Parsons and Edward S. Forman, teamed up with Malina. Parsons was a self trained chemist and Forman a skilled mechanic; the two of them had been working for some time on trying to build liquid and solid rocket motors. In February 1936 Malina prepared a detailed program of work with the purpose of launching a high altitude sounding rocket with a plan for a combination of theoretical studies and experiments. Soon after, in the spring of 1936, they were joined by Amo Smith and Tsien Hsue-shen; the so called "suicide squad" conducted a series of rocket engine experiments on campus and eventually on the Arroyo Seco behind Pasadena. In 1938 Malina and Smith published a paper on the performance of a sounding rocket in the Journal of Aeronatical Sciences, the first paper on rocket flight published by what is now the AIAA. The group rapidly came up with a number of inventions and innovations in the design of rocket nozzles, composite solid propellants and rocket design, such as the regnerative cooling of the motors, and controlled flight.

Later in 1938 their work came to the attention of the US National Academy, which provided initial funding, the first government funding of rocket research in a US university. As the war effort ramped up, the rocket research group at GALCIT grew rapidly, and in particular developed the successful line of Jet Assisted Take Off (JATO) units used to shorten the required length of airplane runways in the pacific theater and for takeoffs from aircraft carriers. Under Frank J. Malina's leadership, the rocket research group carried out a program of theoretical analysis and experiments which led to the launching in 1945 of the WAC-Corporal to a height of 240,000 feet.

The rocket work initiated at Caltech had a number of long term impacts on U.S and international space engineering.

First was the influence of Theodore Von Karman on the methodology of the group. Von Karman was one of the foremost applied mathematicians of the twentieth century. The close coupling of theoretical understanding and lab and field experimentation distinguished the work of the group and enabled it rapidly to exploit and extend their expertise as new design problems were confronted. This approach extended to their innovations in the development of new families of rocket propellants, such as the intiial castable composite solid propellants and hypergolics, many which are still in widespread use today. The basic theory of rocket nozzles developed by the group is the basis of subsequent nozzle theory.

Second was their working within the context of an international research community disseminating their work to their colleagues, open to good ideas wherever they might be found. The weekly research seminars at GALCIT were a continual source of cross fertilisation and their reports on their work not only attracted government funding, influenced the work of others and attracted motivated collaborators. Their approach is in clear distinction to the German work under the Nazis in the 1930s, or Robert Goddard's secretive approach under private funding. Von Karman and his students in both aeronautics and astronautics had a disproportionate impact on international developments. One of the most notable was the work of Tsien Hsue-shen who subsequently went on to become the father of the Chinese rocket program after being forced out of the US during the McCarthy period.

Thirdly the institutional approach they took in setting up JPL and Aerojet Engineering Co was innovative on a university campus and left a lasting legacy.

AEROJET GENERAL COPRORATION AND JPL

The group thus initiated a number of organisational approaches that proved to be successful and models for other university based R and D programs. As the war effort ramped up, the production requirements for rockets quickly outgrew the context of Caltech. The on campus research work eventually laid the foundations for the Jet Propulsion Laboratory which Von Karman and Malina founded in 1943; there they taught the first courses in rocket propulsion in any US university. Malina directed JPL from 1944 to 1946 after von Karman took a leave of absence from JPL in 1944. JPL became one of the models for University managed mission labs growing to over 3000 employees, at the same time as the DOE labs managed by the University of California were established.

In parallel, Malina and Von Karman and their colleagues Martin Sommerfield, Parsons, Forman founded the Aerojet General Corporation to mass produce and commercialise their rocket research. The founders pooled an initial investement of 250 dollars each and the company was incorporated by

A.G. Haley. The establishment of Aerojet was undertaken over opposition both from the University and from the Government sponsors. Such university-corporate coupling to exploit the results of applied research is now a basic strategy of most US research universities. The rocket group at Caltech proved to be an institutional innovator in both the establishment of JPL and in setting up a company to carry out the production work and commercialisation of their R and D.

UNESCO

In 1946, at the end of World War II, Malina made a decisive decision to join UNESCO, at the invitation of its first Director General Julian Huxley. Malina had toured Europe for the War Department visiting the European research institutions and had reported for the Ordnance Department at a meeting of the preparatory commission of UNESCO. Intrigued by the vision and drive of the group that Huxley had gathered together, and discouraged by the way that rocket research in the US was being oriented towards delivery of nuclear weapon and a preparation for future wars, he accepted Huxley’s offer against the advice of his colleagues in California. He took up a post in Paris in Christmas 1946 becoming the deputy director for science and in 1951 became head of the science division.

From 1946 to 1953, Malina worked in various projects in international cooperation ranging from projects in the Negev desert to the Hylean Amazon, from arid zone research to international computing centers. He helped organise meetings of scientists such as the first UNESCO Symposium on Desert Reclamation in Algeria and other symposia in India and other countries. During this time he maintained contact with Von Karman who at the time was helping set up AGARD, the Advisory group for Aeronautical Research and Development, for NATO and other international post WWII organisations.

Not long after Malina left UNESCO, my father was deprived of his U.S. passport as a result of being swept up in some of the investigations of the Mc-Carthy hearings. He was philosophically bitter that the Nazi engineers had become US space heroes but the founders of US rocketry who had dedicated the war years to working for the Allies had been dispersed with Tsien in China and himself in Paris and Parsons similarly deprived of security clearance. The U.S decision to champion the Peenemunde group had been in the face of parralel Russian enlisting of Nazi research assets not only because of the technical innovations of the Germans but in a forerunner of cold war competition.

IAA

Malina remained involved in international collaborations projects. When the IAF was founded beginning in 1949, Malina was hard at work in UNESCO but when Von Karman contacted him again in 1959 he worked with him to establish the International Academy of Astronautics and served as its Director in 1963 after Karman's death. In August 1960, before Kennedy announced the moon program in 1961, my father established the IAA committee for a Lunar International Laboratory,L.I.L., with Bernard Lovell as vice chairman. Later he set up the Committee for Manned Research on Celestial Bodies to study among things ideas for Martian exploration. He championed a broad view of the IAA's mandate to work with scientists and engineers internationally in all disciplines relevant to the future of astronautics but also in the role of the IAA serving as an umbrella for long range thinking on topics not yet within the purvue of national agencies. He played an important role in both the History of Astronautics Committee and was a strong supporter or the Committee for the Search for Extra Terrestrial Intelligence at a time when few national agencies or academies had this long view of SETI; a field that has now blossomed with the discovery of numerous exoplanets and the establishment of exobiology. Clearly Malina brought to bear his experience in international scientific organising that he developed during this years at UNESCO, maintaining a deep value in the importance of free international scientific contact even during the most polarising periods of the cold war.

KINETIC ARTIST

In 1953, Malina decided to leave UNESCO and to paint full time. At roughly the same time he became independently wealthy through the stock he still owned in Aerojet (all the other founders had sold their stock). He started working in conventional painting, but often incorporating a subject matter familiar to scientists, ranging from the test tubes and electronic circuits of the laboratory to the technological landscape of electric pylons and rocket trajectories, to the imagery from fluid dynamics and wind tunnels. He stated: "In regard to subject matter, there is still a strong entrenched belief that only certain aspects of life and of the Universe are "poetic". Since most artists are encultured by a literary type of education, it is perhaps not surprising that so few venture away from terrestial landscape, pots and pans and animals"(6).

After experimenting rapidly with a large number of styles, he began incorporating mixed-media in his work. He created assemblages including string, electric wire and wire mesh. The use of wire mesh immediately led him to experiment with the "Moire" effect, and this to a whole series of experiments in creating optical effects. This again was a revelation to him, for suddenly he realised that his experiments in art could make use of the research in vision that were being studied by psychologists and cognitive scientists, yet which were ignored by artists at the time. Some of his works from this period would now be called Op'Art.

Another revelation occurred one day when he was having trouble getting enough contrast in the "Moire" effect of one of his wire mesh pieces. In frustration, he held a 50W light bulb behind the mesh. However, in a few minutes the heat from the lamp caused a column of smoke to rise from the painting ; he concluded that after all electric light was unsuitable for us in art objects. A few months later, in his studio, he noticed the string of electric lights that had been removed from the Christmas tree and realised the solution to the problem. He made his first electric light picture in 1955, "Illuminated Wire Mesh Moire".

Reading Malina's experimentation in art and new technologies immediately recalls the early days of the "Suicide Squad" when the young rocket engineers laid the ground work for a long term rocket research program. Just as Jack Parsons had stumbled on a new kind of rocket fuel, the composite fuel, by noticing the physical properties of roofing asphalt, so Malina viewed art making as a research activity that could draw on all aspects of contemporary science and technology.

Malina showed his electropaintings in the Salon des R´ealit´es Nouvelles in 1955 and held a one-artist show in the same year. It was the first exhibition of Kinetic art using electric light held in Paris. Working with electronic engineer Jean Villmer, Malina developed an electromechanical system which he called the ”Lumidyne ” system (7). that allowed motion and light as a plastic medium under the control of the artist. He invented also an audio-kinetic system where the motion of the disks was coupled to microphones which picked up ambient sound, forerunners of the interactive computer arts of the 1990s. The visual phenomena that Malina explored were predecessors of the experiments in computer art that began later in the 1960s and 1970s.

Malina himself often used imagery from outer space as subject matter, although many viewers could not recognise the inspiration of the compositions. In ”Away from the Earth” (1966), for instance, the basis of the composition is the trajectory of the Apollo capsule from the earth to the moon. Malina stated : ”The exiting of a representative of earth’s civilization into outer space can, for significance, be compared with our ancestors’ descent from the trees. The psychological and philosophical consequences of this move may be tremendous for the future development of mankind... What canvas will hang on the walls of space ships ploughing space’s waves ?”.

One footnote of interest is that Malina also tried to commercialize his inventions and research in art as he had done through Aerojet. He founded the Electro Lumidyne International (ELI) and obtained some contracts in the advertising business as well as a research grant from RCA. Unlike Aerojet, ELI never turned a profit.

LEONARDO JOURNAL

As he worked as professional artist, he could not help but notice how the working conditions and environment of the artist differed from those he had experienced as a scientist and engineer. Working scientists always wrote about their own work in professional journals ; they were always the first interpreters of their ideas. In art, there seemed to be no professional journals where artists were allowed to write about their work. Malina felt that he had new and valuable ideas in his Lumidyne system, yet in the art world he would have to find a critic to write about the work and often artists were very secretive about their techniques. As he started working in the new medium of kinetic art, Malina wanted to research the technical inventions of other artists, but there were no journals where artists exchanged such useful information. Indeed, it was very difficult to even find the work of predecessors in the technological media such as Thomas Wilfred.

As an engineer, he had been trained by von Karman to apply ideas and techniques from all the available disciplines of science and to work in open international collaboration, yet artists seemed to be totally isolated from many major intellectual developments of the century. Lord Snow’s characterisation of the Two Cultures had validity at a very practical level. New discoveries in materials sciences, psychology of vision, physics, and technology surely were relevant to the art of the future, yet art journals were usually devoid of any discussion of these topics. Artists rarely read the work of aestheticians, philosophers or historians as there seemed to be no connections from art theory to the work of professional artists. And whereas in the technical fields, professional societies existed to allow individuals with similar research interests to exchange expertise, in the arts there were societies of critics but not meaningful societies of working artists internationally. In the sciences every scientist felt part of an international enterprise, while in the arts artists rarely had any contact outside their own circle of friends. In effect, artists were marginalised, and totally at the mercy of the commercial and museum system. It was not a situation which accorded with his view of the role of the artist, or the future of art.

These ideas led Malina to found the new art journal ”Leonardo” in 1967. This was to be a journal for contemporary artists where the artists themselves would write about their own work. It would be a journal of ideas where artists could exchange information and obtain information. There would be articles by researchers in all other disciplines which had bearings on the arts and the

journal would have an international scope. He took the idea to Robert Maxwell owner of Pergamon Press and who had been publishing the IAA journal Astronautica Acta.

The Leonardo Journal has now been published for 40 years and is the leading international scholarly journal which addresses these issues. When Malina had founded the Leonardo Journal he saw it as the visible manifestation of a network of scientist-artists, a vision now fully realised through the organisation, Leonardo-The International Society for the Arts, Sciences and Technology which assumed responsibility for Leonardo Journal after Malina's death.

CLOSING REMARKS

I have been honored to be asked to write a tribute in the memory of my father Frank J. Malina at this 2006 Plenary of the IAA.

It seems clear to me that there are unlikely to be individuals like Leonardo da Vinci who today can really make major contributions in so many different spheres of human activity. Today, achievements of this kind are more likely to arise from teams of individuals working together. This requires new ways or working together, new professional structures and educational systems. In the sciences and engineering more than ever this is the norm. In the arts and humanities, this is now also common, enabled in many cases by the new global communication networks. I believe that my father perceived that to create a saner world we would have to work differently across disciplines and cultures. He and his generation hoped that the spread of a scientific humanism would be the enabling condition for peaceful co existence.

At the same time, there is always a vital need for individuals with vision to drive forward to new solutions and creations. The generation of my father was traumatised by two World Wars, and many of them have identified themselves as survivors and dedicated themselves to creating the structures for a different world. Their vision is often illogically optimistic and generous. Many, like my father, have the courage to change careers, to reeducate themselves in new fields and to work towards a better future in a present which in many ways is threatening.

I think my father would have been encouraged by the resurgence of private initiatives for space launchers and space tourism, led by entrepreneurs and students with other visions than military or governmental for the future of space exploration.

He would have been pleased to see that the development of vigorous space programs in China, India, Europe, Brazil and other developing countries in addition to the U.S.A. He would urge us to find ways to work differently in international cooperation so that our profession can contribute to solving problems on earth, to expanding human civilisation into space but in so doing create the conditions for a more peaceful and saner world.

REFERENCES

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(2) H.L. Dryden, The Contributions of Theodore von Karman : a Review", Astronaut. Aerospace. Eng., 1, p. 12, 1963. See also von Karman's autobiography/ Th v Karman with L.Edson, The Wind and Beyond, (Boston: Little, Brown, 1967).

(3) The role of Tsien is documented in I Chang, The Thread of the Silkworm, (New York: Basic Books, 1995).

A number of books have highlighted the role of John Parsons including Strange Angel by George Pendel (Orlando: Harcourt Inc, 2005) and J. Carter, Sex and Rockets: The Occult World of Jack Parsons.(Feral House,)

A third book looks in detail at the history of JPL, Astro Turf: The Private Life of Rocket Science, M.

G. Lord (New York: Walker, 2005)and ncludes an assesment of the role of Frank Malina.

(4) For attribute to Frank J. Malina's work in astronautics see"A Tribute to Frank J. Malina ", G.S. James and F.H. Winter, Acta Astronautica , 10, p. 231, 1983

(5) The Malina family can be traced back to 1630 in the small Moravian town of Horny Becva.

(6) F.J.Malina, "Reflections of an artist-engineer on the art-science interface", Impact of Science on Society, Vol 24, No 1, p19, 1974.

(7) F.J.Malina, "Kinetic Painting: The Lumidyne System", Leonardo,

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