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Chapter 4

The Genealogy of Influence: Viking Mars Missions' Impact on the Future*

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Abstract

The Viking Missions were not only the first missions to successfully land on Mars, they also provided data and context establishing Mars as an interesting and complex world demanding more exploration. However, Viking's influence, then and now, extends beyond science, to technology, exploration, education, and culture.

Because it is difficult to measure a legacy, we make an effort to trace the impact of Viking on science, technology, culture, and other areas, by creating what we refer to as a "Genealogy of Influence." This is accomplished through interviews, research, identifying tangible productions (papers and reports), and tracing decisions made on subsequent missions as a direct and indirect result of a form or function used for Viking.

Viking is unique in that it embodied many firsts, both technologically and scientifically, in an environment only poorly known, outside of information derived from limited remote sensing technology. Yet, Viking also had, for the time, unparalleled success well beyond expectations despite previous global efforts, even for many years after. Further, the individuals who contributed to Viking set

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publishing precedents and models for public and education outreach that still have an impact on the face of the aerospace industry, and space education experienced by the public. These achievements occurred in parallel and in settings that don't always intersect, and as such the cumulative impact of Viking has not been fully measured or communicated.

We present our current findings as initial ongoing research to survey, for the first time, the cumulative global impact of Viking. Although still in the beginnings of our research, we are uncovering a variety of ways in which this genealogy of influence has had a worldwide impact.

The Genealogy includes references to crucial scientific discoveries, recollections and citations of individuals' influenced by Viking as scientists, teachers, artists, philanthropists; instruments, technologies, and products developed for or influenced by Viking; works of art influenced by Viking; and subsequent Mars exploration directly derived from or dependent upon Viking. We also consider how the Viking mission had an impact on the economy.

Major considerations are the challenges, and the processes we are using to preserve the history, and how to interpret and communicate the findings in a manner that provides both fact and structure, for aspects that cannot be measured, or are subjective.

I. Introduction

We began this journey of researching and communicating the impact of Viking when we discovered through our own informal queries that there was a deficit of public awareness of Viking. From public information professionals, to librarians, and educators from primary through college, many professionals and even more so members of the public, had little or no knowledge of the Viking missions beyond that "something" had gone to Mars some time ago. Many had simply never heard of it or didn't recall it. Others who thought they did, when queried would respond with answers such as "didn't that land in the ocean?" or "yes, isn't that the one driving around?" indicating they mistook it for Apollo or a recent rover, such as *Curiosity*.

We began querying people informally in 2009 when we were curating the private Viking collection. As we began doing more outreach over the following three years and planning the exhibits for the historical preservation project, we began asking more broad audiences, and patterns began to emerge. It was clear we needed to bring to light not just the history, but the lessons of Viking, as we discovered even those were being lost.

Those who really did know about Viking were largely from the "Apollo era," or were in their 50s or above.

It also became apparent that the only Mars exploration that is commonly known to all ages including those younger than 50, were relatively recent missions, such as *Spirit*, *Opportunity*, and *Curiosity*, all of which happened roughly within the last 10 years.

Additionally the missions least recalled, were Orbiter missions. This was also the case on the Viking missions, where there was more awareness of the Landers.

Finally, and not surprising, those most recalled were those that are either still operational, and, in the case of those not operational, those with considerable educational outreach using new technologies and models, such as Web casts, social media, and online educational modules. In other words, things people could search on the internet.

Even *Pathfinder* and *Phoenix*, both critical missions that brought new discoveries to the table, were not among those remembered by those we queried informally, despite the fact they had some media presence. It was simply not in the forefront any longer.

What this tells us is not just that we are losing the continuity of aerospace history, which is critical to trace back provenance of technology, but that we are rapidly losing the very ability to identify and apply valuable information because of the noise of competing "stories" that occupy the minds and time of our young populations.

Why is this important?

First, it is an indicator of the decreasing retention and/or communication of information that has global implications. Some of these seemingly insignificant data points actually contribute to the health of our planet, as well as the future health of other systems and life forms we may come into contact with sometime in our future.

That may seem far reaching in the second case, but we know that preparing and comprehending through research is a long term goal for funding reasons alone.

Second, it is a philosophical concern when the message we are sending to our future leaders in this arena who will make those decisions, is to simultaneously extend our human reach and touch into space, while we lose the general (meaning public and common) awareness and understanding of implications of what that might mean. Not only is the message a dangerous one, but it puts us at risk of making irreversible decisions in our accelerated attempt to acquire more achievements, or "feathers in our cap."

There will always be extremes searching for reasons not to do anything or to act carelessly, but in order to create a community of thoughtful decision makers we must model, preserve, and share the lessons so they may become common with in each step we take. It is only through education and participation that we can create a community with healthy dialogue and leaders.

A singular example that set Viking apart from all subsequent missions was the issue of sterilization, or concern for both contamination of and possible destruction of extraterrestrial organics. A secondary concern is handling of samples for testing and the possibility of sample returns contaminating Earth (although the second was not a Viking objective, the groundwork was laid with the Surface Sampling agenda) and is being studied currently. This will be discussed with other technology achievements later in the paper.

Another trend that became apparent was the reporting of discoveries and facts that seems to negate the original discoveries of Viking, as though there was no current awareness by journalists of those findings. This is very common, including recent comments that "seasons were recently discovered on Mars." This is in large part due to the limited communication technologies of the Viking era, and immature archiving techniques which did not enable subsequent knowledge to be easily passed on, other than by individuals with personal experience.

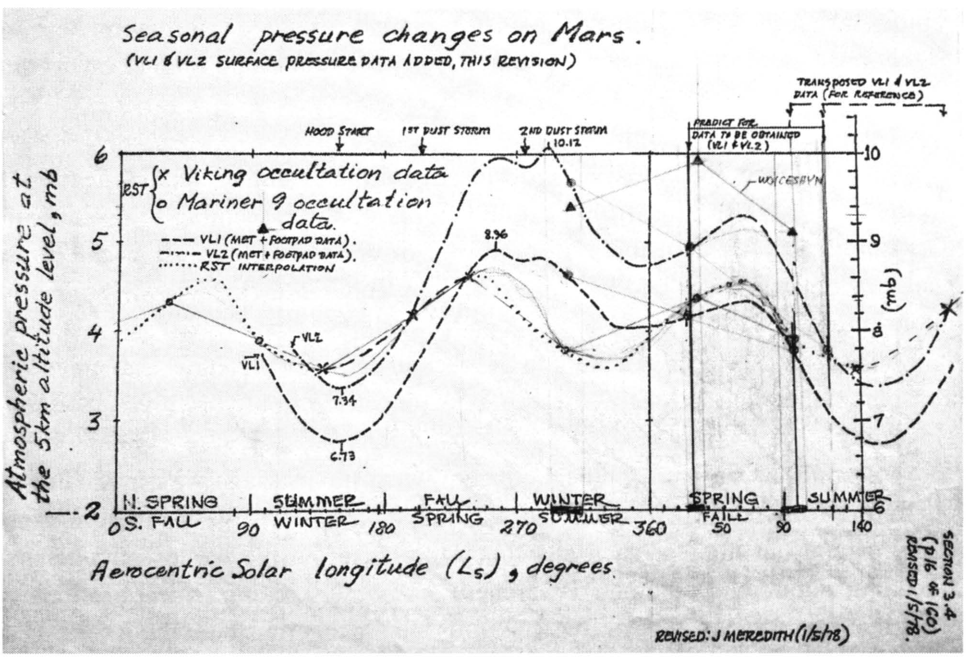


Figure 4–1: Viking diagram showing indications of seasons.
J. Meredith, January 5, 1978.

In summary, what began as historical preservation, became much more of a history, and lessons emerged. And despite the lack of public knowledge, the aerospace community continues to reflect on, analyze, and use Viking data and lessons actively, which enables us to recover some lessons. The history is not yet lost.

For all the missed opportunities and gaps in Viking history, there are sufficient resources to recreate the legacy and lessons, with the right team.

We feel strongly that this opportunity to build and share what is known by those within the historic aerospace community must be taken now, to preserve not just the history of Viking, but also the lessons that might be learned to support future missions and to inspire exploration and discovery, which is the objective of this effort.

II. Measuring Legacies

We begin with an overview of the challenges faced when presenting information to the public that is meant to inform and educate, but exists with inherent room for interpretation.

Sources and Challenges

Records and artifacts (data points and physical documents and hardware) to measure impact are difficult to trace, and in the greater context of history, have been recorded on everything from paper, to microfiche, a variety of magnetic tapes, DVD and other digital formats and platforms, all of which have a finite lifespan unless they are translated into ever-changing current forms and formats.

The challenge of measuring these legacies and impacts further extends to the problems of translation, as well as preserving physical references and artifacts. This includes issues of provenance and source credibility, all of which can be subject to interpretation and scrutiny for accuracy and "completeness."

Finally there is the issue of quantifying results. How do you measure impact when value and import is subjective? You can't. Therefore, for this study and subsequent findings, we record findings, and reference impact in "interpretive form" and provide as much quantifiable data as we can so readers can draw their own conclusions without taking our judgments as to value or import.

For our research, we use sources including personal interviews, government records, public and private information, and extensive information from the Viking mission original documents. Each of these embody some room for interpretation and translation by the readers.

Communication

The ability to communicate and pass on information depends not only on the substance of the physical artifacts, but also on the processes and barriers to communicate.

Aerospace missions use technologies that come from private sector and government efforts, and are increasingly collaborative between nations. As a result, some restrictions are imposed that were intended to prevent nations from sharing technologies that might be used for weapons systems. The International Traffic in Arms Regulations (ITAR), is meant to limit the transfer of knowledge that might be used in this way.

However, these restrictions can also cause bottlenecks and barriers to collaboration and development where technologies that are commonly known, are frequently used in non-flight and non-weapons products, and do not pose significant threat, might fall into the category of being ITAR restricted if they are used on spaceflight systems. Thus, this critical process can sometimes become an unnecessary barrier to collaboration.

One such example was the desired use of thermocouples used on Viking for meteorology, for a subsequent mission. Although the technology was used already by the collaborating nation, (Canada), for other purposes, the technology was considered restricted by ITAR, and the inability to discuss the technology with Canadian cohorts, led to the use of a different and less effective technology. Simultaneously, the same information did receive approval for another mission, NetLander, with Finland and France, but at the time, Canada was not on the approved list because the request was put in prior to beginning the discussions with Canada. The approval was received eventually for Canada but the lag time missed the hardware design stage. This was a case where the paperwork approval process cost more than the instrument being designed.

Reporting Findings

Much of what has been learned by Viking went undocumented due to the era and the lack of mature archiving technologies. As a result, we report what we research and "measure" just as an impressionist artist would, with suggestion combined with data. We plan to relate the results through storytelling along with media aids of the voices, images, documents, and other content provided by Vikings and the institutes that supported Viking. The experience of these results is like a story, best delivered through multimedia, which is the final objective of the project.

To measure and demonstrate the impact of Viking, consider this analogy: where one individual would teach a single class once to a group of third graders there might be some immediate and even residual memory and influence with one or a few viewers. However, when an individual commits himself to regular outreach and educational opportunities, as many of the Viking contributors have done, he not only extends the reach of his influence, but also increases the incidence and likelihood or "stickiness" of those lessons.

Viking was unique because of the high numbers of Vikings who committed themselves to education, accelerating and cementing the impact through mentorship, intern and graduate opportunities, formal teaching, and even founding institutes and funds to support education.

We cannot say all those "touched" were affected, or how, per se, and attribution is not expected to be 100 percent. However the quantity and diversity of people reached through a variety of means by Vikings, and the continued efforts to contribute and influence created, what we hope to show, is a significant ripple effect or "Genealogy of Influence."

III. Human Impact

Human development throughout time has been influenced by discoveries we make (both accidental and intentional), tools we create, events, and leaders that emerge from inspiration. Because the past informs and shapes the future, we cannot omit the impact of individual contributors. Viking contributors' discoveries and influence become the legacy.

Viking contributors have influenced many diverse elements of society in varying degrees. These include peers, students preparing to work in the aerospace industry, children in public settings, teachers, and the general public.

In addition to those who worked on Viking, there are secondary, tertiary, and continued ripple effects, or influences carried by individuals that worked for or with Vikings, or with their data and findings, and even by-products inspired by Viking and expressed in artistic form.

We introduce just a few of these secondary and further influences to demonstrate the exponential effect we refer to as genealogical-like growth.

The Vikings

We refer to "Vikings" as people who contributed to Viking for NASA, JPL, under the primary contract at Martin Marietta, and the subcontractors on the project. This includes the Orbiters, Landers, Deep Space Network, and computing designers and engineers. These individuals worked on Viking in a variety of roles from mission design, and operations, to interns and graduate students, and even family members. We have selected a subset of our individuals to cover in this paper, as the long list has not yet been fully realized, and it would be unmanageable in a format other than our final goal, of digital and scalable interfaces that will grow as we produce and process more content.

We begin with individuals who have the broadest name recognition outside of the aerospace community and then continue to filter to more and more specific arenas of influence.

"Household names" were fairly few due to the era of limited media and person-to-person communications technology. These are names that one might find through simple searches on the Internet now, but then would have been known by local librarians, educators and to some extent, had "celebrity" status in households outside of the aerospace community. From Viking there is really one that stands out in this category, but as time passes, even his recognition has decreased. Arguably this most broadly recognized person from the Viking Missions is Carl Sagan.

Dr. Carl E. Sagan

Dr. Sagan has had an impact on households worldwide, scientific and engineering communities, artists, and leaders of diverse communities and stature. His name recognition extended beyond most Vikings. This is in large part due to his charismatic presentation style noted broadly, and remembered personally, as well as his public outreach efforts and broad subject matter knowledge, from scientific to philosophic. "Some part of our being knows this is where we came from, we long to return. We can. We are made of star stuff."[1]

Dr. Sagan served on the Viking Lander Imaging Science, Flight Team where he not only influenced decisions made during site selection, which was led by Harold Mazursky, but rallied team members to support rich scientific returns. This was the goal of most contributors, but also the hardest achievement in the complex Viking system. He spoke not only to team members but to the public about the possibility of extraterrestrial life, and the considerations of the human spirit in the context of the pursuit of scientific results and principals.

Dr. Sagan influenced individuals as well as decisions, with an impact on mission direction with his extensive research and publications even prior to Viking covering everything from planetary science to biology, while teaching at Harvard and Cornell. He inspired others to join the ranks of exobiologists searching for answers in the "outerworld." His influence extends beyond the mission, to individuals who heard his ideas and work through his books, including *Cosmos*, which inspired the Emmy and Peabody award-winning television series viewed by over 600 million people in over 60 countries,[2] and brought space exploration into homes worldwide. He inspired generations of writers and readers with his

Pulitzer Prize-winning *The Dragons of Eden: Speculations of the Evolution of Human Intelligence*, and many other bestsellers. He also inspired generations of biologists and astronomers, who continue the search for extraterrestrial life to this day.

Figure 4–2: Carl Sagan with Dr. Gerald Soffen at Cape Canaveral. Author appears as child in red. Credit: James E. Tillman.

In addition to being a leading scientist, consultant for NASA from the 1950s, and a writer and teacher, he, along with Bruce Murray and Lou Friedman, founded the Planetary Society, which continues to be the largest space-focused interest group in the world. Further, he has numerous awards, fellowships, and scholarships in his name that provide educational opportunities for students, propelling Viking's influence into the future.

As a result of these tangible legacies, measuring Dr. Sagan's impact is easier simply because it has been recorded, to some degree. And adding to viewers of the original *Cosmos*, the new series, debuting spring of 2014 on National Geographic Channel and FOX TV with host, astrophysicist, Neil deGrasse Tyson, another formidable guide, continues the influence to future generations.

If you aggregated the students, peers, scientists, philosophers, readers and viewers of *Cosmos I* and *II*, these alone would be significant Viking influence. However, Viking was project "home" to numerous other outstanding leaders who had a significant impact on audiences and left their legacies in other circles that continue today.

Aerospace Industry Influencers

These vary from scientists to engineers and mission operations although most contributors at that time were only well-known among science and aeronautics communities due to limited media and communications technology.

Because of the large number of Vikings who committed themselves to education and outreach, and became leaders in aerospace, we cannot reflect them all in this paper. We chose a few to exemplify the depth of impact, using data from the interviews with the most complete heritage.

James S. Martin, Jr., NASA Langley Viking Mission Manager

Jim Martin continued after Viking to influence the aerospace industry as Vice President for Martin Marietta Aerospace.

Martin's legacy and influence was his leadership style which is remembered as tough but fair, with an uncompromising focus on quality that left no stones unturned. Reflections from numerous Viking Project Office members attribute the success of the Viking mission to Martin's dogged pursuit of solutions through a focus on what would become known as the "Top 10 Problems," issues that arose that needed to be solved in order to prevent compromising a critical aspect of the mission.[3]

A. Thomas Young, NASA Mission Director for Viking

Tom Young's work continues to inform, shape, and direct aerospace missions as he advocates and provides decision makers with perspectives needed to make critical decisions.

His influence began with Viking and continued with numerous influential roles including: Deputy Director of the Ames Research Center, Director of the Planetary Program in the Office of Space Science at NASA Headquarters, Senior Vice President of Martin Marietta Corporation, President of Martin Marietta Electronics & Missiles Group, and Executive Vice President of Lockheed Martin Corporation. He also provides leadership as a Fellow of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, and other institutes.

Dr. Thomas A. "Tim" Mutch

Where Martin's influence was direct, measurable and accountable by all who worked for him, Dr. Mutch, Viking Imaging Project Manager, was a critical link in the human chain of influence due to a significant precedent that he managed; the Viking Intern program. Mutch, led the Viking Intern Program, initiated by Carl Sagan and Jerry Soffen, a precedent not only for NASA, but other institutes, that began bringing students into the planning and operational phases of missions, and has been referred to as the catalyst of internship programs today.

The depth of involvement from Viking Interns from the formal program led by Tim Mutch also provided a critical link to maintaining and extending the Viking knowledge to future missions, as many of the interns continued to become leaders in the aerospace industry as a result of their Viking experience.

It is through the insistence of Carl Sagan and the leadership of Dr. Mutch that the program existed, and the program, has had impact on virtually every mission proposed.

Dr. Gerald A. Soffen

Dr. Soffen's influence extends well beyond his Project Scientist role on Viking, to his work as NASA Langley's Chief Environmental Scientist, Director of Life Sciences at NASA Headquarters, and NASA Goddard Space Flight Center. But his continuing legacy is in the form of his impact on youth beginning in 1990, when he led the formation of the University Programs office, and when he created the NASA Academy. Gerry's legacy and influence continues beyond his own hands, with results which have been shared in interviews with some of his graduates, such as William J. Pomerantz, VP of Special Projects at Virgin Galactic and graduate of NASA Academy,[4] and in his memorial pages.[5]

Again, quantifying impact is difficult, but the Academy and those who have benefitted from the Soffen Memorial Fund are each the beginnings of new ripples or branches in the evolving influence of Dr. Gerald Soffen, and they spread with each individual they reach. For example, Will Pomerantz, graduate of NASA Academy, and now Vice President for Special Projects at Virgin Galactic, is now the Chair of Students for the Exploration and Development of Space (SEDS) where he continues to model and support the continued learning of future aerospace leaders. In conversations with Pomerantz, he talks of Dr. Soffen as a legend and the impact he had when he first met him.[6]

Dr. Raymond E. Arvidson

Dr. Arvidson was the Team Leader for the Viking Lander Imaging System operations on Mars after the death of Tim Mutch. His work through the life of the last Lander (I), gave him intimate insight into systems and human operations and flow that would influence his career, and subsequently put in place tools and methodologies that would change how future missions were done.

The lessons he shared included things to emulate, as well as thing to improve. One critical improvement that affected all future missions was the design and implementation of documentation systems that would provide current mission team members tools to record daily decisions and results in digital summaries, to accompany the storage of data. This system was called QUILL and was utilized on the Mars Exploration Rovers, and became a web based system on Mars Science Laboratory. Both enabled better group decisions and problem solving for real time operational decisions, as well as to optimize the measurement campaigns for each instrument: "how much time you spend at one location before moving on? How do you fold in the overall theme of the mission?"

Additionally, the systems provided a mechanism to archive the data and decisions for later viewing as a complete end to end "mission replay." From a historical viewpoint, this has become an immensely critical tool to be able to pass lessons from one mission to the next and avoid the loss of knowledge as teams and technology change.

Another lesson that Dr. Arvidson brought from Viking to subsequent missions was a model for effective operations in an integrated team environment in order to maximize science return with limited time and access to onboard systems. In other words, how to best utilize the up and downlink sequences in a matrixed multi-instrument environment that relied on limited periods of access to instruct the onboard systems and provide data for each waypoint. This was a team management as well as time management model that worked well on Viking and was carried to subsequent missions.

His influence extended to both orbital, lander, and rover missions with more operational time on more missions than any other aerospace leader to date. Missions he influenced include:

- *Magellan Radar Orbiter* Mission to Venus
- *Mars Global Surveyor* Mission—Project Science Group Member
- *Mars Exploration Rover* Missions MER (*Spirit* and *Opportunity*)—Deputy Principal Investigator
- *Mars Phoenix Lander* Mission—Robotic Arm Co-Investigator (aka "Dig Czar")
- European *Mars Express* orbiter—Co-Investigator for the hyper-spectral mappers, OMEGA
- *Mars Reconnaissance Orbiter*—Co-Investigator CRISM
- *Mars Science Laboratory* (MSL) *Curiosity*—Science Team Member (and mobility specialist).

Dr. Arvidson's influence did not stop at the missions he served on, but extends his impact to his students from Washington University in St. Louis and other institutes. His experience as a Viking Intern translated to a leadership role in providing opportunities for students on the missions he has served on.

Gentry Lee

Gentry Lee, was the Director of Science Analysis and Mission Planning on Viking, and currently serves as Chief Engineer for the Solar System Exploration Directorate at the Jet Propulsion Laboratory (JPL). Lee has influenced the aerospace community of peers as an aerospace leader, and readers worldwide as an author.

He co-authored *Cradle*, *RAMA II*, *The Garden of RAMA*, *RAMA Revealed*, and wrote *Bright Messengers*, *Double Full Moon Night*, and *The Tranquillity Wars*. Four of his books were *New York Times* bestsellers and were translated into over twenty-five languages. Lee also worked with the late Carl Sagan, on *Cosmos*.

Because of his writing, he has extended his influence to those who might not be an audience of the more technical realms within which he is also a leader and innovator.

Dr. Gilbert V. Levin

Dr. Levin not only led the development of the biology experiment, the Labeled Release (LR), but he continues to drive the continued search and research for organic forms on Mars. Despite the Viking Science Team's decision that organics (or "life") could not conclusively be determined based on the biology experiments on Viking, Dr. Levin continues his work based on the findings of two out of three of the experiments that might have indicated a possible presence of organics.

The LR was one of three experiments on Viking that combined were meant to determine whether or not there was life on Mars.

> The LR worked by releasing radioactive gas from radio-labeled compounds in the event they were metabolized by microorganisms in the Martian soil. i.e. LR squirted a drop of carefully designed radioactive food onto a tiny cup of Martian soil and monitored the air above the soil to detect radioactive gas that any microorganisms present might breathe out.[7]

This information from Dr. Levin's website describes the details of the original search and his subsequent research and comparisons with significant findings from other missions, suggesting that perhaps his experiment did detect organics.

Regardless of the results, Dr. Levin has kept the discussion alive, pushing the scientific inquiry that is essential to the discovery process. It is this very inquisitive and rigorous nature that keeps science alive when interruptions of science and society threaten to push them aside.

Business and Entrepreneurial Influencers

These individuals have contributed to the economy as entrepreneurs and business leaders, influencing economic development and education through business start-ups, product innovation, and public speaking.

Norman L. Crabill

Viking Mission Design & Analysis Manager served 37 years with NACA/NASA and continued as an aerospace entrepreneur. He initiated the Digital Flight Recorder Program and the NASA Storm Hazards Program and worked with Martin Marietta as an FAA contractor. Mr. Crabill still consults in aerospace.

Jeremy A. Jaech

Jeremy was a student working for Professor James E. Tillman and later co-founded Aldus, which became Adobe Software. He also founded Visio which was purchased by Microsoft and is currently on his fifth start-up, SNUPI, and serves as the Regent for the University of Washington where he first worked on Viking software programming for Professor Tillman. He has referenced his work for Jim Tillman as being important to his professional development.

Dr. Robert L. Huguenin

Participated in pioneering development of spectrophotometric remote sensing technology developed for mineralogical mapping of Solar System objects providing hyperspectral technologies used for Earth remote sensing applications.[8]

Dr. Iris Mack

Was an intern in the formal Viking Intern program. She was also an astronaut candidate for the Space Shuttle following her Harvard doctorate in Applied Mathematics and London Business School Sloan Fellow MBA.

Dr. Mack's career and commitment to education has served to influence countless young women and African Americans interested in pursuing careers in aerospace and technical fields. Her influence extends to her students as a former MIT professor, a speaker worldwide on quantitative finance, and high frequency trading, as the Founder and CEO of Phat Math Inc. a prototype mathematics edutainment social network for students in grades K–12, and will soon include students in The Energy Institute at Tulane University's Freeman School of Business. Her career and current business has been cited as one of the Top 50 Social Sites for Educators and Academics and 25 Useful Networking Sites for Graduate Students.

She also serves on various boards, including the National Academy of Sciences Transportation Research Board, AlgoAnalytics Trading and Financial Analytics (India), MarketExpress Financial News and Research (India), The Edwin Moses Global Institute, Women Mentor Women Foundation, and I Can Still Do That Foundation.

These kinds of contact and outreach change the lives and direction of young students, leaving a legacy, just as teachers do, that is passed from generation to generation with a broad brush.

There are countless other leaders on Viking and emerging from Viking later that we cannot mention in detail. Therefore, this list is a high level brush of just a few we have spoken to or researched, to date. A cursory review shows the depth and breadth of Viking influence from just this short and incomplete list.

- *Israel Taback*, "The father of Mars Viking Lander"[9]
- *Angelo "Gus" Guastaferro*, Viking Deputy Project Manager; Vice President with the Lockheed Martin Missiles and Space Company, Deputy Director of the NASA Ames Research Center, consultant to NASA
- *John F. Newcomb*, Viking Project Management
- *David W. Thompson*, Viking Intern, Founder/CEO of Orbital Sciences
- *Dr. Benton C. Clark*, developed the X-ray fluorescence spectrometers for geochemical analyses of Martian soil samples onboard the Viking landers; Chief Scientist, Flight Systems, Lockheed Martin Astronautics, *Giotto* mission, co-investigator lightflash detector and sunshade for Particle Impact Analyzer (PIA) experiment
- *Prof. James E. Tillman*, Viking Meteorology Team Member; contributed to *Pathfinder* informally, Finnish delegate to MetNet Mission
- *Dr. Paul D. Spudis*, Viking Intern, Senior Staff Scientist at the Lunar and Planetary Institute
- *Andrew L. Chaikin*, Space Historian and Author
- *Steve Albers*, Viking Intern and Researcher at NOAA
- *Olivier de Goursac*, Viking Intern from France who continued his work in Europe.

The Next Generation of Influencers

These students and peers of Vikings, aerospace leaders, and next generation scientists and engineers educated through institutes founded by Vikings, continue the legacy through new analysis of data, continued research and exploration of Viking contributors' research, and inspiration and resources initiated by Vikings.

Dr. Christopher P. McKay

Now a Planetary Scientist for NASA Ames, McKay continues his study of terraforming Mars that began in 1978 after he gave a small seminar on the possibility of introducing life to Mars, which was followed by his Co-Founding of The Mars Underground, the organization that breathed life back into the search through determination, creative alliances, and just enough controversy to keep the spotlight from dimming completely.

Dr. Steven W. Squyres

Dr. Squyres, Principal Investigator, *Mars Exploration Rover* Missions (MER), attributes his career development to Viking, beginning with meeting Joe Veverka during his graduate studies. After spending some time in a room filled with images of Mars, "I knew what I wanted to do for the rest of my life. It was a transformational experience."

His first influence was Dr. Veverka, but his Viking influence did not end there. Mike Carr, Viking Team Member, and planetary geologist at the U.S. Geological Survey; Carl Sagan, Viking Lander Imaging Science-Flight Team Science Investigator, Astrophysicist, Author; Alan Delemere, retired Ball Aerospace and Technology Corporation Engineer who subcontracted for Viking; Fred Huck, Viking Research Engineer at NASA Langley, who joined the Lander Imaging Science Flight Team as Experiment Investigator; and others on Viking cemented Steve Squyres' commitment and desire to pursue an exploratory space career.

Today, Dr. Squyres continues the legacy of Viking, inspiring new generations of explorers who follow his current work, including investigations of Mars as the scientific PI for MER, co-investigator on the *Mars Express* mission, the *Mars Reconnaissance Orbiter*, the *Mars Science Laboratory* mission, and the *Cassini* mission to Saturn.

The direct attribution by Dr. Squyres is evidence of ongoing and future impacts of Viking on missions, even 30 years later.[10]

Dr. Neil deGrasse Tyson

Dr. Tyson began his journey at the Hayden Planetarium as a nine-year-old boy first introduced to space. His voice now narrates and educates generations to come through current and past exhibits such as "Dark Universe."

His first direct influence from Viking was through Carl Sagan, from whom he received a personal letter after his application to Cornell University was forwarded to Carl. "I understand you are considering Cornell," wrote Sagan. Dr. deGrasse Tyson then met Carl Sagan at 17 years old for his tour of the university. His commitment at that point was solidified when he said to himself, "If I am ever in a position of influence the way he is, then I will surely interact with students the way he has interacted with me."[11]

His continued impact extends further through literature with 10 books written, many journal publications, multiple appearances in front of children, educators, scientists, and world political leaders covering topics from night skies to "Implementation of United States Space Exploration Policy," and numerous courses taught at institutes including at Princeton and Columbia, Universities, the University of Maryland, and the University of Texas.

The most recent and global influence by Dr. deGrasse Tyson is as the host for the new *Cosmos* series, being broadcast on National Geographic and FOX TV.[12]

Dr. Dante Lauretta

The Principal Investigator of the Origins Spectral Interpretation Resource Identification Security Regolith Explorer, (OSIRIS Rex), was a student of Ray Arvidson, Viking Intern, who in turn invited Dr. Lauretta (at that time a prospective student) to participate in a research position with a McDonnell Fellowship for Space Science. In an interview, Dante recalled that although *Mars Observer* ended up not making it to orbital insertion, and the project folded, his entry into the field was still successful, and he began a research path that would eventually lead him back to spacecraft, and even provide opportunities for more students, although at a later point in the mission process. His disappointment with *Mars Observer* was sufficient for him to carefully consider the point at which he would invite student participation.[13]

William J. Pomerantz

Pomerantz is Vice President for Special Projects at Virgin Galactic, Trustee and Chairman of the Board of Advisors of Students for the Exploration and Development of Space, primary author and manager of the $30 million Google Lunar XPRIZE, and the $2 million Northrop Grumman Lunar Lander XCHALLENGE. Additionally, Will has worked at Brown University, the Futron Corporation, the United Nations, and was the co-founder and the Editor-in-Chief of *SpaceAlumni.com*.[14]

Dr. David Crisp

Influenced by Vikings James E. Tillman and Conway Leovy, now a Senior Research Scientist at JPL for NASA *Orbiting Carbon Observatory 2*, Crisp used Viking elements to model the *Mars Polar Lander*. Despite the demise of the Lander, elements were used later on *Phoenix*, including thermocouples. He also served on science teams for the *Venus VEGA* Balloon Mission, *Hubble Space Telescope* Wide Field/Planetary Camera 2 (WFPC2), *Mars Pathfinder* Lander Atmospheric Structure Instrument, and ESA's *Venus Express*, has developed *in situ* atmospheric structure and meteorological instruments, and served as the Chief Scientist of the NASA New Millennium Program.[15]

IV. Institutional Impacts

The individuals of Viking initiated an unprecedented number of institutes, organizations, foundations, educational scholarships, grants, and fellowships that to this day lead the world in space education and outreach. The institutes that follow were founded by, initiated, or supported by funding in the name of Vikings.

The Planetary Society

Founded by Vikings Carl Sagan, Bruce Murray, and Louis Friedman with members including Jim French, Norm Crabill, and many others.

NASA Academy

Dr. Gerald Soffen initiated the NASA Academy during his post-Viking years, and as a direct result, influenced multitudes of students personally as a visible participant, which continues today. Graduates remember Dr. Soffen and share their own experiences on his Memorial page set up by his wife and the Soffen Fund.[16]

SETI Carl Sagan Institute and Carl Sagan Exoplanet Postdoctoral Fellowships

Carl Sagan's legacy continues to influence students with these Fellowships initiated in 2008 to "to inspire the next generation of explorers seeking to learn more about planets, and possibly life, around other stars."[17]

NASA Internships

Viking set a NASA precedent by implementing the first internships for a government aerospace mission. This was initiated by Carl Sagan and led by Tim Mutch, and became a precedent that influenced NASA continued education, and also created an opportunity that could be attributed to the success of Viking Interns such as Orbital Science Founder David Thompson, Lunar & Planetary Institute's Paul Spudis, HST's Kenneth Carpenter, noted space historian Andrew Chaikin, and many others.

Soffen Memorial Fund

The Dr. Gerald A. Soffen Memorial Fund for the Advancement of Space Science Education was set up to "continue Jerry's commitment to the future of space by supporting motivated students in the fields of space science and engineering." Since 2002, it has provided travel grants, and aspires to offer Astrobiology Graduate Fellowships.[18]

Many students have benefited from these and other fellowships, giving an additional boost to the Viking legacy. These students have gone on to become leaders in the industry with this "reinvestment" made possible by the Viking team members.

V. Scientific Discovery

All of the science experiments on Viking were completely new and developed for Viking. This made the integration process itself wholly unique and challenging, where each instrument and its requisite singular requirements also had to interact with all others as well as a centralized communications system that managed the command sequences required to request, collect, analyze, and send results.

Viking's project office operational model of having science teams work together to define the touch points between instruments as well as the interdependencies during the engineering and design process was a challenging one, but the results were a science team that was highly knowledgeable about the aggregate payload, as well as their own instruments.

This model paid off, as challenges occurred and schedules and uplinks had to be altered in order to achieve various results and solve problems discovered in flight and after landing. The model included having a specific integration manager assigned to oversee this role. Roger Waldman was one of the contractors who worked with each of the teams to ensure changes made on instruments would be communicated to other teams and adjustments made to ensure the final cohesion of instruments on the payload. In an interview with his daughter, Cynthia Waldman, who also worked on Viking as a recent graduate, she remembered her father doing his Master's Thesis on Viking configuration management.

A well-known example of challenges and successful problem solving was the conundrum discovered when the Surface Sampler arm did not deploy correctly. This required a new set of sequence commands as well as around-the-clock problem solving and modeling using the Science Team Lander (STL) on Earth to simulate the various commands and results. It was through the experimentation on Earth using the STL that the problem of a stuck pin was discovered, as well as the solution. Apparently the original code, to fully extend and retract the arm to release the pin, had been rewritten such that the full extension did not occur and the pin did not drop. This was rectified by programmers and communicated to Jim Martin as he addressed the Press with the resolution. The details of this occurrence were learned through a series of interviews with Viking Project Office, Martin Marietta, and JPL staff.

Biology

Viking had four biology experiments designed originally, and three made the selection process for payload and became the Viking Biology Science Experiments. These included the pyrolytic release, the labeled release, and the gas exchange. The Lead Investigator for the Biology Team was Harold P. Klein.

Viking may not have left a clear legacy confirming life on Mars, but it has clearly established the rigorous and persevering scientific explorative process, pursuing that important question of extent or historical life, that has kept the research and inspiration alive by Vikings such as Dr. Gilbert Levin, Biology Team Member who designed the Labeled Release (LR) experiment, and Patricia Straat. Further, it established, if only for a brief moment after initial tests were in, the possibility that data from two of the biological experiments might suggest that organic responses to the scientific experiments were being considered.

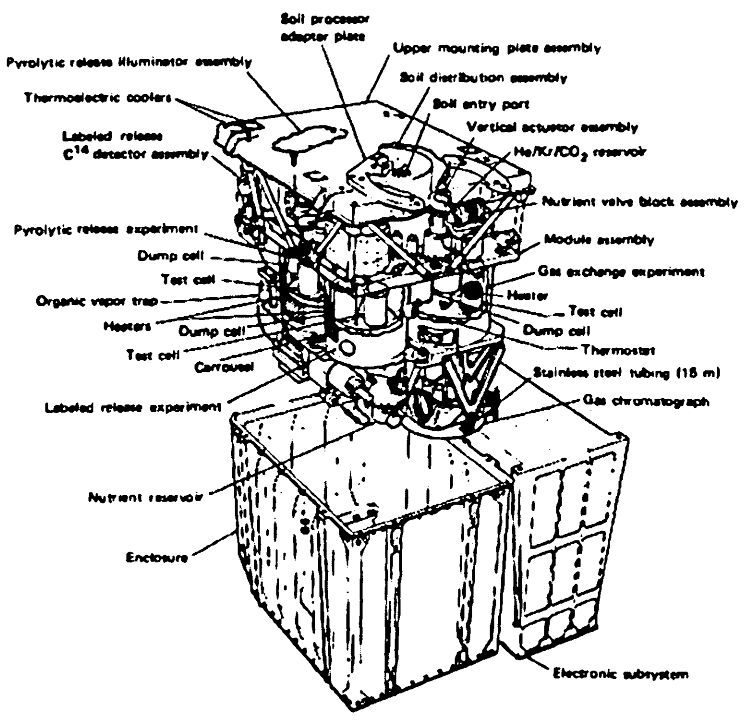
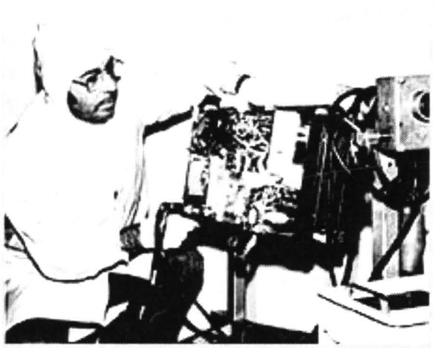


Figure 4–3: Viking Biology Experiment Payload. Credit: NASA.



The Viking Gas Chromatograph Mass Spectrometer. A gas chromatograph uses a thin capillary fiber known as a column to separate different types of molecules, based on their chemical properties. Image Credit: NASA

Figure 4–4: Viking Gas Chromatograph Mass Spectrometer. Credit: NASA.

Despite the advance agreement by the Biology Team that life was to be defined by two positive responses, after consideration by NASA and the planetary community, it was reconsidered, and finally announced by the Science Team Leader, Gerry Soffen, that "Scientists finally concluded that we found no evidence of life on Mars."[19]

This does not, however, mean that determination was conclusive across the board, and continued research by Dr. Gil Levin and others, and comparisons with data from subsequent missions such as *Phoenix* and MSL have produced tantalizing clues, including the discovery by the *Phoenix* lander of perchlorate salts, an oxidative agent that might have masked the presence of organics. These discoveries and continued research led by Viking Dr. Gilbert Levin have brought back the results of the Viking biology experiments to the forefront.

Meteorology

Before Viking, Mars' atmosphere was largely unknown. The discoveries and depth of meteorological data from Viking have enabled subsequent missions to land successfully, and have contributed to our holistic understanding of Mars. A few discoveries include: thermal modeling, seasons on Mars, and dust storms.

Geology

The geological studies on Viking were the defining success of the program. Between the orbiters, which took over 50,000 images of the surface, and the landers, that provided the first close-up surface images, Viking enabled the first geologic understanding of Mars.

Because the imaging data was the primary source of information, geology was also the discipline that led to our understanding of Mars as we know it today, and has remained the focus of most subsequent Mars missions, as Viking set the model for deducing history through mineralogy.

The discoveries of the geology "detectives," the science team members and outside experts, concluded there was the possibility of flowing water, through the images of rivers, channels, and valleys that implied historic liquid. They provided the first knowledge of volcanoes. And they discovered what appeared to be locations where, at one time, large floods of water flowed around craters and other geologic formations.

The very first "employment" of geologic information was to identify the landing zones for the Mars landers. This effort was led by Harold Mazursky, with Norm Crabill as his Deputy, and many contributors, including Dr. Sagan. The Viking Interns contributed greatly to this effort, doing meteorite crater counts to assess boulders below resolution scale, creating mosaics, labeling images for scientists to review.

The geologists of Viking further influenced the direction of Mars exploration by mentoring numerous future leaders in this area who continue to explore Mars, the Moon, and other planets.

VI. Technology and Instrumentation

Significant information in this section was provided by Dr. Benton C. Clark, Viking investigator, who has served on numerous missions following Viking.

Sterilization

Viking was a highly measured and planned mission that took into account both meeting high standards of achievement and understanding the implications of its "footprint." The most notable difference between Viking and all subsequent missions is that Viking is the sole spacecraft to undergo sterilization, as compared to current missions which undergo "sanitation" to minimize earthly or human impact on another planet.

Interviews with Viking engineers, and fact sheets from the mission documents indicate this was one of the key defining differentiators between Viking and all other missions. All parts of Viking had to be "baked" between 113 and

120 degrees centigrade which would have destroyed traditional instruments and computing systems as well as the tapes on which data was to be stored, albeit temporarily.

This singular requirement affected every system and subsystem and increased the cost, according to the project office team, approximately 20 percent.

This requirement was based on an international agreement, COSPAR, at the time led by NASA, concerned about the contamination of another planet, as well as the integrity of the samples that were to be taken by Viking.

This included the study of purification of hydrazine.[20]

A direct consequence of the sterilization requirement was the need to create a data storage system that could withstand the heat of the process. Out of this, the metal tape, tape recorder was developed.

Mass Memory

Figure 4–5: Metal tape, tape recorder for Viking development.
Credit: James E. Tillman.

Traditional tape media would not meet the heat exposure required to sterilize the instruments, therefore, an alternative was needed.

Interviews with Ben Clark, Norm Crabill, Bud Reynolds, John Newcomb, and James E. Tillman, provided details of the provenance of the Viking development recorder in the image above. The recorder pictured in Figure 4–5 is a part of the private Tillman collection and is used for educational purposes.

Imaging

The Viking missions demonstrated the immense value of imaging to a variety of disciplines and the Viking camera systems on *Spirit* and *Opportunity* are directly based on Viking influence according to Steve Squyres, Principal Investigator of MER. They were not the same as those on Viking, however it was Fred Huck, Viking research engineer at NASA Langley that Dr. Squyres sought out specifically for advice during the design of the cameras for *Spirit* and *Opportunity*. "Fred was hugely influential. The things that I have learned from Fred are woven into the very design of the cameras on *Spirit* and *Opportunity* today.[21]

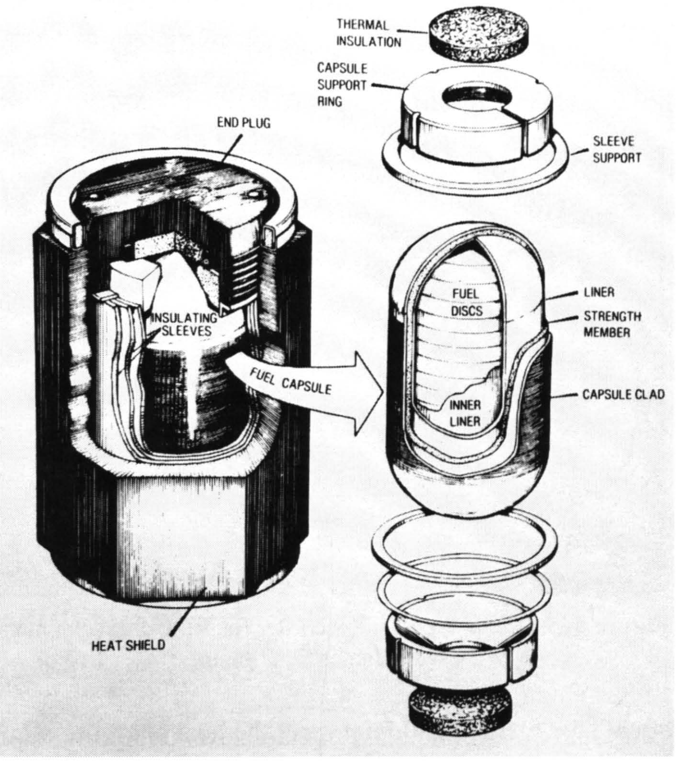


Figure 4–6: SNAP 19 Viking heat source diagram. Credit: ERDA.

The SNAP-19 is one of a series of nuclear powered sources developed for space use, based on the design for NASA's *Nimbus III* weather satellite, *Pioneers 10* and *11*. Contractors for SNAP-19 included Teledyne Isotopes, Savannah River Laboratory, Mound Laboratory, and ERDA's Space Nuclear Division.[22]

Thermal Switch

Thermal switches accepted or rejected the heat from the nuclear generators, controlling the temperature and triggering the switches which alternately turn on and off a Freon reservoir that regulates the temperature of the Lander.

This mechanical switch would provide a path for heat to flow from the hot RTG into the thermally-controlled warm compartment of the Lander, and then interrupt the thermal path if the temperature became too warm. As a result, although the external temperatures were sub-freezing, the internal temperature where most of the electronics and instruments were contained remained near average room temperature.

Descent Rockets

Hydrazine descent rockets were designed for Viking, but there was a concern that the exhaust might kill the native biota, which prompted tests in White Sands, New Mexico, simulating hydrazine engines igniting over a variety of biota at the simulation site. The results showed that the engines did not alter the biota, and as such the engines were used.

This was based on a requirement from the science teams that no prospective life forms would be disturbed. This was critical to measure and accurately report the results of their instrument tests.

Multiple-Nozzles

These were a new design specifically for Viking from the originally proposed 20:1 area ratio bell nozzles similar to the lunar descent system. The redesign was due to a concern that existing designs for the lunar descent were based on landing on the Moon which had zero atmospheric pressure, versus landing on Mars which, it was discovered, had an atmospheric pressure that would cause a destructive burn with the current configuration. The concern was that the design would create a crater upon descent not only compromising the stability of a safe landing, but also destroying any possible organic indicators that the soil samples were meant to collect data from. The original design had three nozzles arranged in parallel formations, and the new design after much study was 21 much smaller nozzles in an array with various vertices inclines, thus decreasing and distributing the disturbance to a minimal or acceptable level.

The Viking Project Office (VPO) instructed Martin Marietta to do whatever was necessary to resolve this problem. Some concerns were expressed and solutions described in a Joint Army Navy NASA Air Force (JANNAF) presentation and NASA CR-2814 that describes designing the final multiple nozzle configuration to produce a level of disturbance that was considered by the Viking Lander Science Teams to be acceptable.[23]

These configurations became the basis for other descent nozzles and the lessons were taken by team members to subsequent missions.

EEPRO[24] Heat Resistant Plated Wire Memory

The Electrically Erasable Programmable Read Only Memory stored the software code for operating the computer system, but electronic storage at that time would not preserve the programmed bits properly during the terminal heat sterilization cycle. A heat resistant plated wire memory could keep the program code intact. However, there were packaging problems to make the plated wire array small enough to fit inside the available volume. As a result, this technology was high on the Top Ten Problems list well into system development.

Entry Aeroshell

A special lightweight ablator material was developed specifically for Mars entry, a key to maintaining the total capsule within its permissible weight limit. During passage through the atmosphere, this material sloughed off at a predetermined rate such that it carried off a major fraction of the heat energy generated during the deceleration of the capsule as it hurtled toward the Martian surface.

Parachutes

A special "disk-gap-band" parachute was designed and tested in wind tunnels to verify that it could operate effectively, even though it was necessary to deploy it while the capsule was still moving faster than the speed of sound in the atmosphere.

Landing Legs

Unlike the Apollo lunar lander, Viking was three-legged, with crush elements to take up impact, and a special deformable element to absorb strong loads in case of hitting rock.

Abrasion Protection and Tests

To protect the Lander from a predicted high erosion rate, latex paint was added to reflect airborne particles of abrasive sand.

Other aspects developed specifically to meet unique requirements for Viking included: the sample acquisition—metallic bi-stem arm, sample processing instrumentation, the bioshield, and dust protection methods.

Orbital Entry and Descent Methodologies

In addition to orbital methodologies, Viking was unique with the first trans-Mars trajectory that went all the way around Earth orbit, as explained in interviews Norm Crabill and Bud Reynolds: "We launched into an orbit around the Sun that would intersect the Mars Orbit on the other side of the Sun."[25]

Throttleable Engines

Developed especially for the Viking Project were special rocket engines with variable throttle to smooth out the landing, counter surface winds, and minimize disturbance of the surface during touchdown: an aeroshell-mounted deorbit system, and Descent Radar—four-lobe radar, adapted for Viking.

VII. Post Viking Missions

Viking's legacy extends into future missions from a human and instrumentation perspective. Because we have discussed some of the details previously we provide here simply references to missions that employed Viking people and/or derived systems.

We provide just a few details for some missions that show Viking influences, as individuals interacted with others extending the influence to even the fourth generations. For example, Dante Lauretta, a student of Dr. Ray Arvidson, and OSIRIS Rex PI, employs Amy Shaw, a student of Dr. Arvidson, who himself was an Intern on Viking.

Martin Marietta's 1979 Rover Study under Wayne Darnell, of Langley Research Center, summarizes numerous options and configurations for the repurposing of Viking Lander 3 (VL3) in the form of a roving vehicle. Although these proposals were not accepted, the studies were useful for the subsequent designs of rovers that were launched later. An additional design for a proposed 1981 mission would have mounted tank-type tracks developed for a potential lunar rover, onto the three footpads.

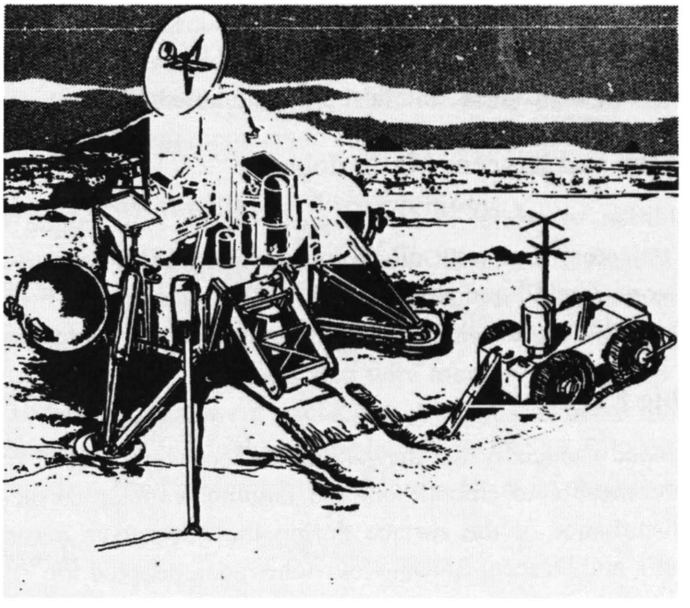


Figure 4–7: Viking '79 Rover study final report from 1974_NAS1-12425.

Although not all these missions successfully landed, the systems and technologies included derived elements, and or Viking-influenced human knowledge.

InSight: Viking influenced this mission by providing the first measured constraint on Mars' core size, by combining radio Doppler measurements from Viking and *Mars Pathfinder*, which determined spin axis directions 20 years apart. Project contributors include students of Vikings, in planning and design.

Phoenix: There were significant influences from Viking that stemmed from Viking contributors, including the work of Dr. Ray Arvidson, Ben Clark, and others, as well as meteorology instrumentation.

Pathfinder: Numerous Viking heritage technologies and methodologies were used including the Metal tape, tape recorder.

Spirit and *Opportunity*: Both employed camera systems attributed extensively in design by Viking Fred Huck, as shared by Dr. Steve Squyres, who personally recruited him because of his extensive experience and knowledge from Viking.

In addition, Dr. Ray Arvidson, another Viking Intern, served at Co-Principal on these missions with Dr. Steve Squyres.

Curiosity: Dr. Arvidson worked on *Curiosity* as did Benton Clark, and other Vikings, with others consulting and advising, including Larry Crumpler and Jane Aubele, Viking Interns.

Other missions influenced by contributing Vikings or derived instruments or technologies include:

Post-Viking Orbiters

- *Mars Observer*
- *Mars Global Surveyor*
- *Mars Climate Orbiter*
- *Mars Odyssey*
- *Mars Express*
- *MAVEN*

Post-Viking Landers

- *Mars Polar Lander*
- *Mars 98*
- *OSIRIS-REx*

VIII. Arts and Culture

Art is a natural by-product of exploration, curiosity, and discovery processes, and is both inspired by real events and is the inspiration for more art and more exploration and discovery. It is a cyclical and constantly scaling genesis of expression, and is expressed beautifully in a collection unveiled at the 30th Viking anniversary.

https://www.nasa.gov/externalflash/Mars_as_art/

The images "art" were chosen by scientists, artists, photographers, and photo editors. Viking is the first of the sequence of images representing all missions following Viking.

Figure 4–8: Image from Viking I Orbiter in Mars as Art exhibit.[26]

Art also represents both mainstream and subcultures, and Mars artists inspired by Viking include both. When observing the subcultures, you also find as in early adopters of technology and behavioral trends, indicators of what might become mainstream in a near or far future.

Vikings as Artists and Writers

Numerous Viking team members were artists as well as the roles they had on Viking, while others began their artistic endeavors following the missions. Through their art, these individuals bring their influence to entirely new audiences creating an even greater sphere of influence in Vikings "genealogy."

- *Andy Chaikin*, Viking Intern/Space Historian/Writer
- *Robert Dewar*, Viking Imaging/Sculptor
- *Kenneth L. Jones*, Viking Lander Imaging Resident Team Leader/Photographer
- *Charles "Charlie" Kohlhase*, Viking Trajectory Design/Artist
- *Gentry Lee*, Viking Director of Science Analysis and Mission Planning/ Science Fiction Author
- *Carl Sagan*, Viking Lander Imaging, Science Team/Author
- *Al Treder*, Viking Trajectory/Photographer
- *Cynthia Waldman*, Biology Team/Author.

Vikings Art

Viking was the subject of art for citizens around the world. This included iconic representation that would preserve the legacy through postage, fine art exploring the unknown, and interpreting the discoveries. It also included humorous representations that showed the human challenges and interpretations of each stage of the mission. Each of these expresses a different side of the mission from contributors and those observing, cumulatively reflecting the immense influence of Viking in the arts and culture.

Figure 4–9: Stamps inspired by Viking.

Stamps can be seen as global cultural expressions of events and people of current importance in a geographic region. Viking inspired recognition by numerous nations, resulting in commemorative stamps marking mission milestones. Because of their large distribution, they also serve as tools to inform, educate, and influence those who view them.

The adoption of Viking as a subject for many stamps globally is interpreted as expression of broad influence.

Figure 4–10: Viking Emblem and Icons.

The Viking missions were filled with artist representations of the mascot Viking, as well as inspired art from a juried contest to choose the official emblem. The Viking Student Emblem Contest was sponsored by NASA, and inspired kids from around the United States.[27]

Many cartoons were produced during the Viking era representing the philosophical and engineering challenges of the missions. These both entertained and plagued those involved and observing, but ultimately captured and expressed the moments that weighed on everyone at that time.

Viking Inspired Artists and Writers

Luděk Pešek has painted Mars since before the Viking landings, inspired by their pending arrival.[28]

Dr. Robert T. McCall is a painter representing Mars and other extraterrestrial worlds for over 30 years.

Dorian Sagan and *Nick Sagan*, both sons of Carl Sagan, became writers.

James Cameron is the producer of *Titanic* and other titles, including one featuring Mars and using the Viking Lander mission as a subject.

IX. Summary

Although Vikings are almost 40 years removed from the milestones that made history, their influence can be seen in missions, stories, art, and entrepreneurism. Each of these arenas not only represents Viking legacies, but also the livelihoods and economic base that supports them. Through the influences mentioned and others not included, Viking has contributed to the growth of a diverse and deep economic base and work-force, with momentum and passion for Mars and space exploration.

Even when Mars missions were side-lined for the period following Viking, those inspired by Viking sparked a movement that kept it alive. The Mars Underground, The Mars Society, SETI, and the work of many passionate individuals who refused to let die the dream of going to Mars and finding extraterrestrial life, were considered fringe, and rebellious, but their perseverance paid off and new missions were born, bearing Vikings "genes" and lessons.

We continue to interview, scientists, engineers, artists, and others who find their focus on Mars, and will continue to capture and share the story of Viking Genealogy of Influence.

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