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"A cosmic Rorschach test": The origins and development of the search for extraterrestrial intelligence, 1959-1971

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“A Cosmic Rorschach Test”: The Origins and Development of the Search for
Extraterrestrial Intelligence, 1959-1971

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A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

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Abstract

The Search for Extraterrestrial Intelligence (SETI) emerged in the 1960s and quickly attracted much attention from both scientists and the public. The breadth of terms included in SETI discourse provides an excellent lens view the effects of context and the multiplicity of reactions on the part of scientists to ongoing contentious debates over science's relationship to society and the federal government. This thesis presents three case studies of the development of SETI during the 1960s. The first case study analyses the origins of SETI as a scientific research project and speaks to the relationship between science and technology. The second case study examines the transition of some scientists interested in SETI to public advocates for the undertaking of a large-scale SETI project. These discussions spoke of their moral responsibility to the effects of their research and of the larger trajectory of the space science program. The third case study examines the 1971 CETI conference and elucidates the difficulties of conducting interdisciplinary research. SETI discourse was far more complex during the 1960s than any subsequent period and spoke to the broader societal discourses.

Introduction

Approximately every ten years since the 1960s, the National Research Council of the National Academy of Sciences in the United States has published a decadal survey that, “attempt[s] to identify priority programs over a very broad range of science...that directly contribute to the resolution of primarily astronomical questions.”¹ The second decadal survey published in 1972 included a section entitled, “Astronomy and Exobiology,” that discussed the possibilities of finding and contacting extraterrestrial life and civilizations primarily using radio telescopes. The discussion concerning this idea, more commonly referred to as the Search for Extraterrestrial Intelligence (SETI), included a much more philosophical and esoteric set of questions than others areas of research discussed in the survey. These included, “How quickly does a civilization, under the pressures of economy, become invisible—not as a result of inadequate technology but rather of superior technology? Are self-destroying wars a common destiny of civilizations?”² These questions spoke to more than just astronomical questions; they spoke to profound questions about the nature of life and of civilizations. The section also spoke of the difficulties of conducting any SETI project. Interestingly, these technical difficulties were not just issues of knowing when and where to look for extraterrestrial signals, but also, difficulties of conducting this type of research in the contemporary

¹ The decadal surveys are produced by a group of leading astronomers and astrophysicists with the input of many others in the field. The formal titles of these reports are as follows: for the 1960s, *Ground-Based Astronomy: A Ten-Year Program* (also known as the Whitford report); for the 1970s, *Astronomy and Astrophysics for the 1970s* (also known as the Greenstein report); for the 1980s, *Astronomy and Astrophysics for the 1980's*, for the 1990s, *The Decade of Discovery in Astronomy and Astrophysics*; for the 2000s, *Astronomy and Astrophysics in the New Millennium*, and for the 2010s, *New Worlds, New Horizons in Astronomy and Astrophysics*. This quotation is taken from the 1970s report: *Astronomy and Astrophysics for the 1970s*, (Washington D.C.: National Academy Press, 1972), v.

² *Astronomy and Astrophysics for the 1970s*, (Washington D.C.: National Academy Press, 1972), 49.

scientific climate. “Despite the power and promise of our instruments for serious searches for other civilizations, no major search has taken place. The explanation lies in the intense pressure on major astronomical instruments to produce astrophysical results that are the mainstream of astronomical research. Because we cannot accurately predict the effort needed to detect another civilization, quick results cannot be guaranteed... In today’s rush such a time scale is usually considered unacceptable.”³ This stark assessment of the state of the astronomical field and SETI’s place within it prompts the question of why SETI was included in the decadal surveys, particularly given the frequent use of the decadal surveys to obtain funding for future astronomical projects.

As astronomical research is heavily dependent upon available instrumentation, the decadal survey’s recommendations about the next generation of astronomical instrumentation are an important element in setting the scientific priorities of the field. Many of the decadal survey’s recommendations have come to fruition, including the Very Large Array radio telescope in Socorro, New Mexico, the High Energy Astronomical Observatory satellites, and the Very Long Baseline Array to name just a few. In addition to being an excellent tool in the ongoing struggle over the allocation of federal funding for science in the United States, the decadal surveys are an unparalleled resource in determining the research priorities and goals of the astronomical community. Considering SETI’s absence from the 1960s decadal survey, an analysis of SETI’s origins and development during the 1960s is necessary to understand the remarkable inclusion of SETI in the 1970s decadal survey. In addition of elucidating the contingent development of early radio astronomy, SETI’s inclusion reflected the contentious debates

³ *Astronomy and Astrophysics for the 1970s*, (Washington D.C.: National Academy Press, 1972), 51.

about science's position and moral responsibility to society ongoing in the 1960s U.S. science community.

SETI's beginning can be traced to 1959 when scientists proposed using radio telescopes to search for signs of extraterrestrial intelligence. Over the next decade, SETI became one of the more controversial issues in space science. Classifying attempts to talk to extraterrestrials as a scientific endeavor seemed ludicrous to some scientists and the idea of spending money on such projects produced ire in many of their colleagues. However, the controversy over SETI was much more than an argument over the potential successful detection of extraterrestrial signals; the argument was over the definition of success. Some proposed SETI as a framework for space science research—a framework that asked profound questions. While critics often pointed to the difficulty of defining terms necessary for any discussion of extraterrestrial intelligence and the extremely long time it would take to reach any definitive conclusions, they missed the larger goals of SETI research. Their failure to understand the claims of SETI scientists is understandable given the dramatic shifts in the nature and type of questions that scientists argued could and should be asked within the framework of SETI. Its inclusion in the 1970s decadal survey is explicable given this decade of contentious debate and the high level of attention garnered by SETI.

While debates over SETI have been ongoing in the scientific community for the past five decades, the historical issues surrounding extraterrestrial life and intelligence have only recently started to be examined by historians. Steven J. Dick published *The Biological Universe*, the first study of the history of twentieth century ideas of extraterrestrial life, in 1996. Covering a large number of topics including exobiology,

UFOs, SETI, and the Viking missions, Dick builds upon Michael Crowe's study, entitled *The Extraterrestrial Life Debate, 1750-1900*, by examining the emergence and impact of what Dick termed the biological universe. The question of the twentieth century extraterrestrial debate, according to Dick, was, "The whole thrust of physical science since the seventeenth-century scientific revolution has been to demonstrate the role of physical law in the universe, a mission admirably carried out by Kepler, Galileo, Newton, and their successors. The question at stake in the extraterrestrial life debate is whether an analogous 'biological law' reigns throughout the universe..."⁴ The biological universe combined the Copernican Revolution and the Darwinian Revolution into an idea that the universe was teeming with life. Dick argues that the idea did not find its beginnings in the twentieth century, rather new technologies allowed the scientific community to begin the process of seeking evidence to support their claims.

Situating SETI within the developing concept of a biological universe provides key insight, particularly its relationship to other areas of space sciences. However, Dick's analysis does not, and did not set out to, examine the development of the meaning of SETI within the SETI community nor the reasons behind the lack of similar programs in countries outside of the United States and the Soviet Union despite their strong radio astronomy programs. In order to address these issues, this study presents three case studies of the development of SETI in the United States from 1959 to 1971. Each case study examines the arguments put forth by scientists interested in SETI; taken together they show these scientists used SETI to speak to larger issues in American science. The broad terms involved in SETI discussions included the development of the universe, life,

⁴ Steven J. Dick, *The Biological Universe: The Twentieth-Century Extraterrestrial Life Debate and the Limits of Science*, (Cambridge: Cambridge University Press, 1996), 1-2.

and humanity. The malleability of the SETI framework reflected many of the scientific and political issues of their day.

Chapter one examines the emergence of SETI as a scientific discussion and the development of the SETI community. Between 1959 and 1961, Giuseppe Cocconi and Philip Morrison published the first theoretical paper on SETI, Frank Drake conducted the first SETI observations, named Project Ozma, and the SETI community began to be established at the first conference devoted to extraterrestrial intelligence. These scientists argued forcefully that radio telescopes made it possible for extraterrestrial intelligence to be considered scientifically; extraterrestrials were no longer solely the subject of science fiction novels. In addition to echoing the idea of Dick's biological universe, the scientists' arguments spoke directly to the relationship between science and technology. They argued for SETI on the basis that technology broadened the boundaries of science and allowed scientists to ask new questions that previously would have not been empirically testable. Additionally, Drake's Project Ozma showed that new areas of observation pushed scientists to create their own technology. When the amount of information recorded as part of Project Ozma became a burden on the small group of observers at the National Radio Astronomy Observatory (NRAO), the group devised the first digital recording system for astronomical data.⁵ The relationship between science and technology has received much attention from both politicians and historians of science and technology. This case study adds to the literature discussing the complexity of the relationship, particularly in regards to the radio astronomy community.

⁵ Drake was one of the first employees of the newly established National Radio Astronomy Observatory. Details of both Project Ozma and the foundation of the National Radio Astronomy Observatory can be found in chapter one.

Scientific and technological advancement was a key arena of the Cold War and as a result, the relationship between science and technology became a political issue.

Vannevar Bush, the most influential architect of Cold War research and development institutions, argued that basic science research was the key to both scientific and technological, and thus national advancement. The government needed to fund basic science to ensure the growth of technology and industry. Vannevar Bush argued that technology was little more than applied science and thus the focus of federal spending should be on pure science. Historians of science and technology have refuted this idea of the relationship between science and technology. Melvin Kranzberg's and Edwin Layton's studies proposed that science and technology formed separate communities with disparate goals. Scientists sought knowledge and technologists sought better technology. However, more recent studies have questioned Kranzberg's and Layton's stark contrasts between science and technology.⁶ Other scholars have pointed to radio astronomy as exemplifying a more complex relationship than Kranzberg's and Layton's analysis would suggest.⁷ SETI reveals the complex relationship between science and technology even more clearly. The development of SETI between 1959 and 1971 showed that scientists interested in SETI were well versed in technology and they thought the technology with which they worked was intimately connected to the advancement of science, and they constructed new technology to meet their experimental needs.

⁶ See Melvin Kranzberg, "The Disunity of Science-Technology," *American Scientist*, vol. 56 (1968): 21-34. Melvin Kranzberg, "The Unity of Science-Technology," *American Scientist*, vol. 55 (1968): 48-66. Edwin Layton, "Mirror-Image Twins: The Communities of Science and Technology in 19th Century America," *Technology and Culture* vol. 12 (1971): 562-580.

⁷ David O. Edge and Michael Mulkay, *Astronomy Transformed: The Emergence of Radio Astronomy in Britain* (New York: Wiley, 1976). Richard Hirsh, *Glimpsing an Invisible Universe: The Emergence of X-Ray Astronomy* (Cambridge: Cambridge University Press, 1983). Martin Harwit, *Cosmic Discovery: The Search, Scope and Heritage of Astronomy* (New York: Basic Books, 1981). Woodruff T. Sullivan, III, *Cosmic Noise: A History of Early Radio Astronomy* (Cambridge: Cambridge University Press, 2009).

Chapter two explores the connection between the political context of the scientific community and the redefinition of SETI as a pathway towards a less dangerous relationship between science and technology and political institutions. This chapter focuses on a series of books written by scientists who forcefully advocated for SETI on the basis that it exemplified a scientific research program that recognized the power of research to set humanity on either a pathway towards destruction or towards a cooperative, peaceful world. The scientific community's reaction to the dramatic changes in the relationship between the federal government and science during the Cold War has received a considerable amount of attention from scholars. Alice Kimball Smith and Jessica Wang have examined the Federation of Atomic Scientists, later the Federation of American Scientists, as one of the political reactions of the scientific community to the creation of atomic weapons.⁸ Through public education campaigns and lobbying efforts, the Federation of American Scientists attempted to reverse or at least halt the growth of the relationship between the federal government and science and to limit the danger of nuclear weapons. Their efforts achieved mixed results; however, Smith and Wang show that many members of the scientific community were uncomfortable with the military-industrial-academic complex and sought to change it through political action. Their difficulties with organization and the rise of the McCarthy Era quieted the movement during the 1950s; however, other studies, such as the work of Kelly Moore, have shown the reemergence of these issues in the 1960s.⁹ These studies point to clear discomfort among the scientific community about nuclear weapons, the military-industrial-academic

⁸ Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War*, (Chapel Hill, N.C.: University of North Carolina Press, 1999). Alice Kimball Smith, *A Hope and A Peril: The Scientist's Movement in American, 1945-47*, (Chicago: University of Chicago Press, 1965).

⁹ Kelly Moore, *Disrupting Science: Social Movements, American Scientists, and the Politics of the Military, 1945-1975*, (Princeton: Princeton University Press, 2008).

complex, and a relationship between science and technology which seemed dangerous to civilization. However, these studies limit themselves to traditionally defined political action in the form lobbying efforts and political organizations.

The series of books published by SETI advocates in the 1960s redefined the framework of SETI to speak to contemporary political issues. The SETI scientists' discourse directly linked the international, competitive framework established around nuclear weapons to the longevity of a civilization, a terms which received remarkable attention in many SETI discussions. Focusing on the longevity of a civilization was not an abstract calculation for many of the scientists. As humanity was the only technical civilization they had to study, an evaluation of the current status and the future of humanity formed the basis for discussions concerning SETI research. This shift to thinking about SETI in the terms of contemporary politics is evident in the series of books they published to educate the public about SETI. These scientists, many of whom were also politically active in other lobbying efforts, such as the Federation of American Scientists, advocated forcefully and publically for the undertaking of SETI on the basis that the long term planning and the global consciousness they thought SETI could foster befitted their moral responsibility to ensure that their research positively benefitted humanity.

At the beginning of the 1960s, the Cold War and the perils of nuclear weapons appeared to be turning the new frontier of space into the latest battlefield. Scientists reacted to the political events of their time in a multiplicity of ways. The invention of nuclear weapons and the development of the military-industrial-academic-complex, for which many scientists thought they bore some responsibility, provoked educational and

lobbying efforts. The influence of politics on the scientific research agenda was clear to many scientists and also provoked less traditional responses among these scientists. In one such response, SETI advocates redefined SETI as a broad framework for the future of space sciences—a framework that they hoped would ensure space was not the latest, most dangerous battlefield of the Cold War.

Chapter three examines the redefinition of SETI in a framework for interdisciplinary research at the 1971 Communication with Extraterrestrial Intelligence Conference at the Byurakan Astrophysical Observatory of the Armenian Academy of Science.¹⁰ This conference not only brought together the Soviet and American scientists who had been working on issues of extraterrestrials for the past decade but also included a sizable contingent of social scientists and historians. In addition to discussions of technical issues of search strategies and telescope design, the conference attempted to define many of the previously unexamined terms related to communication with extraterrestrial intelligence. Much of their discussion revolved around separating the historical experience of humanity from the intrinsic characteristics of an intelligent species. The conference attendees determined that if their discussions were going to be fruitful that they would have to clearly define their terms. Successful interdisciplinary efforts relied upon clear and consistent definitions. They discussed what it meant to be intelligent, what the possibility of artificial intelligence meant for the discussion of extraterrestrial intelligence, and the connection between language, mathematics and science. In doing so, they raised new, broad, profound questions about the nature of

¹⁰ Communication with Extraterrestrial Intelligence (CETI) was the Soviet designation for discussions of communications with extraterrestrial civilizations. Here after this conference will be referred to as the 1971 CETI conference.

humanity, intelligence, and life while showing the immense difficulties that accompanied any attempt at cross-disciplinary work, particularly between the sciences and the social sciences. Their discussions of interspecies communications raised questions about the universality of mathematics and science. They proposed that competition and cooperation might be necessary for the emergence of intelligent civilizations; however, the struggle between the two traits may greatly impact the outcome of any civilization. The sheer number of terms that discussions of extraterrestrial intelligence included made an alluring framework for interdisciplinary work; however, the 1971 CETI conference shows the difficulties of conducting interdisciplinary work. Before any conclusions can be drawn, before any research programs can be proposed, scholars from different disciplines had to lay out a framework of new definitions—a difficult and complex process.

The flexibility and breadth of the framework of SETI made it an excellent mirror for larger scientific and political issues of the 1960s. While it is important to note that the redefinition of SETI into larger and broaden concepts did not completely replace older focuses, the arguments for SETI dramatically evolved over the course of the 1960s. Scientists, grappling with the impact of new technology, argued that radio astronomy made it possible to begin examination of extraterrestrial intelligence in a scientific way. Technological advancement not only answered previously raised scientific questions, but also broadened the boundaries of scientific inquiry. However, technological advancement had not been without its costs. Scientific and technological advancement in the form of nuclear weapons had dramatically altered the scientific and political landscape. Many scientists argued that this impact had been almost wholly negative. Now, space appeared to be the new frontier of science and scientists feared that the Cold War would turn it into

the latest battlefield. Some scientists became vocal advocates for SETI, redefining it into a framework for space sciences that asked the profound questions while settling the practical issues. Using SETI as a framework would ensure that space sciences would not be co-opted as nuclear science had been.

By 1971, SETI had become accepted in the scientific community as a topic of discussion and interested scholars attempted to integrate the previous decade of work on topics pertaining to extraterrestrial intelligence. They brought together an international cohort of scientists, social scientists, and historians to discuss issues of intelligence, humanity, and the universal nature of mathematics and science. While new and interesting questions were raised, the conference highlighted the difficulty of integrating the scholarly advances of the past decades across disciplines. The process of defining a new set of mutually intelligible terms became the key push of the conference—new fields required a coherent language. Overall, the development of SETI during the 1960s elucidates the unsettled nature of new scientific enterprises of the Cold War period. Increased funding brought technological advancement along with a new relationship between science and the federal government. The exact nature and impact of this relationship was unsettled and was hotly contested not only through traditionally-defined political means but in scientific research itself.

Chapter One: Science or Science Fiction?: The Establishment of the Search for Extraterrestrial Intelligence as a Scientific Matter

The Search for Extraterrestrial Intelligence emerged between 1959 and 1961 as part of a discussion about the possibilities new technology created for science. While ideas of extraterrestrials were not unknown to society, most scientists thought that extraterrestrials were little more than plot devices for science fiction novels. Advances in scientific theory and technology post-Second World War prompted much curiosity about the nature of the universe and of life. The post-war period and the beginning of the Cold War brought an influx of money, particularly to physics, but also to many other disciplines. The money and focus on scientific advancement not only buoyed old disciplines of science, but also helped create new disciplines including radio astronomy. According to some scientists, this technology not only allowed old questions to be answered but broadened the questions that scientists could empirically examine. For a small but increasingly vocal group of scientists, extraterrestrial life and intelligence was one such issue. Their arguments spoke to the much larger issues of the relationship between science and technology. According to scientists interested in SETI, new technology did not simply answer previously theoretical scientific questions, but opened new and unexplored areas to scientific inquiry. While most arguments for SETI acknowledged that extraterrestrial intelligence previously had been rightfully left in the domain of science fiction, they argued science could and should now begin discussing these issues in an empirical and logical way. In other words, the time for SETI had come and research in this realm would prove fruitful for science and new technology allowed extraterrestrial life and intelligence to be defined scientifically for the first time.

Given the dominance of astronomers and biologists in later discussions about extraterrestrial intelligence, theoretical physics seems an unlikely place to find the beginning of the SETI discourse. However, this beginning clearly illustrates that early interest in extraterrestrial intelligence was provoked by curiosity about possibilities new technology created for all branches of science. The conversation about the possibility of communication with extraterrestrial intelligence was first sparked by the September 1959 *Nature* publication of “Searching for Interstellar Communication” by two theoretical physicists at Cornell University, Cocconi and Morrison. In the previous year, Morrison had published a paper on the possibility of conducting gamma ray astronomy. This theoretical paper, which widely underestimated the experimental difficulties of gamma ray astronomy, sparked the interest of Cocconi. In the course of their conversations on the topic, they realized gamma rays did not only occur naturally but could be produced artificially and that this was happening just a few floors below them. Other physicists at Cornell were studying synchrotron radiation and their experiments produced gamma rays as a byproduct. In later interviews, both Cocconi and Morrison stated that they had no particular interest in extraterrestrial life prior to the publication of their paper. When asked what life experiences led him to publish this paper, Morrison replied that in regards to extraterrestrial intelligence, “I never thought of it except in a general way that it’s in the culture.”¹¹ Cocconi echoed the same idea when asked at what time he first developed interest in extraterrestrial life. “I cannot quote a date. It was something I took for granted. It was more or less obvious that evolution could take place elsewhere in the universe.”¹²

¹¹ David W. Swift. *SETI Pioneers: Scientists Talk About Their Search for Extraterrestrial Intelligence*. (Tucson, Arizona: The University of Arizona Press, 1990), 22.

¹² David W. Swift. *SETI Pioneers: Scientists Talk About Their Search for Extraterrestrial Intelligence*. (Tucson, Arizona: The University of Arizona Press, 1990), 51.

Terrestrial technological advancement in the form of the Cornell synchrotron was much more important and interesting to the authors of the first scientific paper to discuss interstellar communications than scientific or philosophical ideas of extraterrestrials.

In their short speculative paper, Cocconi and Morrison recognized that some scientists would meet any paper that dealt with extraterrestrials with skepticism if not outright rejection. They attempted to meet their potential critics forthrightly by acknowledging their assumptions about the existence of extraterrestrial intelligent life and then proceeding to calculate the optimum channel for communication between stars. The crux of their analysis focused on this issue

We shall assume that long ago they (an extraterrestrial civilization) established a channel of communication that would one day become known to us, and that they look forward patiently to answering the signals from the Sun which would make known to them that a new society has entered the community of intelligence. What sort of channel would it be?¹³

Their initial discussions focused on gamma rays; however, Cocconi and Morrison decided that other regions of the electromagnetic spectrum were probably more likely candidates for communication between civilizations in the galaxy. They limited their analysis to the radio region of the electromagnetic spectrum because it was less likely to be absorbed by planetary atmospheres and required less power or less complicated techniques to be detected at great distances. For a pictorial representation of the region Cocconi and Morrison were referring to see Image One.

¹³ Giuseppe Cocconi and Philip Morrison, "Searching for Interstellar Communications," *Nature*, vol. 184, no. 4690 (September 19, 1959): 844.

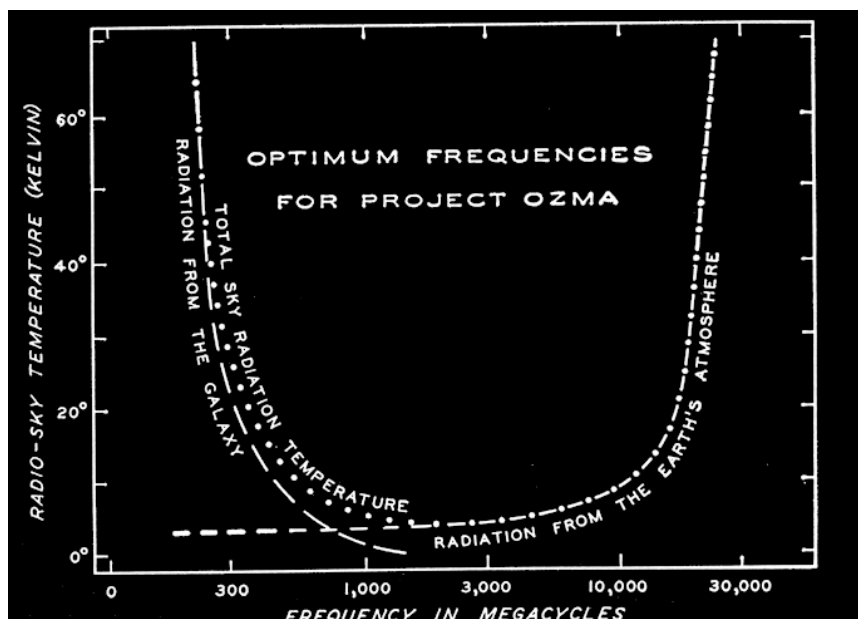


Figure One: This graph was produced by Drake for Project Ozma to illustrate the region of the electromagnetic spectrum that would not be absorbed by planetary atmospheres (they used the Earth's atmosphere as a model) and would be detectable against background radiation. Cocconi and Morrison based their paper on the same assumptions. From: Drake, Frank. "How Can We Detect Radio Transmissions from Distant Planetary Systems?," *Sky and Telescope* 19, no. 3 (January, 1960): 141.

Furthermore, they proposed narrowing the search to frequencies that are unique in some way, as these were potentially known by every civilization that would have the technology to detect radio signals from space. The radio emission line of neutral hydrogen at 1420 megacycles per second, also known as the 21 cm line, fit all of these characteristics and Cocconi and Morrison proposed that any search should begin at that frequency.¹⁴ Acknowledging that no contemporary theories reliably predicted the existence or quantity of planets or extraterrestrial civilizations, Cocconi and Morrison were not interested in speculating about their values. Instead, their interest laid in the technical details involved in sending artificial signals through the galaxy and they felt that the theoretical analysis of the issue was worthwhile.

¹⁴ Giuseppe Cocconi and Philip Morrison, "Searching for Interstellar Communications," *Nature*, vol. 184, no. 4690 (September 19, 1959): 845.

Anticipating the reaction of many scientists, Cocconi and Morrison concluded their paper with a brief argument about the nature of analysis concerning extraterrestrial life and intelligence. “The reader may seek to consign these speculations wholly to the domain of science-fiction.”¹⁵ While scientific understanding of life and the solar system was steadily advancing at the time, many scientists were reluctant to extrapolate those theories to the wider galaxy without further studies. Cocconi and Morrison themselves acknowledged that they knew little definitively about key elements which would be necessary to determine the probability of extraterrestrial civilizations. However, they went on to say, “We submit, rather, that the presence of interstellar signals is entirely consistent with all we now know, and that if the signals are present the means of detecting them is now at hand.”¹⁶ By this, they did not intend to imply that they knew extraterrestrials were, at that moment, circling a distance star trying to communicate. They meant that the existence of intelligent life on Earth implied that there was the potential possibility of intelligent life arising on other planets. Bearing this in mind, they argued that scientists now had the technology to begin a search for interstellar signals. New technology had not only provided a way for scientists to answer their previously raised questions about the nature of the universe, but had also opened new areas of inquiry that were previously deemed unscientific. In other words, technological advancement had broadened the boundaries of scientific inquiry.

Simultaneously and without knowledge of Cocconi and Morrison’s work, Drake, a young radio astronomer at the newly established National Radio Astronomy Observatory, planned and conducted the first Search for Extraterrestrial Intelligence.

¹⁵ Cocconi and Morrison, “Searching for Interstellar Communications,” 846.

¹⁶ Cocconi and Morrison, “Searching for Interstellar Communications,” 846.

Unlike Cocconi and Morrison, Drake had been interested in ideas about life on other worlds from childhood. In an interview, Drake stated, “I became interested at a very early age in the nature of other planets and whether there was life on them.”¹⁷ Following this interest, Drake enrolled in a basic astronomy class while in college; however, this class never discussed the possibility of extraterrestrial life. “...I took that elementary course in astronomy in general, though there was nothing in it about ETI (extraterrestrial intelligence). It was very stimulating and certainly got me started in astronomy, but didn’t mention ETI.”¹⁸ It is important to note that Drake here is referring to what would later become known as optical astronomy. While radio signals from space had been detected by Karl Jansky in the 1930s, before the Second World War and even afterwards in the United States, no work was conducted in the field of radio astronomy. In fact, a field of radio astronomy did not exist at all; astronomy before the Second World War only referred to optical astronomy and few were interested in the possibility of scientific research outside the optical band.¹⁹ Drake joined the Navy during the Second World War and received training in electronics. After the war and following both his interests in both electronics and astronomy, Drake received his Ph.D. in astronomy from Harvard University in 1958. While Drake’s interest in the possibility of life on other worlds would

¹⁷ Swift, *SETI Pioneers*, 58.

¹⁸ Swift, *SETI Pioneers*, 58.

¹⁹ There is one exception to this characterization of pre-Second World War astronomy and the lack of interest in radio astronomy. The discovery of radio signals from space was the result of Karl Jansky’s work at Bell Laboratory. He was tasked with finding the sources of interference of wireless communication. In August of 1931, his experiments showed that there were three sources that interfered with wireless communications: nearby thunderstorms, distant thunderstorms, and signals from space. While Jansky requested that he be allowed to follow up on the signals from space, Bell Laboratories was not interested in studying a phenomenon that they could do nothing about to reduce the level of interference. Jansky’s results received a fair amount of national newspaper attention and were followed up by Grote Reber in Chicago. Inspired by Jansky, Reber built his own radio telescope and mapped the Milky Way; however, his work was not seen to be important by astronomers and despite his numerous attempts, he was not able to obtain a job in astronomy or at any observatory.

be a constant throughout his life, the scientific establishment in which he was educated was not interested in something they saw the stuff of science fiction.

The reluctance of United States astronomers in the post-war period to accept and engage in astronomical research outside of the optical band of the electromagnetic spectrum unexpectedly laid the groundwork for Drake's first SETI effort, Project Ozma. Compared to Britain and Australia, the United States greatly lagged behind in the development of radio astronomy. The advance in radar technology and electronics training sparked the interests of many in these countries. After the war, British and Australian scientists repurposed radar equipment and began experimental radio astronomy work. There were certainly scientists interested in radio astronomy in the United States; however, they were not able to successfully build any facilities large enough to compete with the British or Australians in the decade after the war. The extent of the United States' inability to compete with other radio astronomers became clear at the 1954 Radio Astronomy Conference held by the National Science Foundation, the Carnegie Institute of Washington, and the California Institute of Technology. Soon after, John Hagen published the proceedings of this conference in *Science*.²⁰ From these proceedings, it was clear to many in the United States that while American scientists had made strides in the theoretical understanding of radio astronomy, they could not compete with concrete discoveries made by those in other countries, such as the discovery of the Sun at radio frequencies, the detection of radar echoes from meteor trails, and the detection of the first discrete source of radio emission in Cygnus. Simply put, after this

²⁰ John P. Hagen, "News and Notes", *Science* vol. 119, no. 3096 (April 30, 1954.): 588-600.

conference, those interested in radio astronomy knew that future success in the United States would be dependent upon the building of new, larger facilities.

While national funding for radio astronomy lagged behind other countries, other branches of science, particularly nuclear physics, experienced an enormous increase in attention and funding in the United States. A byproduct of the success of the Manhattan Project, nuclear physicists and the federal government had entered into a fruitful relationship during the war which neither wanted to see end after the war's conclusion. However, a direct relationship between scientific research and the federal government and its defense industries broke with their traditional peacetime relationship and caused uneasiness. As a result, the federal government contracted with universities and new types of organizations for research. One type of organization, the consortium, emerged as part of this phenomenon. A leading consortium of the time, Associated Universities Incorporated (AUI), became well known for establishing Brookhaven National Laboratory, the first nuclear facility dedicated to research, and other projects such as Project East River, which was the first study of potential effects of a surprise nuclear attack. However, the president of AUI, Lloyd Berkner, was concerned that AUI was becoming too tied to nuclear research. He and AUI's Board of Directors wanted to diversify their facilities to areas outside of nuclear research.²¹ Both the needs of AUI and radio astronomers could be met with a national radio facility and AUI proposed just that to the National Science Foundation (NSF). With a great deal of controversy over issues of radio astronomy's relationship to the federal government and being placed under the control by nuclear physicists, AUI was granted control of the National Radio Astronomy

²¹ Associated Universities Incorporated executive committee minutes, 20 July 1951, AUI Records.

Observatory (NRAO) and the groundbreaking ceremonies took place in October 1957 at Green Bank, West Virginia.²² The difficulties for national radio astronomy at a national facility did not end with its establishment.

Under the direction of Lloyd Berkner, who served as the interim president of NRAO, a scientific staff, including Drake, was hired and oversaw plans to build a 140 foot telescope. While this telescope was of modest size for the time, the 140 foot telescope experienced tremendous construction problems due both to its design and problems with the steel that was to be used in its construction. Ultimately, the 140 foot telescope would require years and a vastly increased budget to complete. Construction troubles placed NRAO in a difficult position; already on shaky ground due to the controversy over its creation, NRAO needed to quickly establish observational capacity to ensure future funding. In order to start researching, NRAO decided to purchase a smaller 85 foot telescope from the Blaw Knox Company which was currently planning to construct a similar telescope for the University of Michigan.²³ While construction on the 85 foot telescope was under way, the scientific staff began to plan the projects that NRAO would undertake once the 85 foot telescope was completed.²⁴ In an interview discussing his work on extraterrestrial intelligence, Drake stated that since beginning his graduate education, "...whenever I contemplated an instrument, an optical or radio

²² Richard Emberson, "National Radio Astronomy Observatory," *Science*, vol. 130, no. 3385, (November 13, 1956), 1307-1318.

²³ The Blaw-Knox Company was able to quickly construct the 85 foot Telescope at Green Bank as they used the plans for a telescope of the same dimensions which they were in the process of constructing for the University of Michigan. The Blaw Knox Company was an engineering firm which specialized in constructing bridges. The use of bridge building companies for the construction of early radio astronomy telescope was common.

²⁴ Lloyd Berkner served as the interim president until a permanent director could be found. By the spring and summer of 1959 when the observation schedule was being set, the first NRAO director, Otto Struve, had been hired.

telescope, I would as an aside ask myself, ‘Could this be used to search for life?’ The answer was always ‘No’ until we came to the modern radio telescope.”²⁵ As part of the planning process for the 85 foot telescope, Drake calculated the distance at which the strongest signals leaving earth could be detected. His calculations showed that these signals could be detected upwards of 10 light years from Earth. Within a 10 light year radius of Earth, there were many solar type stars, and with this in mind, Drake planned the first Search for Extraterrestrial Intelligence. Drake now had the technology to conduct a search for life on other planets. Project Ozma was scheduled as part of the first cycle of observations of the 85 foot telescope.²⁶

Similar to Cocconi and Morrison’s concerns over the reception of their work, Drake and the rest of the scientific staff decided not to publicize Project Ozma to ensure that the newly established NRAO would not be criticized for its undertaking. Additionally, Drake designed the project so that it could easily be used for other research. In total, only around \$2,000 was spent on equipment specifically for the project. This money went to purchase the narrowband filters necessary for the search.²⁷ The project was designed to search two nearby solar type stars, Tau Ceti and Epsilon Eridani. Remarkably, Drake chose to search at the 21 centimeter line, the same wavelength that Cocconi and Morrison would recommend in their paper. In Drake’s case, this frequency was chosen both for similar reasons to Cocconi and Morrison but also so that it would be useful for other projects being planned at NRAO. In one recollection of the project, Drake explained his choice,

²⁵ Swift, *SETI Pioneers*, 59.

²⁶ K. Kellermann and G.A. Seielstad. *The Search for Extraterrestrial Intelligence: Proceedings of a NRAO workshop held at the National Radio Astronomy Observatory, Green Bank, West Virginia, May 20, 21, 22, 1985*, (1986), 23-24.

²⁷ Kellermann and Seielstad. *The Search for Extraterrestrial Intelligence: NRAO workshop*, 19.

Now just then there was a lot of excitement about the detection of the Zeeman effect in the 21 centimeter line, and so we decided we will build an instrument which will be useable to search for the Zeeman effect. We would need two channels, good frequency stability, narrow bandwidth, all very similar to the SETI requirements; and in order that the systems would be suitable for the 21 centimeter Zeeman effect, we would build it and do the search at the 21 centimeter line... It was a way to prevent criticism of the observatory, and in a way, kill two birds with one stone.²⁸

It is not certain that had radio astronomy and NRAO experienced a smoother, earlier beginning in the United States, Project Ozma would have been undertaken given the lack of SETI projects in Britain and Australia. However, Drake found himself in a situation where he had both a great deal of flexibility and the technology necessary in order to conduct the first SETI project.

Technological advancement was not only partially responsible for the undertaking of Project Ozma, but the project itself produced important technological advances. Observation for the project began on April 19, 1960 and observed between ten and twelve hours per day for a month. This produced a large amount of data which at the time was recorded on strip charts that had to be analyzed by astronomers. As this process became tedious, Drake decided to rig a system that would allow the data to be digitally recorded. The system was eventually attached to a printer and connected to the IBM 610 that had been purchased by NRAO. Drake claimed that Project Ozma was the “first digital system in astronomy”.²⁹ The amount of data that Project Ozma generated led to the development of new techniques and technology to process the data. Like Cocconi and Morrison, Drake thought the new technology in the form of radio telescopes provided a method to answer his questions about life on other planets. Project Ozma, for Drake,

²⁸ Kellermann and Seielstad. *The Search for Extraterrestrial Intelligence: NRAO workshop* 19.

²⁹ Kellermann and Seielstad. *The Search for Extraterrestrial Intelligence: NRAO workshop* 25.

represented the first empirical experiment that would begin a scientific search for extraterrestrial intelligence.

The decision to keep Project Ozma quiet was quickly reversed during its planning phase due to the publication of Cocconi and Morrison's paper. Otto Struve, the first director of the NRAO, knew how critical it was for his nascent organization to receive proper credit for its project and announced Project Ozma at a lecture at MIT the following week. The publication of Cocconi and Morrison's paper and the announcement of Project Ozma attracted a great deal of attention from other scientists and the public to the issues of extraterrestrial intelligence. Morrison recalled the reactions, "It got a huge newspaper and media coverage, which we didn't anticipate... The media kept chasing me because I was going around the world. In every city I visited there would be messages from reporters wanting to talk to me..."³⁰ In the popular media the attention was positive and optimistic; however, it was much more divided in the scientific community. Of his colleagues' reactions, Morrison said, "Most felt it was not a good idea, probably foolish, certainly completely speculative, and hardly worth discussing."³¹ Drake and Struve echoed Morrison's characterization. Drake remembered the response of his colleagues was, "...uniformly positive but not enthusiastic. Again I think that it was the fact that we weren't investing a great deal of resources." Continuing he would state that, "People didn't think that it was worth a very careful analysis, but since it wasn't crazy they said: 'These guys want to spend two thousand dollars, let them do it.'"³² While the response to Project Ozma was mixed, particularly among scientists, the publicity that it received

³⁰ Swift, *SETI Pioneers*, 24.

³¹ Swift, *SETI Pioneers*, 24.

³² Swift, *SETI Pioneers*, 69.

resulted in connecting those scientists who were interested in extraterrestrial life to one another.

The attention received by Cocconi, Morrison, and Drake led to the development of a small but enthusiastic network of scientists who were interested in extraterrestrial life and intelligence. Drake would attribute this to the idea that finally, “People knew who they could write to find out who was interested.”³³ These scientists came from many disciplines and Drake invited them to the first SETI conference held at NRAO in Green Bank, West Virginia, which was funded by the National Academy of Sciences’ Space Science Board. The group of attendees would become the leading figures of SETI in the 1960s. Their camaraderie was evident at the meeting. In celebration of his Nobel Prize in Chemistry, Melvin Calvin produced pins in the shape of dolphins for all the attendees. A clear reference to John C. Lilly’s work on dolphin intelligence, the attendees of the conference would dub themselves the Order of the Dolphin.

The 1961 SETI Conference was arguably the most important event in the development of the ideas and community of SETI in the 1960s. As an attempt to order the conversation at the conference, Drake constructed an equation that arguably has formed the framework for all subsequent discussions about extraterrestrial intelligent life. The Drake Equation elegantly categorized the numerous assumptions about the universe, life, and intelligent civilizations of both his previous work and Cocconi and Morrison’s work. While the exact proceedings of the meeting were never published, the relevant work of those who attended the conference and others whose work was viewed as influential was published shortly after the meeting. This volume, *Interstellar*

³³ Swift, *SETI Pioneers*, 60.

Communications, was the first publication to discuss the factors that these scientists thought to be important to any discussion of intelligent life and showed that they agreed with the opinions of Cocconi, Morrison, and Drake in that life on other planets could and should be discussed by the scientific community and laid on firm theoretical ground.

The Drake Equation, which estimates the number of communicative civilizations in the galaxy, is:

$$N = R_* f_p n_e f_l f_i f_c L$$

Where the terms are defined as follows:

R_* = mean rate of star formation over galactic history

f_p = fraction of stars with planetary systems

n_e = number of planets per planetary system with conditions ecologically suitable for the origin and evolution of life

f_l = fraction of suitable planets on which life originates and evolves to more complex forms

f_i = fraction of life-bearing planets with intelligence possessed of manipulative capabilities

f_c = fraction of planets with intelligence that develops a technological phase during which there is the capability for and interest in interstellar communication

L = mean lifetime of a technological civilization³⁴

The Drake Equation estimated the number of communicative technical civilization within the galaxy by accounting for various factors related to the formation

³⁴ This version of the Drake Equation is taken from Carl Sagan's section in Cyril Ponnampertuma and A.G.W. Cameron *Interstellar Communication: Scientific Perspectives*. (Boston: Houghton Mifflin Company, 1974). Drake first published an early version on the equation in Frank Drake, "How Can We Detect Radio Transmissions from Distant Planetary Systems?," *Sky and Telescope*, vol. 19, no. 3, (January, 1960), 140-3. This version of the equation is used because it was used at the 1961 Conference and gives a clear and concise definition of all variables.

and development of stars, planets, life, and intelligence. These factors can be broken into three groups. The factors, R_* , f_p , and n_c are all related to the cosmogony of planetary systems. Cosmogony is the study of the structure and development of stellar systems, just as its more well-known cousin, cosmology, studies the structure and development of the universe. Contemporary planetary cosmogony was attempting to understand the relatively slow rotation rates of stars of certain spectral types. Very hot and massive stars rotate quickly; however, there is a sharp decline in rotation speeds for cooler, less massive stars. Astronomers, including Otto Struve and William McCrea, theorized that the reduction in rotation rates of stars in the spectral classes G, K, and M could be accounted for if planets are present within their systems. McCrea argued that up to 95% of the momentum of a system was concentrated within the orbital motion of its planets. At the time of the conference, nearly 10,000 stars had been counted within a 100 light-year radius of Earth, many of which were G, K, and M class stars.³⁵ Scientists at the 1961 SETI conference agreed that McCrea's theory generally accounted for the decline in star rotation rates and predicted the existence of planets in many stellar systems. The theory, which required as many as ten planets to form simultaneously, also potentially pointed to at least a few planets in these star systems being within a zone similar to that occupied by Earth which could allow for life to originate. The 1961 SETI Conference thus concluded that the most promising theories of planetary cosmogony predicted that G, K, and M class star systems were likely to have a family of planets, a few of which would be positioned within the habitable zone.

³⁵ Cyril Ponnampertuma and A.G.W Cameron. *Interstellar Communication: Scientific Perspectives* (Boston: Houghton Mifflin Company, 1974): 7-9.

The next three variables in the Drake Equation: f_i , f_l , and f_c built upon the theoretical and experimental work of scientists in the 1950s who began examining if organic life could originate from inorganic materials. These variables relate to the probability of life originating in the galaxy and the subsequent development of that life, and formed the basis of many discussions at the 1961 SETI conference. In 1953 the famous Miller-Urey experiment attempted to replicate the conditions of primitive Earth, in order to test if these conditions favored the development of life. The experiment bolstered the idea of life originating on Earth as over 20 amino acids, the building blocks of life, were produced. Melvin Calvin had been invited to discuss the origins of life on Earth and the potential for the development of life on other planets. While at the conference, he won the Nobel Prize in Chemistry for his work on the manufacturing of organic compounds in plants being based on chlorophyll instead of carbon dioxide as previously thought. Based on the Miller-Urey experiment, his own work, and the likelihood of other earth-like planets, Calvin concluded that, “There are... at least 100,000,000 planets in the visible universe which were, or are, very much like the earth. From what we have discussed so far, this would mean certainly that we are not alone in the universe.”³⁶ The potential existence of intelligent life on other planets in the galaxy was predicted to be fairly likely by attendees of the 1961 SETI Conference and the acceptance of the high probability for f_l and f_i led to a discussion of the best methods, with which to contact and communicate with extraterrestrial intelligent life.

The participants at the conference agreed with Cocconi, Morrison, and Drake on the properties of the best frequencies at which to begin a search. Drake assumed that

³⁶ Ponnampuruma and Cameron. *Interstellar Communication*, 75.

advanced technical civilizations would reach technical perfection, meaning that their receivers and transmitters would be limited only by natural phenomena and not deficiencies in equipment.³⁷ Signals transmitted throughout the galaxy are limited by both galactic background noise and by atmospheric radiation. The best range of frequencies for interstellar communications has become known as the ‘waterhole’ and within this region, the 21 centimeter line was viewed as the best placed to begin any search. Not only was it highly probable that advanced technical civilizations existed in the galaxy but, humanity had now developed the technology to begin a search. However, if intelligent communicative civilizations arise frequently in the galaxy it would be logical that they would have contacted Earth in some demonstrable fashion. Obviously, this was not been the case. This question, that is “Where is Everybody?” has been termed the Fermi paradox which had been raised in the 1950s and was raised by many critics of Project Ozma.³⁸

Drake proposed a few possible reasons why contact by extraterrestrial civilizations had not previously occurred. Civilizations that are close enough to attempt contact with Earth may be more technologically advanced than humanity. If this is the case then these civilizations may be using communication technologies that have not yet been discovered on Earth and thus are not detectable. A few scientists of the time proposed that extraterrestrial civilizations may use laser technology, either infrared or optical. However most scientists agreed that microwave photons were the carrier of choice for transmitting information across the galaxy, because this part of the

³⁷ Frank Drake, “How Can We Detect Radio Transmissions from Distant Planetary Systems?,” *Sky and Telescope* vol. 19 no. 3 (January, 1960): 168.

³⁸ Jill Tarter. *The Search for Extraterrestrial Intelligence (SETI)*. Annual review of Astronomy and Astrophysics 39 (September 2001), 520

electromagnetic spectrum were easily generated, launched, focused and captured, and they are not absorbed as lower frequencies are in space.³⁹ If these assumptions about the technological choices of extraterrestrial civilizations are valid then there are two possible scenarios for methods of contact using radio waves. Extraterrestrial civilization may try to generate a signal that violates the laws of natural emission mechanisms or this civilization may generate a signal that first mimics an interesting astrophysical phenomenon that would invite more investigation.⁴⁰ The existence of either method of communication could only be discovered by more exploration of the galaxy such as the type that occurred in Project OZMA. While the conference attendees admitted that they knew nothing concretely about the technology which other civilizations might use for interstellar communications, they argued that the technology they currently possess was advanced enough to begin a search and future technology advancement would aid their efforts.

The second possibility Drake proposed to answer the questions raised by the Fermi paradox was that extraterrestrial civilizations capable of communication are all listening for other civilizations or such civilizations, "...have grown tired of waiting for interstellar communication and ha[s] gone on about its business."⁴¹ Though Drake acknowledged this as a possibility, as sending signals is energy intensive and requires a long term commitment, he argued that civilizations who have reached this level of advancement would create enough signals from their own affairs as to allow detection.

³⁹ Tarter. *The Search for Extraterrestrial Intelligence (SETI)*, 521

⁴⁰ Tarter. *The Search for Extraterrestrial Intelligence (SETI)*, 522.

⁴¹ Drake, *Intelligent Life in Space* (New York: The Macmillan Company, 1962), 102.

The last possibility Drake discussed at the 1961 conference concerned the last variable in the Drake Equation: L. Drake argued that civilizations that reach a level of technological advancement which allows them to communicate also reach a level of advancement which allows them to destroy themselves. The unpacking and assessment of the assumptions made by Cocconi, Morrison and Drake led the conference attendees to discuss the profound philosophical implications inherent in searching and potential communication with extraterrestrial intelligence. This is not to say that the implications had not been hinted at in work on extraterrestrial intelligence before. The name of Project Ozma, a clear reference to L. Frank Baum's land of Oz, hinted at ideas beyond the technical details of the project. Cocconi and Morrison stated in "Searching for Interstellar Communications" that, "Few will deny the profound importance, practical and philosophical, which the detection of interstellar communications would have."⁴² However, it was not until the 1961 conference that these ideas came to the forefront of the discussion and moved the discussion to encompass more than the technical and scientific ideas on which they had previously been focused.

Given the group's reliance on the assumption that life was possible on other planets because it had occurred on Earth, their discussion of the longevity of extraterrestrial civilizations required them to discuss the longevity of intelligent life on Earth and the potential factors that could lead to its demise. Discussions of the longevity of intelligent civilizations would soon come to dominate the discourse concerning SETI, and led to philosophical discussions about the role of technology within society and scientists' moral responsibility concerning the implications of their work, particularly

⁴² Cocconi and Morrison, "Searching for Interstellar Communications," 846.

when that work could lead to technology that could negatively impact the longevity of life on Earth. However, the early development of SETI in Cocconi and Morrison's paper and Drake's Project Ozma shows a much different discussion about the relationship of science and technology. In their discussions, technology is a driving force that enlarges the boundaries of what can be considered science. The Cornell synchrotron heavily factored in to Cocconi and Morrison's theoretical discussions of gamma ray astronomy and led them to discuss not only natural but potentially artificial sources of gamma rays. While Drake always had an interest in life on other planets, it was not until the development of the modern radio telescope that he was able to begin experimentation on the issue. Technology is not the only factor; certainly scientific theories and cultural ideas also factored into their decision to pursue SETI. Many contemporary scientists did not accept their arguments that extraterrestrial life and intelligence was worthy of scientific consideration. Despite this criticism, SETI quickly became an area that not only attracted a great deal of attention both among scientists and the public, but also created a small, vocal group of respected scientists from many disciplines that began to advocate for the undertaking of large-scale SETI projects.

Chapter Two: Towards a Safer Path: The Development of SETI as a Framework for Space Sciences

After a decade of strained relations with the Soviet Union, war in a country few Americans could have previously found on a map, and tense social conflicts over race and ideology, the 1960s ushered in a feeling of great hope for the future in the United States. This atmosphere, seemingly embodied by the youthful, energetic John F. Kennedy, swept across the nation. The promise of tomorrow was intimately tied to the scientific and industrial might of the United States; victory in the Cold War would come not only on the battlefield, but in the laboratory and the market. Scientific and technological advancement opened the new frontier of space to exploration and discovery. However, the dawning of the Space Age was inextricably linked to the international competition of the Cold War through the Space Race. Despite the almost universal connection between space and hope for the future, the exact nature and meaning of space exploration, space sciences, and the future was unsettled and extremely contentious.

Within this context and following the 1961 SETI Conference, a few members of the Order of the Dolphin perceptibly shifted from scientists who were interested in SETI for scientific and technical reasons to forceful, public advocates for the undertaking of large-scale SETI projects. Certainly, the arguments concerning the scientific nature of SETI continued throughout the decade; however, in a series of books published for a general audience these SETI advocates added another layer to the ongoing debate over the value of SETI projects. Their arguments engaged a much larger conversation concerning the moral responsibilities of scientists for the implications of their scientific

research. An analysis of their arguments shows that they were uncomfortable with the current scientific establishment and its connection to the political establishment. They advocated for SETI as the ultimate goal of space science research, one that would establish a framework for a space science research program that corrected the mistakes of the nuclear physics program. From their arguments, a clear critique of contemporary science emerges which portrays the scientific community as shortsighted, focused on achieving advancement without concern for possible consequences, and subservient to national interests. SETI advocates argued that using SETI as a framework for space sciences would allow them to raise profound questions in concert to dealing with the practical concerns of communication with extraterrestrial intelligence. They based their arguments on the idea that SETI exemplified the characteristics they saw as befitting the moral responsibility of scientists within society. These characteristics included long-term planning, recognition of the implications of their work, and the pursuit of scientific research that transcended nationalism. SETI advocates hoped that through raising the profound questions inherent in SETI they could ensure that their work would positively benefit humanity.

SETI advocates were worried about the state of the world and the future of life on Earth. Their direct and indirect experiences, particularly with nuclear technology, showed the ability of science and technology to profoundly change the future of humanity; however, they had no illusions that those changes were guaranteed to be positive. The arguments put forth by SETI advocates implied that the power of science must be accompanied by a sense of moral obligation on the part of scientists. The past two decades had been filled with ever-increasing technological advances; however, these

advances had not brought about a peaceful, cooperative world. Instead, nuclear weapons appeared to be placing the future of life on Earth in jeopardy. While the conversation had been ongoing since the end of the Second World War, the speed of advancement in nuclear technology and its dangers seemed to be increasing. In these years, the crisis over nuclear weapons was not an abstract problem. The early years of the 1960s brought with it the Soviet testing of “Tsar Bomba,” the largest and most powerful nuclear weapon ever detonated, on October 30, 1961. The Cuban Missile Crisis in 1962 brought the world dangerously close to the beginning of a nuclear world war. Even international cooperative scientific research programs, such as the International Geophysical Year (IGY), sparked new competition between the United States and the Soviet Union. The IGY’s most famous achievement, Sputnik, was not heralded as the latest and greatest scientific advancement but the opening of a new arena for the Cold War. The launching capacity needed for satellites was used by both countries in the construction of Intercontinental Ballistic Missiles and Sputnik itself, sparked the Space Race, which threatened to militarize space. It was within this context that SETI advocates argued for the undertaking of large-scale SETI projects on the basis that they could provide a much needed perspective on humanity’s position within the Galaxy. Whether life on other planets existed or not, SETI advocates hoped the act of searching itself would redirect humanity towards a safer path.

The moral responsibility of scientists was explicitly linked to the question of the existence of extraterrestrial intelligence through the last term in the Drake Equation, L , the longevity of a civilization. SETI advocates frequently and forcefully expressed fears that the average length of this time could be very short. Their ideas of the evolution of

intelligent life directly resulted from their ideas concerning the evolution and experience of intelligent life on Earth. Thus, their assumptions about life on other planets directly relied upon the existence of life on Earth. The first book published by a member of the Order of the Dolphin, *Intelligent Life in Space* by Drake in 1962, laid out the case for potential life on other worlds similar to the way the case had been presented to scientists. Drake based his case for the potential existence of life on other worlds upon the assumption that the Sun and the Earth were average for the universe. “Would it not then seem reasonable to suppose that the Sun’s planet companions are average too; that the universe is the home of many worlds much like ours; and that even the living things of Earth are average?”⁴³ Drake argued that an assumption of mediocrity for life and planets previously had proved fruitful for science, such as in the case of Galileo’s questioning of whether Earth was the most important object in space.⁴⁴ These assumptions lead Drake to then discuss what he termed ‘The Most Difficult Problem,’ that is the issue of intelligence.

In order to communicate with life on other planets, intelligence must not only arise but must arise in a fashion that produces science and technology. Drake assumed that life on other planets would develop similarly to life on Earth. He argued that, “One of the most fundamental features of evolution is the continuous improvement in intelligence made by the creatures of the Earth.”⁴⁵ However, Drake not only accounted for the existence of science and technology but also its potential implications for society. Key to Drake’s ideas concerning these matters was the idea of technological adolescence.

⁴³Drake, *Intelligent Life in Space*, (New York: Macmillan, 1962), 45.

⁴⁴Drake, *Intelligent Life in Space*, 15.

⁴⁵Drake, *Intelligent Life in Space*, 70.

Based on the evolution of science and technology on Earth, Drake assumed that any civilization that developed technology that would allow them to communicate also developed the technology which would give them the ability to destroy themselves. For Drake, science and technology were synonymous with intelligence; however, intelligence itself was not enough to ensure the survival of any civilization. In fact, it might even be the key factor in its demise. In the next chapter, Drake explicitly stated his concerns about the confluence of the creation of communication and nuclear technology. "...man's nuclear skill could lead to the termination of his communicative state."⁴⁶ While science and technology was the driving force behind humanity's ability to communicate with other planets, technological advancement had also placed humanity in the position where its entire existence was at stake.

Drake's arguments concerning intelligent life on other worlds directly addressed his view of humanity and its current status. Drake's book did not merely inform a general audience about the latest advancements of science, but spoke directly to world events, their causes, and potential consequences. Drake argued that the traits which had previously allowed humanity to survive and thrive were the exact traits that placed humanity in danger.

Intelligent as man have become, he still retains some of the aggressiveness that has been important in his struggle for survival through the centuries. Mankind has had many wars, and men still fight among themselves. Today, this is very dangerous because man's intelligence has given him the means to destroy himself and all other life on earth. If, though some folly, this great disaster should happen, life may not appear again. Surprisingly, this must be taken into account when calculating the possibilities of finding intelligent life in space.⁴⁷

⁴⁶ Drake, *Intelligent Life in Space*, 75.

⁴⁷ Drake, *Intelligent Life in Space*, 71.

Basing the arguments for SETI on the existence of life on Earth had led directly to a discussion between scientists about their thoughts and conceptions of humanity's past, present, and future. The combination of nuclear weapons and man's aggressiveness led many to predicting a bleak outcome for the future.

The publication of *Intelligent Life in Space* represents a marked transition of scientists from being quietly interested in SETI to their active advocacy of SETI. While Drake was the first scientist to undertake a SETI project with Project Ozma, he agreed to keep the project quiet initially. Even after Struve publicized the project, Drake's publications on the matter focused on the technical details involved in the project. Before the 1961 SETI Conference, his arguments about SETI had simply assumed that life on other planets potentially existed. Early excitement over SETI had prompted the 1961 conference and as an attempt to order the conversation, Drake developed a formula that would unpack the assumptions of previous SETI conversations. The terms of this equation directly influenced the trajectory of the conversation concerning SETI. The Drake Equation led to a discussion of scientific theories of planetary cosmogony, the origins of life and, most importantly for SETI advocates, the longevity of a civilization. As ideas of extraterrestrial intelligent life were based upon the experience of life on Earth, some scientists interested in SETI began to focus on the factors that could affect the longevity of humanity and its communicative state. In the 1960s, these factors seemed obvious. While scientists were perhaps more acutely aware of the potential dangers of nuclear weapons, the whole world was focused on the possibility of a nuclear world war. Fears of the annihilation of life on Earth heavily factored into Drake's discussion of the existence of extraterrestrial life. A new and complex layer was beginning to be added to

the conversation about SETI and this layer directly spoke to the moral responsibility of scientists and the relationship of science and technology.

Carl Sagan, another member of the Order of the Dolphin, openly advocated for the undertaking of large-scale SETI projects. In 1966, he and the Soviet scientist Iosef Shklovskii published *Intelligent Life in the Universe*, an updated and heavily supplemented version of Shklovskii's *Universe, Life, Mind*. Published with an American audience in mind, Sagan and Shklovskii's book follows a similar format to Drake's book, albeit it was much more detailed, particularly in regards to the scientific information presented. Shklovskii and Sagan directly addressed the scientific nature of SETI. "Is it in fact possible to call a book with intelligent life in the universe 'scientific'? We are deeply convinced that the problem can be approached responsibly only if the assumptions involved are stated explicitly, and if the most efficient use of the scientific method is made."⁴⁸ Shklovskii and Sagan clearly thought that SETI was grounded upon a firm scientific basis; however, they argued that opponents of SETI were correct in their assessment that it would not have been deemed scientific in the past. In their view, the rate of scientific advancement was increasing and this opened new areas to scientific examination. "The pace of science is now swift. In earlier times, the suggestion of Cocconi and Morrison would never have been accepted for scientific publication; it would have been considered too speculative by far. Now the temper of the times is different."⁴⁹ While they were certainly interested in the acceptance of the scientific

⁴⁸ I. S. Shklovskii and Carl Sagan, *Intelligent Life in the Universe*, (San Francisco: Holden-Day, 1966), 359-60.

⁴⁹ Shklovskii and Sagan, *Intelligent Life in the Universe*, 391.

community, Shklovskii and Sagan wrote for a public audience and like Drake, were heavily influenced by their ideas concerning the state of the world.

Shklovskii and Sagan clearly connect their ideas concerning the state of world affairs to views of extraterrestrial life throughout their book. This is evident in the title of certain chapters, such as chapter two, “Extraterrestrial Life as a Psychological Projective Test”.⁵⁰ Within this chapter, they discuss the state of the world as they saw it, “The pace of world events is out of the hands of the ordinary individual. We have no assurance that tomorrow will not find the world a radioactive pyre.”⁵¹ It was not simply the existence of nuclear technology that provoked fear in Shklovskii and Sagan; government involvement and the use of nuclear technology in the Cold War were central to their views on the potential longevity of a civilization. Referring to the Drake Equation, they said, “There is a sober possibility that L for Earth will be measured in decades. On the other hand, it is possible that international political differences will be permanently settled, and that L may be measured in geological time.”⁵² Ostensibly, the conversation concerning SETI seems abstract and solely concerned with statistical probabilities; however, this passage points to concrete consequences of nuclear technology. The contemporary state of the world for Sagan and Shklovskii was one in which the longevity of humanity was at stake. The tone of this passage greatly differs from the dispassionate discussions of the probabilities of planetary evolution or the origination of life. The potentiality of nuclear weapons was not simply a matter of determining potential probabilities; for Shklovskii and Sagan, it was an issue that deserved and needed urgent and close attention.

⁵⁰ Shklovskii and Sagan, *Intelligent Life in the Universe*, 18.

⁵¹ Shklovskii and Sagan, *Intelligent Life in the Universe*, 19.

⁵² Shklovskii and Sagan, *Intelligent Life in the Universe*, 412.

At other points in *Intelligent Life in the Universe*, Shklovskii and Sagan forcefully and explicitly expressed their opinion of nuclear technology. Speaking of the view that extraterrestrial civilizations may have of the ongoing Soviet and American nuclear tests, they wrote, “Even we who live on Earth can hardly consider these barbarous experiments, which could lead to the destruction of life on our beautiful world, as manifestations of intelligence!”⁵³ This tactic, that is the evaluation of the trajectory of humanity based upon the supposed opinions of a much more advanced extraterrestrial civilization, was a key theme in many SETI arguments and served as a way to discuss the different pathways available to humanity. Given Sagan’s rise to popularity and forcefully denouncements of nuclear weapons, expression of these opinions does not come as a surprise; however, they represent another member of the Order of the Dolphin who shifted to being a forceful, public advocate for the undertaking of large-scale SETI projects after the 1961 SETI Conference. For Sagan, these were to be part of a larger exploration of space using a variety of techniques including ground-based operations such as SETI and unmanned and manned space exploration. For the 1960s conversation concerning SETI, it was another example of the shift evident in some members of the Order of the Dolphin towards advocacy for SETI based upon the future of humanity and the role of scientists within that future.

Following the publication of Drake’s book, the most controversial member of the Order of the Dolphin, John C. Lilly, published *Man and Dolphin* in 1961. A physician and a neuroscientist, Lilly conducted experiments that attempted to establish interspecies communication between humans and dolphins. While others would, for the most part,

⁵³ Shklovskii and Sagan, *Intelligent Life in the Universe*, 253.

discredit Lilly's work due to his connection with psychedelics and the counterculture movement, in the early 1960s his work attracted much attention from scientists. His work and his attendance at the 1961 SETI Conference was influential enough to prompt the other members to name their group the Order of the Dolphin. Another member of the Order of the Dolphin, Melvin Calvin, gave all members a dolphin pin in celebration of his winning of the 1961 Nobel Prize in Chemistry. Lilly's presence at the conference and support of SETI underscores the diverse, multi-disciplinary nature of scientists who were connected to it in the 1960s. While the Order of the Dolphin certainly implied a sense of group identity and camaraderie, it is important to note that it was not an official organization in any sense and members of the group pursued and advocated individually for their own work and future SETI projects. The famous biologist, J.B.S. Haldane, was unable to attend the 1961 SETI Conference and was asked by Carl Sagan afterwards to become a member of the Order of the Dolphin. Sagan quoted his response, "he [Haldane] wrote me that membership in an organization that had no dues, no meetings, no responsibilities was the sort of organization he appreciated; he promised to try hard to live up to the duties of membership."⁵⁴ While *Man and Dolphin* had little information about the issues discussed by Sagan and Drake, Lilly expressed the same connection between his work with interspecies communication and his negative appraisal of the contemporary situation in regards to nuclear weapons.

Lilly's book explores his reasons for undertaking research in interspecies communication and presented the results he had produced thus far. He frequently expressed the idea that interspecies communication, whether with terrestrial or

⁵⁴ Carl Sagan, *Cosmic Connection: An Extraterrestrial Perspective*, (Garden City, N.Y.: Anchor Press, 1973), 167.

extraterrestrial creatures, would soon be established and would have profound consequences for humanity. “If no one among us pursues the matter before interspecies communication is forced upon *Homo sapiens* by an alien species, this book will have failed in its purpose.”⁵⁵ Continuing, he laid out his purpose behind writing the book. “But if this account sparks public and private interest in time for us to make some preparation before we encounter such beings, I shall feel my time was well spent in the research here described.”⁵⁶ Lilly sought to do more than educate his audience; he wanted to start a conversation about the issues inherent in interspecies communication.

For SETI advocates the future of the world seemed bleak; however, it was not hopeless. Humanity had the ability to choose its future path and scientists had a moral responsibility to guide them through humanity’s technological adolescence. Their advocacy of SETI was based upon its characteristics, which they believed befitted their moral obligations as scientists. Scientists played a key role in the creation of nuclear technology and, for SETI advocates this implied that they also had some responsibility for its implications for society. However, SETI advocates were not simply blaming other scientists for the results of their past work. They used the example of nuclear technology to better inform themselves about the areas of research they should undertake in the present and in the future. Lilly best expressed this idea

If and when interspecies contact is made, it may be used as a force for peace or as further aid to warfare. It may be that we shall encounter ideas, philosophies, ways and means not previously conceived by the minds of man. If this is the case, the present program of research will quickly pass from the domain of scientists to that of powerful men and institutions and hence somewhat beyond the control of the first venturers. When the time comes, I hope that the ideas here presented will

⁵⁵ John Cunningham Lilly, *Man and Dolphin* (Garden City, New York: Doubleday, 1961), 11-12.

⁵⁶ Lilly, *Man and Dolphin*, 12.

help those men of goodwill to lead wisely and that they will be a bit better informed than they were in 1945 concerning another scientific advance, that time in applied nuclear physics.⁵⁷

In the view of SETI advocates, recent scientific advancement had not made the world a safer and better place. Instead, because of the lack of recognition of the effects that nuclear technology would have on the world, in fact, the world had become a much more dangerous place. SETI advocates argued that once scientists created technology, they no longer had complete control over it. Thus, if they wanted to ensure that future technology would not continue to negatively influence the future of humanity, scientists must be aware of the potential consequences of their work.

SETI advocates' discussions of the potential consequence of a SETI project that successfully established communication with an extraterrestrial civilization showed one potential safe pathway through humanity's technological adolescence. Through contact with more advanced and wiser civilizations, humanity could progress into the nuclear age without destroying itself. They believed that this event would be monumental. Speaking of the type of change the establishment of communication with an extraterrestrial civilization would bring, Philip Morrison said, "...the discovery of intelligence and its subsequent impact would not be a quick event, but would resemble more the discovery of agriculture than the discovery of America."⁵⁸ While detractors of SETI often argued that the distance between extraterrestrial civilizations and Earth precluded the establishment of any sort of conversation, Sebastian von Hoerner argued that extraterrestrial civilizations could and would attempt to guide other civilizations through their technological adolescence with its initial communication. He stated that, "... the means

⁵⁷ Lilly, *Man and Dolphin*, 12-13.

⁵⁸ Steven J. Dick, *Life on Other Worlds: The 20th-Century Extraterrestrial Life Debate*, (Cambridge: Cambridge University Press, 1998), 239.

of avoiding self-destruction will be among the primary contents of initial interstellar communications.”⁵⁹ His ideas were influential among SETI advocates. In *Intelligent Life in the Universe*, Shklovskii and Sagan cited his ideas and concluded that, “Any information at all received by a planetary civilization could assist the society in overcoming difficulties which impede its further development.”⁶⁰ SETI advocates argued that contact with extraterrestrial civilizations would be made with a more advanced civilization that had learned to deal with the danger of nuclear weapons and thus humanity would have an example to follow.

SETI advocates did not argue for SETI simply on the basis that humanity’s salvation laid in the establishment of communication with extraterrestrial civilizations. Even the possibility of a null result for the search for intelligent life in the universe produced optimism in SETI advocates. Any project that was large enough to produce a definitive null result would require a dramatic shift in the perspective and the priorities of humanity and science. A project of this magnitude would require international cooperation between scientists and long-term planning. SETI advocates conceded their opponents’ argument that SETI had an extremely small chance of obtaining any results in the short run. Sebastian von Hoerner, in his article, “The Search for Signals from Other Civilizations”, said that, “...we must accept very long waiting times (of at least 1000 years and probably more)...” He would go on to say that SETI would be successful in terms of finding extraterrestrial intelligence, “...only if the more highly advanced civilizations are able to think, to plan, and to act in terms of thousands of years. This is extremely different from our own situation in which we would be happy if we could

⁵⁹As quoted in: Shklovskii and Sagan, *Intelligent Life in the Universe*, 413.

⁶⁰ Shklovskii and Sagan, *Intelligent Life in the Universe*, 417.

solve the problems of the next 5 years.”⁶¹ The shortsightedness on the part of nuclear physicists had placed humanity in the position in which it currently found itself. To ensure the survival of humanity in terms of millennia as opposed to decades, SETI advocates argued that long term planning was needed and was sorely lacking among the contemporary scientific establishment. Carl Sagan stated that, “Space exploration provides a calibration of the significance of our tiny planet, lost in a vast and unknown universe. The search for life elsewhere will almost surely drive home the uniqueness of Man... In this perspective, the similarities among men will stand out overwhelmingly against our differences.”⁶² SETI advocates argued that the positive attributes of SETI were not directly tied to its results. If pursued vigorously, SETI’s characteristics would lead to a recalibration of humanity’s vision of itself and its future, irrespective of the discovery of extraterrestrial civilizations.

The changes that SETI advocates proposed would be the result of SETI were concrete changes in the relationship between science and the state. The shortsightedness of scientists in their embrace of military technology for the sake of advancement had resulted in the subservience of science and scientists to national interests. SETI advocates wanted to use SETI to reverse this trend and to ensure that their work benefitted the whole of humanity and not solely the nation-state. SETI advocates criticized the subservience of science and scientists to national interests on the basis that it undermined the exchange of scientific ideas and limited research to areas that were deemed to be nationally important. Carl Sagan argued that, “...the exploration of space

⁶¹ Sebastian von Hoerner, “The Search for Signals from Other Civilizations.” *Science* vol. 134, no. 3493 (December 8, 1961), 1841.

⁶² Sagan, *The Cosmic Connection*, 66.

has been defined largely in terms of narrow considerations of national prestige, both in the United States and the Soviet Union...”⁶³ Sagan also criticized the interference of intelligence agencies, such as the CIA, in matters of international exchange of scientific ideas. “The general effect of such incidents is to detract from the creditability of legitimate scientific exchanges among scientists of different countries. Such exchanges are particularly necessary in an age that hangs a thread away from nuclear destruction, and in which scientists have access to at least half an ear of the politicians in power.”⁶⁴ SETI advocates argued that contemporary science of the 1960s was shortsighted and bound to national interests. This not only put international scientific cooperation in jeopardy but also placed humanity in a dangerous position. Scientists, because of both the power of their scientific research and their position of authority within society, had a moral responsibility to protect and guide humanity towards cooperative internationalism if they wanted to ensure humanity’s successful progression through its technological adolescence.

With the publication of books for a general audience, Drake, Sagan, and Lilly added a new complex layer to the ongoing debate over SETI. Prior to the 1961 SETI Conference, they and other members of the Order of the Dolphin carefully analyzed the technical apparatuses needed for communication with civilizations on other planets. At the conference, these scientists began to unpack the assumptions of the prior SETI conversation. The Drake Equation elegantly laid out the numerous assumptions that he, Morrison, and Cocconi had previously made. The last term in Drake’s Equation required the discussion of factors that might limit the longevity of any civilization. As the

⁶³Sagan, *The Cosmic Connection*, 52-53.

⁶⁴ Sagan, *The Cosmic Connection*, 99.

scientists had only one civilization to examine, humanity, they looked to the experience and evolution of life on Earth as an example. They assumed that little was unique about the experiences of humanity including its contemporary situation. In order to estimate the potential number of civilizations in the galaxy, SETI scientists began to discuss the future of humanity. These discussions led a few members of the Order of the Dolphin to become forceful public advocates for SETI. They quickly transitioned from scientists who quietly discussed the boundaries of scientific inquiry to scientists who openly critiqued the contemporary scientific establishments' failure to recognize and utilize the power of science for the benefit of humanity. Failure to do this had not only undermined many of the aspects of science that SETI advocates found valuable but had placed the future of humanity in doubt.

The search for extraterrestrial life transitioned into being as much about ensuring humanity's survival as it was about scientific discovery of the universe. SETI advocates attempted to conceive of a way to grow out of humanity's technological adolescence without destroying all life on Earth. The evolution of Drake's discussion of Project Ozma illustrates the transition some members of the Order of the Dolphin undertook after the 1961 SETI Conference. Initially, Drake focused on the technical details of interstellar communication. The resultant scientific controversy was concerned about whether Project Ozma could be considered as scientific. After the 1961 SETI Conference, Drake published *Intelligent Life in Space* in which he openly and publically discussed the relationship between science, technology and the future of humanity. In regards to Project Ozma, he elucidated the reasons behind the naming of his project

The Project [Ozma] is named after the Princess of Oz, which, as you may remember from reading the popular “Oz” books, is a mythical land far away, difficult to reach, populated by strange and exotic beings. This seems like a good description of the place mankind is searching for. Also, the land of Oz is a land of childhood, and as we saw earlier, man is only now emerging from his childhood and preparing to take place among the community of galactic civilizations that may exist.⁶⁵

The conversation about SETI was no longer limited to a discussion among scientists about the boundaries of empirical analysis. SETI advocates broadened the discussion to include and focus upon scientists’ moral responsibility to humanity. They argued that science was powerful force in the evolution of civilization on Earth and that to ensure that science benefited humanity, scientists must be aware of the potential consequences of their work.

SETI advocates argued that a new perspective on humanity’s place within the galaxy would guide humanity through its technological adolescence. However, while their language and discussion of extraterrestrial civilizations might imply that their ideas about humanity were abstract; they advocated for SETI on the basis that it represented many of the features that contemporary science was lacking. SETI advocates viewed contemporary science as shortsighted, focused on achieving advancement without concern for its possible consequences, and subservient to national interests. They advocated for SETI based on the idea that the project exemplified the characteristics they saw as befitting the moral responsibility of scientists within society. These characteristics included long-term planning, recognition of the implications of their work and the pursuit of scientific research that transcended nationalism and benefited humanity.

⁶⁵ Drake, *Intelligent Life in Space*, 106.

In the view of SETI advocates, the future of humanity was not determined; however, their assessment of the contemporary situation was bleak. Through careful planning and a new perspective, humanity could ensure its own survival. Drake thought that, “Somewhere, locked up inside mankind, is the answer, but it is still too early in the lifetime of our own civilization to know how wise man is going to be in using the great marvels of modern science or how long he will remain interested in them.”⁶⁶ The Search for Extraterrestrial Intelligence has often been encapsulated by the question: Are we alone? However, in light of this examination of the arguments put forth by its proponents in the 1960s, a more accurate representation can be summed with these questions: Who are we and what will the future be? SETI advocates were worried about the state of the world and the future of life on Earth. Their experience, particularly with nuclear technology, showed the ability of science and technology to profoundly change the future of humanity; however, they had no illusions that those changes were guaranteed to be positive. The arguments put forth by SETI advocates implied that the power of science must be accompanied by a sense of moral obligation on the part of scientists. Ultimately, whether, humanity discovered that it was the lone case of intelligent life in the galaxy or that intelligent life was abundant, advocates for SETI wanted to ensure that humanity was ready and able to meet the challenges of either situation.

⁶⁶ Drake, *Intelligent Life in Space*, 76.

Chapter Three: What Does It Mean To Be Intelligent?: The 1971 Communication with Extraterrestrial Intelligence (CETI) Conference

In the decade following the first theoretical and experimental SETI work, extraterrestrial intelligence attracted much international and multidisciplinary attention. At its beginning, American scientists interested in searching for extraterrestrial intelligence argued that scientific and technological advancement in the post-war period allowed them to start examination and discussion of extraterrestrials in a scientific manner. In the intervening decade, these scientists broadened the meanings and definition of SETI. Among the more politically inclined, SETI became a framework to discuss the moral responsibilities of scientists for the implications and impacts of their research. In comparison to the ongoing nuclear research in the United States and the Soviet Union, SETI advocates argued that SETI research was one potential pathway towards a cooperative, peaceful world through scientific research that was cognizant of its key characteristics.

By 1971, the attention attracted to SETI led NASA to commission a study for a large-scale SETI project. Led by John Billingham and Bernard Oliver, Project Cyclops was a detailed SETI proposal that would come to be the standard for any future proposal. At the same time, the National Academy of Sciences in both the Soviet Union and the United States planned the first international conference to discuss issues of extraterrestrial intelligence. Held September 5-11, 1971 at the Byurakan Astrophysical Observatory of the Armenian Academy of Sciences, the First Soviet-American Conference on Communication with Extraterrestrial Intelligence (CETI) brought an international cohort of leading scholars in a variety of fields together to discuss issues

pertinent to Soviet and American conceptions of the scientific examination of extraterrestrial intelligence.⁶⁷ The 1971 CETI conference attempted to integrate the methodologies and theoretical advancements of the previous decade and in the process elucidated the difficulties of transforming multidisciplinary work into interdisciplinary work.

The 1960s brought much development in areas of science and social science, such as cybernetics, mathematical theories of communication, and artificial intelligence. These advancements tested and often blurred the traditional boundaries of science and the humanities. The framework of ideas concerning extraterrestrial intelligence (ETI) in both the United States and the Soviet Union lent itself well to these discussions because of the broad nature of the terms included. SETI had found its beginning in being defined as solely scientific; however, at the 1971 CETI Conference, ETI now served as a means to define the separation between the universal laws of science and mathematics and the historically contingent development of humanity. The 1971 CETI Conference was arguably the pinnacle for theoretical discussions of the issues concerning extraterrestrial intelligence. While previous discussions of ETI had been mostly limited to conversations among Soviet and American biologists and radio astronomers, the impressive list of attendees at the 1971 conference included scholars from the Soviet Union, the United

⁶⁷ A complete transcript of the process was published in the following volume: Carl Sagan, editor. *Communication with Extraterrestrial Intelligence (CETI)*. (Cambridge: M.I.T. Press, 1973). Additionally, this volume included a number of previously published articles in order to provide background about some of the topics covered at the conference. Presenters at the conference gave talks on their areas of interest. At the end of most presentations, there was a short period of discussion. After a series of presentations on related topics, there was another, usually longer, period to discuss all of the previous sessions. Citations in the chapter will include the title of the session. Over fifty participants from the United States, the Soviet Union, Britain, Canada, Hungary, and Czechoslovakia attended the conference. For this chapter, the first time a participant is mentioned their full name and organization, as listed in the conference proceedings, will be included. Subsequently, they will be referred to by their last name.

States, Britain, Hungary, Canada, and Czechoslovakia. These scholars came from a diverse set of disciplines including astronomy, biology, virology, electrical engineering and, for the first time, a sizable contingent of scholars from the humanities, including history and anthropology. The interdisciplinary nature of the conference led the attendees to focus on defining terms that had been left unexamined by the earlier scientific work. These scholars discussed the dividing lines between the sciences and the humanities. By defining extraterrestrials as the other, their discussions attempted to define the key characteristics of humanity. They asked themselves how to define concepts such as intelligence, civilization, communication, and if it was possible to separate their cognition structure from objective phenomena. The 1971 CETI Conference excellently illustrates the difficulties and excitement that new interdisciplinary fields presented to the traditional disciplines in both the social sciences and the sciences. The conference was not intent on finding answers to previously raised issues, but instead raised new and broad questions with the intent to develop a set of definitions concerning the meaning of terms such as civilization, intelligence, progress, and even science and mathematics themselves.

The influence of the early evolution of SETI in the United States was evident at the 1971 CETI Conference as they used the Drake Equation to structure their conversations. However, their focus differed dramatically from previous conversations about extraterrestrial intelligence in the United States. At the 1961 SETI Conference in Green Bank, West Virginia, the attendees, most of whom were directly connection to astronomy and biology, focused on the terms of the Drake Equation that dealt with astronomical issues and the origins of life. In the intervening decade, a small group

formed the Order of the Dolphin and used SETI as a platform to discuss their political beliefs and ideas of the moral responsibility of scientists by focusing on the last term of the Drake Equation, L . This allowed them to discuss the connection between contemporary political issues and the longevity of humanity. The 1971 CETI Conference focused on the terms that had not received the same attention as the rest. While discussions touched on all of the variables in the Drake Equation, the evolution of intelligence and of intelligent technological civilizations was the focus of much of the conversation and prompted the most vigorous debate among the attendees. Previous ETI conversations had mostly assumed that there would be enough intelligent advanced civilizations in the galaxy interested in communication with others if humanity could only figure out the correct search technique. The 1971 CETI Conference began to examine this assumption through attempting to define what was meant by intelligence. This question had many facets, some of which were easily recognizable as scientific questions and others that required defining a separation between universal phenomena and the historical/anthropological development of humanity.

The conversation about intelligence began with presentations by D. Hubel, a physiologist, and G. Stent, a virologist, about the development of neurons and a central nervous system; however, even these conventional scientific presentations touched upon ideas and concepts that were much less clearly definable in a scientific manner.⁶⁸⁶⁹ Hubel's presentation detailed the development of the compartmentalization that was thought to occur with the evolution of single cell animals to multicellular organisms,

⁶⁸ D. Hubel, Department of Physiology, Harvard University Medical School, Cambridge, Massachusetts.

⁶⁹ G. Stent, Department of Virology, University of California, Berkeley.

including a muscular system and an endocrine system. In detail, he discussed various types of nerve cells and the development of different nervous systems through electrical and chemical signals. His presentation laid the groundwork for Stent's discussion of the development of learning, a characteristic that can be attributed to even simple organisms. The development of a central nervous system, according to Stent, exhibits the general attribute of plasticity which, for him, is synonymous with learning. "Its [the central nervous system] plasticity allows the nervous system to have a history—that is to say, its present state depends on past experience."⁷⁰ Stent then discussed the evolutionary advantages that a central nervous system gives to any organism. They both argued that learning was a prerequisite for intelligence; however, the highest levels of specialization of the nervous system and the idea of learning itself raised questions among the presenters and the other scholars about how best to define this concept and to which organisms they could be attributed to.

The ultimate effects of the specialization of the nervous system and the definition of learning pointed to concepts that were not easily defined as scientific. Hubel, himself, pointed to the possibility of a connection between the central nervous system and nebulous concepts that were possibly better suited to other areas of scholarship. In his presentation, Hubel said, "Close to the end there are specializations for the organizations of movement and somewhere in between one has everything else—memory, the soul, and perhaps even the social sciences."⁷¹ In the midst of his lecture concerning neurons and the central nervous system, Hubel points to concepts found more often in a religion class

⁷⁰ "Evolution of Intelligence," in *Communication with Extraterrestrial Intelligence (CETI)*, ed. Carl Sagan (Cambridge: M.I.T. Press, 1973), 80.

⁷¹ "Evolution of Intelligence," in *CETI*, 73.

than a science class. While Hubel does not expand upon this idea, it marked the beginning of connections between scientific ideas such as the development of the central nervous system to much broader ideas such as the soul, a concept that certainly had no scientific definition at the time. Some of the attendees questioned Stent's definition of learning. When asked if any social insects exhibit signs of plasticity, Stent answered in the affirmative for bees but wavered on the topic of flatworms. Regarding flatworms Stent answered, "That is a sensitive subject. It is operant learning. Training has been reported, of course, for many invertebrates."⁷² The subsequent discussion of the topic led F. H. C. Crick to summarize Stent's point as plasticity was a necessary condition for learning but not a sufficient condition and remarked that the subject was in its infancy.⁷³ Any definition of intelligence contained some form of the ability to learn; however, it was evident from Hubel and Stent's presentation that even this groundwork contained areas and concepts that blurred the lines between what had been and could be examined scientifically. Even the definition of learning, the basis for intelligence, was debated and ultimately left unsettled at the conference.

Building upon Hubel and Stent's presentations, R. B. Lee, an anthropologist, presented his ideas of the evolution of technical civilizations in which he attempted to combine scientific and social science methodologies into a coherent framework in order to talk about the experience of humanity as a case study for intelligent civilizations.⁷⁴ As with all discussions beyond basic intelligence, Lee's presentation was limited to extrapolation based on the human experience, as this was the only technical civilization

⁷²"Evolution of Intelligence," in *CETI*, 84.

⁷³ F. H. C. Crick, Medical Research Council Laboratory of Molecular Biology, Cambridge University, U.K.

⁷⁴ R. B. Lee, Department of Anthropology, University of Toronto, Toronto, Ontario, Canada.

that he had available to study. Lee presented three models which he referred to as tools, that he thought would be useful for examining the development of human civilization.

“These three tools—evolutionism, historical materialism, and uniformitarianism—offer a basis for using our experience to shed light on intelligence as a general process.”⁷⁵ For Lee, evolution provided an explanation for diversity and development of different species on Earth and provided the beginning for a discussion about understanding the “nature of life forms”.⁷⁶ Historical Materialism, according to Lee, “seeks to elucidate the general laws of human history and society...[and] attempts to do for intelligent life on this planet what the Darwinian synthesis has done for life in general.”⁷⁷ Lee’s third tool, uniformitarianism, sought to connect the experience of intelligent life on Earth with intelligence in general by claiming that there are general laws operating in the universe and that comprehensive generalizations could be drawn from an understanding of humanity.⁷⁸ In order to understand the development and key characteristics of intelligence, according to Lee, both scientific and social science theories must be understood and applied. For Lee, historical materialism built upon Darwinianism and provided the best framework for a discussion of the development of intelligence. This combination of theories obviously crossed the line between the traditional division of science and social science and showed that neither one, in and of itself, provided a sufficient framework in which to develop an understanding of intelligence. For the attendees of the 1971 CETI Conference, the development of a new framework that

⁷⁵“Evolution of Technical Civilizations”, in *CETI*, 86.

⁷⁶“Evolution of Technical Civilizations”, in *CETI*, 86.

⁷⁷“Evolution of Technical Civilizations”, in *CETI*, 86.

⁷⁸“Evolution of Technical Civilizations”, in *CETI*, 86.

combined both social science and science was necessary to discuss intelligence, but this new framework required the establishment of new definitions and concepts.

Using his three tools, Lee spoke about the evolution from simple organisms to intelligent humans in order to define intelligence and discuss the possibility that it allows humans to progress past their biological imperatives. He rejected the idea that tool making is the key characteristic of humanity in light of the recent evidence that other animals, such as chimpanzees, were also toolmakers and users. Instead, he argued that, *“Human intelligence reduced to its essentials is synonymous with human language.* Intelligence is improved communication, the transmission of more complex information from one individual to another.”⁷⁹ This definition of intelligence implied that intelligence was a characteristic of a species not of an individual. For the attendees of the 1971 CETI Conference, this definition of intelligence had many implications. They discussed at length the relationship between cooperation and competition in the development of intelligent species. The driving force behind the development of intelligence was natural selection based on competition; however, Lee’s definition of intelligence also required a great deal of cooperation between members of a species. T. Gold summarized this position thusly, “Perhaps such fierce competition is, indeed, a necessary thing to create our level of intelligence.”⁸⁰⁸¹ Assuming that a general model of intelligence was also beholden to these biological processes, any intelligence species, including humanity, would have cooperative and competitive characteristics. However, this model of intelligence, based upon the scientific theory of Darwinianism, only explained the

⁷⁹“Evolution of Technical Civilizations”, in *CETI*, 91. Italicized in original text.

⁸⁰“Evolution of Technical Civilizations”, in *CETI*, 105.

⁸¹ T. Gold, Center for Radiophysics and Space Research, Cornell University, Ithaca, New York.

development of intelligence; the development of a civilization required combining scientific theories of evolution with social scientific research concerning the development of human civilization.

While the conference attendees accepted Darwinianism as the probable mechanism for the emergence of intelligence, Lee's presentation pushed the attendees to think about its implications. Lee combined his Darwinian model of the development of intelligence with his anthropological training in language and concluded that, "Once language becomes established, it has its own logic of development. In fact, language becomes elaborated far beyond the adaptive needs of the organisms who possess it."⁸² Language, synonymous with intelligence, was understood to be created by the process of Darwinianism; however, language itself created new processes after its emergence—processes that were not well understood but connected in an unclear way to the rise of civilizations. Lee argued that not all human groups which have language develop into civilizations, such as the !Kung bushmen of southern Africa. In essence, while intelligence was a necessary condition for civilization, it was not a sufficient condition. In order to estimate the number of technical civilizations in the galaxy, general laws of the civilization were needed; however, from Lee's presentation, it was clear that key factors in the development of civilization were unknown to any degree of certainty at the time.

In comparison to the 1960s SETI discussions, the 1971 CETI Conference, Lee's presentation, and general discussion about ETI dramatically differed. Cocconi, Morrison, and Drake had initially argued that scientists should discuss and even search for extraterrestrial intelligence because the advancement in technology allowed the question

⁸² "Evolution of Technical Civilizations", in *CETI*, 92.

to be examined scientifically.⁸³ They carefully laid out their cases keeping in mind the criticism that they were likely to receive from their scientific colleagues. While they were certainly arguing that new areas could and should be examined, they argued for a broadening of the boundaries of science not a blurring of the boundaries. It was science that could answer the questions they deemed important. By 1971, they had succeeded in attracting the attention of many scientists and even those who were skeptical of their claims joined the conversation. However, the 1971 CETI Conference is evidence of the remarkable broadening of the conversation. The attendees of the conference no longer defined ETI as an area that consisted of terms that were solely matters of scientific consideration. They sought to combine the approaches of science and social science to deconstruct the attributes of humanity. This process led them to discuss much broader concepts and forced them to reexamine their conceptions of humanity as a case study for intelligence. The attendees discussed broad concepts and, as a result, discussed the boundaries of science and social science. Before they came to any discussion of extraterrestrial civilization, the attendees were already blurring the lines between scientific and social science concepts and theories in an attempt to come to broader and more profound conclusions about life, intelligence, and human civilization.

These profound concepts and their implications were not lost on the attendees of the conference. In response to Lee's presentation, E. S. Markarian commented on this new ETI conversation.⁸⁴

⁸³ Cocconi was not a participant at this conference. P. Morrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts. C. Sagan, Chairman, Center for Radiophysics and Space Research, Cornell University, Ithaca, New York.

⁸⁴ E. S. Markarian, Institute of Philosophy and Law, Armenian Academy of Sciences, Erevan.

Theoretical syntheses of fundamental concepts and ideas often arise through a new, extended interpretation of earlier concepts developed in narrower fields of learning. The concept of information and control, for example, arose in the social sciences and only then, following the emergence of information theory and cybernetics, transcended those boundaries and acquired the new meanings that they have today in these fields.

The reverse process also seems possible when concepts born in the natural sciences may acquire a much broader meaning on the fertile grounds of the social science—for example, the concept of adaptation.⁸⁵

Previously, extraterrestrial civilizations were assumed to develop similarly to humanity in potentially great enough quantities that communication was thought to be possible.

However, when scholars at the 1971 CETI Conference, turned their attention to these assumptions, it appeared that neither social science nor science adequately explained the terms of the Drake Equation. In order to use humanity as a case study for intelligent life as general concept, the 45 critical stages between a simple organism and a technical civilization needed to be known. Using the framework that Lee established which combined scientific and social scientific theories, the rest of the discussion focused on separating the essential characteristics of humanity and the potential types of civilizations that could exist.

Similar to their discussions of the relationship between language and the development of civilizations, attendees at the conference discussed the potential variety of civilizations and the likelihood that a civilization would develop into a technical civilization. The attendees accepted Lee's assertion that both competition and cooperation were key characteristics to any discussion of civilization. The discussion then turned to the potential implications of the idea that one of these characteristics could be more influential within a civilization. J. R. Platt built upon the discussion of the lifetimes

⁸⁵"Evolution of Technical Civilizations", in *CETI*, 109.

of technical civilizations by arguing that competition may be a key factor in the development of advanced technology—an advancement with numerous consequences.⁸⁶ Platt stated that, “I think that the lifetimes of extraterrestrial societies may involve a race between cooperation and competition.”⁸⁷ Agreeing with Lee, Platt argued that cooperation was a key element to the development of language but went further by arguing that, “competition may be necessary for fast technology development”.⁸⁸ Using the ideas of both competition and cooperation, Platt proposed three potential types of civilizations based upon the speed of the evolution of cooperation and competition. If a society was able to solve its social organization problems before the emergence of high technology (i.e. the society exhibits cooperation over competition), it probably would not develop high technology and might be characterized as a very docile society akin to social insects such as termites. If the reverse was true in that high technology evolves prior to extensive cooperation, Platt envisioned a society where it is used to solve the problems of social organization. For this society, Platt gives the example of a nuclear Hitler where all resisters were destroyed. The third case, and the case of humanity in Platt’s opinion, was one where, “...the social organization or conflict problem is not solved before technology”.⁸⁹ Platt’s discussion connected to both the development of technical civilizations and the lifetime of these civilizations. Searching and communicating with ETI required that extraterrestrial civilizations develop high technology; however, the attendees of the conference, who were certainly drawing on previous SETI conversations, argued that competition also may cause civilizations to

⁸⁶ J. R. Platt, Michigan Mental Health Center, University of Michigan, Ann Arbor.

⁸⁷“Lifetimes of Technical Civilizations”, in *CETI*, 153.

⁸⁸“Lifetimes of Technical Civilizations”, in *CETI*, 153.

⁸⁹“Lifetimes of Technical Civilizations”, in *CETI*, 153.

destroy themselves. Importantly, civilization was no longer simply synonymous with humanity; the deconstruction of humanity into key characteristics, such as cooperation and competition, allowed the attendees of the conference to begin proposing alternative development pathways for intelligent civilizations.

The attendees of the 1971 CETI Conference also discussed alternative concepts of humanity. Besides the United States, the Soviet Union was the only other country that undertook searches for extraterrestrial intelligence and their previous decade of work provided a different conception of humanity and other potential civilizations. In 1962, the Soviet astronomer N. S. Kardashev published a paper that established a framework for the development of civilizations based on their energy usage.⁹⁰ Instead of focusing on the previous development of humanity, Kardashev's framework defined civilizations more advanced than humanity. He distinguished three types of civilizations. A Type I civilizations was, "a civilization able to use the equivalent of the present energy output of terrestrial civilization for interstellar communication."⁹¹ A Type II civilization was, "a civilization able to use the equivalent of the energy output of the sun for interstellar communications."⁹² Finally, a Type III civilization, the most advanced civilization Kardashev proposed, would be, "able to use the equivalent of the energy output of the Milky Way Galaxy for interstellar communication."⁹³ Kardashev's framework was far more robust than other frameworks for more advanced civilizations, and as a result, heavily factored into discussions at the 1971 CETI Conference. Technological advancement was seen as the key to the expansion of energy consumption and this

⁹⁰ N. S. Kardashev, Institute for Cosmic Research, Soviet Academy of Sciences, Moscow.

⁹¹ "An Elementary Glossary", in *CETI*, 404.

⁹² "An Elementary Glossary", in *CETI*, 404.

⁹³ "An Elementary Glossary", in *CETI*, 404.

advancement in technology raised questions about the possibility of non-biological life forms.

Much of the discussion concerning Kardashev's civilizations also included conceptions of artificial intelligence, mainly in the form of cybernetics, which had become very popular among portions of the scientific community in the 1960s. The combination of artificial intelligence and advanced civilizations caused many of the attendees to question whether nonbiological civilizations might exist. I. S. Shklovsky stated, "I think that such very advanced civilizations must not be biological but, rather, computer-devised and spread out over enormous areas. It is even now becoming clear that the existence of biological systems in environments which command such enormous energy resources would be extremely difficult."⁹⁴⁹⁵ While computer-based civilizations might certainly have an advantage of being able to live in far harsher climates than biologically based one, the existence of computer-based civilizations far more advanced than humanity raised important definitional questions about humanity and its future. Platt responded to Shklovsky's remarks, "Here on Earth, we are in the midst of a great watershed, a world transformation...altogether we are in a transition period on a scale such as no society has ever encountered."⁹⁶ Extrapolating from humanity's current situation and growth, Platt proposed that technological advancement had many implications and could possibly result in a civilization that was not only radically different from its previous state, but could potentially be characterized as a new species. "It will be a new form of society, totally different from anything that has ever existed in

⁹⁴"Lifetimes of Technical Civilizations", in *CETI*, 149.

⁹⁵ I.S. Shklovsky, Institute for Cosmic Research, Soviet Academy of Sciences, Moscow; and Shternberg Astronomical Institute, Moscow State University

⁹⁶"Lifetimes of Technical Civilizations", in *CETI*, 151.

the world before, as radically different as a new species, if we survive.”⁹⁷ Similarly to language, the attendees of the 1971 CETI Conference argued that technology and its implications potentially defined civilization. Technology was not simply a tool that intelligent civilization used to shape the environment around them; technology was a force that shaped a civilization and could potentially be the mechanism causing a civilization to transition from one species to another.

Attendees at the 1971 CETI Conference intimately linked progress to science and technology, and in the process developed a definition of progress that required exponential growth in science in order for a society to continue progressing. G. M. Idlis remarked, “The concept of a progressively developing civilization boils down to the development of that civilization in science, to the consecutive solution of topical scientific problems.”⁹⁸ Continuing, Idlis spoke about the pace at which science must progress. “To sum up, then, for a civilization to develop progress it is essential that that development be exponential.”¹⁰⁰ Idlis argued that humanity had reached this point in the time of Newton and that ever since, the science of humanity had been growing at an exponential rate; i.e. humanity had been exhibiting progress. In order for a civilization to progress, its science must grow exponentially and this process occurred by the expansion of the axioms of science. Ultimately, according to Idlis, this led to a narrowing of the topical windows available to science. “..it [a civilization] will later be solving a smaller and smaller share of the real problems facing it. Civilizations will eventually be solving

⁹⁷“Lifetimes of Technical Civilizations”, in *CETI*, 151.

⁹⁸ “Evolution of Intelligence”, in *CETI*, 82.

⁹⁹ G. M. Idlis, Astrophysical Institute, Kazakh Academy of Sciences, Alma-Ata.

¹⁰⁰“Number of Advance Galactic Civilizations,” in *CETI*, 183.

one problem only, that of their existence.”¹⁰¹ Science was the defining characteristic of a progressive technical civilization. Combined with the previous discussion concerning intelligence, the attendees of the 1971 CETI defined any progressive technical civilization as possessing language and science.

While language and science were potentially the universal characteristics of technical civilizations, B. I. Panovkin questioned whether the combination of the two limited the mutual intelligible communication between intelligent civilizations.¹⁰² “There is also, however, a third expressed condition for CETI. This is the possibility of transmitting substantive semantic information—the possibility of understanding your correspondent, understanding what he is driving at.”¹⁰³ Any communication between civilizations through electromagnetic signals has two parts. The civilization sending the signal must first decide what message it would like to send. The general consensus at the time was that communication could be established through the ideas of science and mathematics, as these are general principles that should be understandable by any technical civilization. Panovkin argued that the construction of the message was not as easy as simply expressing mathematical principles because of the nature of language. “...the transmitting correspondent must reflect in his mind the object he wishes to communicate about. Once reflected in his mind, this object has to be coded in a system of symbols, and that requires a second operation of equal importance...that is, the real contents have to be translated into a set of symbols, coding.”¹⁰⁴ Even if contact could be established with an extraterrestrial civilization, Panovkin argued that it may be

¹⁰¹“Number of Advance Galactic Civilizations,” in *CETI*, 183.

¹⁰²B. I. Panovkin, Radioastronomical Council, Soviet Academy of Sciences, Moscow.

¹⁰³“Message Content,” in *CETI*, 316.

¹⁰⁴“Message Content,” in *CETI*, 317.

impossible to establish communication between the two civilizations on the basis that he was unsure if one's cognition structure could be separated from one's understanding of objective phenomena.

Panovkin's analysis of the difficulties of establishing communication became even more complicated for the civilization receiving the message. "To understand the meaning of the communication, he has to compare the symbols with the object, with the images of the object implied, and this means that the second correspondent must also effect a process of reflection. The real object must be reflected in his thinking."¹⁰⁵ In effect, Panovkin argued that the universal nature of science and mathematics was limited by the language in which science and mathematics was expressed. Science and mathematics, while theoretical concepts, were directly tied to and discovered through interaction with the systems of Earth and humanity. According to Panovkin, the expression of mathematics and science was limited to symbolic language and that symbolic language was directly tied the humanity's experience and ways of perceiving the world.

Practical activity is what brings us into contact with the material world and this enables us to build up scientific theories. We can not separate one from the other. Therefore, the cognition images we use in our scientific learning, the structure of our notion is symbols reflecting the real world around us—all this includes as the objective properties of the things around us the instruments of our learning.

The result of these ideas for any attempts to communicate with ETI, according to Panovkin, meant that humanity may be limited to communication between planets with similar symbolic language and cognition structure. Furthermore, Panovkin's remarks

¹⁰⁵“Message Content,” in *CETI*, 317.

undercut the assumption that science and mathematics were universal, objective phenomena and created one of the more vigorous debates at the conference.

Panovkin's questioning of the universality of science and mathematics was supported by comments of other attendees. W. H. McNeill commented that, "The confidence that I know many mathematicians and natural scientists have that they have a universal language seems to me a case of chauvinism, to use our favored term."¹⁰⁶¹⁰⁷ McNeill here was pointed to the previous argument for the existence of extraterrestrial life and intelligence that claimed it was chauvinistic to assume that Earth and its life were somehow unique or the center of the universe. The same assumptions used by scientists in favor of searching for extraterrestrial life had used against their detractors when they argued that ETI was simply science fiction, according to McNeill, also might imply that it was misguided for them to assume that human language was in any way universal. Panovkin further argued that, "I disagree with the point of view that mathematics are universal. What are the sources of mathematics, the bases of mathematics? There may be different axiomatic bases of mathematics such phenomena are infinity are generalizations from human knowledge. Other societies may have other generalizations."¹⁰⁸ For Panovkin, it was potentially impossible to separate the historical development of language and science from its description of phenomena. Humanity's understanding of the rules and principles of the universe developed from its experience of humanity's immediate environment. If that experience can be generalized then other civilizations' science and mathematics were also historically contingent of their environment and their

¹⁰⁶"Consequences of Contact," in *CETI*, 346.

¹⁰⁷ W. H. McNeill, Department of History, University of Chicago, Chicago, Illinois.

¹⁰⁸ Carl Sagan, editor. *Communication with Extraterrestrial Intelligence (CETI)*. (Cambridge: M.I.T. Press, 1973), 340.

development of science. Ultimately, for Panovkin, science and mathematics was historically constructed through the symbolic language used to describe those concepts.

The issue of the ability of two civilizations to establish a common language that would allow them to communicate attracted much attention before and at the conference. Prior to the conference, a Dutch mathematician, Hans Frudenthal, had proposed a language which could potentially serve as a language for interstellar discourse.¹⁰⁹ Named Lincos, Frudenthal's language, was briefly mentioned as one method to establish an interstellar language, though many were skeptical of Frudenthal's claims. The attendees at the conference who thought that Panovkin's view was overly pessimistic argued that the presence of the message itself implied that there would be enough similarities between the two civilizations to establish communication. Oliver remarked that while he found McNeill's comments interested, he thought they were the result of, "an intelligent person who is not intimately acquainted with science and with the problem of interstellar communication." He would go on to say that these opinions potentially have "political significance".¹¹⁰ Oliver rejected the idea that a universal language cannot be established because of the issues that McNeill raised on the basis that he simply did not know enough about the issues at hand and that he was overestimated the difficulties of communication. However, while a case can certainly be made for an historian such as McNeill not being aware of the details and the development of the scientific conversation concerning ETI, it is important to note that the idea that science and mathematics might not be universal was not simply a position held by nonscientists within the group. Panovkin, himself, held a position on the Radioastronomical Council of the Soviet Academy of Sciences in

¹⁰⁹ Hans Frudenthal was not a participant at this conference.

¹¹⁰ "Message Content," in *CETI*, 347.

Moscow and was certainly much more versed in the technical details of ETI. The issue of the universality of science and mathematics was one of the more contentious issues at the 1971 CETI Conference. Not only was the issue important in the estimation of the probability that humanity could communicate with other civilizations, it pushed the attendees to rethink their conceptions of science and mathematics and its relationship to language.

“In order to study anything, we must, of course define it. In the case of CETI, we know nothing; we are forced, therefore, to make definitions. Engels said definitions do not of themselves mean anything in science. Nevertheless, they are essential.”¹¹¹ The 1971 CETI Conference brought together interested scholars from around the world to discuss issues pertaining to ETI. Unlike previous conversations about ETI, this group of scholars included a strong cohort of social scientists and was not limited by the nationalistic boundaries evident previously. Many attendees, including those who had previously been involved in ETI research, remarked that they had difficulty defining what were the precise boundaries of the issue they discussed. Like previous conversations, the attendees at the conference based their extrapolation on their conceptions of humanity as it was the only example of a technical civilization they had; however, this conference examined the middle terms of the Drake Equation, areas that had previously been left relatively unexplored. In order to have a conversation about these terms, the attendees had to define what they meant by intelligence, civilization, and technology.

These discussions employed the theories and methodologies of both the social sciences and the sciences in an effort to determine the key attributes of each of these

¹¹¹“Number of Advanced Galactic Civilizations,” in *CETI*, 182.

concepts. The results were often messy and unsettled, though the attendees agreed to some key characteristics. Intelligence was seen as synonymous with language and required a great deal of cooperation. Advanced technology was connected with the competitive impulse created by natural selection. Humanity, thusly, was characterized by tension between these two characteristics. However, they fundamentally disagreed about the nature of science and mathematics and, interestingly, this debate did not fall on the traditional disciplinary boundaries. While they came to no definitive conclusions about many of these issues, the questions that they were asking themselves touched upon profound issues of the nature of humanity and the universality of science and mathematics, a profundity that was not lost on the conference attendees.

Conclusion

During the 1960s, the Search for Extraterrestrial Intelligence found its beginnings in the disparate work of radio astronomers and theoretical physicists. By the time of its inclusion in the 1970s decadal survey, a multi-disciplinary international community had formed around SETI. This community pushed the field into new areas including discussions of politics, society, and the state of human affairs. They sought to explore the meanings of intelligence, life, and civilizations through the combination of scientific and social science research. Given the tremendous interest in and growth of SETI in the 1960s, its inclusion in the 1970s decadal survey comes as no surprise. The survey's section on the Search for Extraterrestrial Intelligence concluded with the following statement, "In the relatively near future we foresee the construction of major facilities, such as a giant radio receiving array, and the operation of a project that will have as its goal the detection of intelligent life elsewhere. In the long run this may be one of science's most important and most profound contribution to mankind and to our civilization."¹¹² However, that same survey's warning about the inability of the astronomical field to sustain support for such a project that did not produce immediate result proved far more prophetic than their optimistic vision of a large telescope dedicated to SETI.

Since the 1970s, SETI has retreated from a multi-disciplinary, international community to an astronomical research project that has been given little attention by leading astronomers and astrophysicists. While some small-scale SETI projects were

¹¹² *Astronomy and Astrophysics for the 1970s*, (Washington, D.C.: National Academy Press, 1972), 51-52.

conducted over the next few decades, no large-scale long-term SETI project has ever been undertaken. The 1980s decadal survey was far less optimistic about the prospects of SETI, going as far as to question the designation of SETI as scientific. In the same paragraph that recommended that a long-term SETI effort should be undertaken, the 1980s decadal survey stated that, “These questions reach far beyond astronomy, and even beyond science as we currently think of it.”¹¹³ Additionally, the types of questions that the 1980s decadal survey thought SETI would answer were far more circumscribed than the ones proposed in the 1970s survey. These questions returned to the early days of SETI’s focus on technical issues involved in contacting extraterrestrial civilizations including, “Have condensations to planets and the origin of life occurred elsewhere as well? And has that life evolved into communicative intelligence, with which we human beings might be able to enter a conversation about life in the Universe?”¹¹⁴ While questions about the existence of other planets and potential life on them have continued to intrigue both scientists and the public, exobiology/astrobiology and exoplanet studies have attracted far more sustained attention and funding than SETI. Successful results have certainly come easier to the fields of exobiology/astrobiology and exoplanet studies. However, the arguments made by scientists interested in SETI in the 1960s challenged this definition of success—arguments that were mostly ignored by the end of the 1970s.

During the 1960s, discussions concerning SETI mirrored the contentious nature of American science in the period. Space was just beginning to be explored and the nature of that exploration was contested and unsettled. SETI scientists, particularly those who

¹¹³ *Astronomy and Astrophysics for the 1980’s* (Washington, D.C.: National Academy Press, 1982), 91.

¹¹⁴ *Astronomy and Astrophysics for the 1980’s* (Washington, D.C.: National Academy Press, 1982), 91.

advocated publically for its undertaking, argued that if scientists did not steer the course of space sciences then space would become the latest battleground of the Cold War; the pattern of nuclear physics was not one that they wanted their work to follow. The relationship between nuclear physics and the federal government brought a great deal of theoretical and experimental advancements but scientists, including scientists interested in SETI, questioned whether these successes were worth the cost. These scientists questioned if the advancements of nuclear physics should be considered successes if they potentially placed the future of life on Earth in jeopardy—a valid and pressing concern at the time. Scientists interested in SETI presented a different definition of success. Their definition hinged on recognition of their relationship and responsibility to society. For SETI to be defined as a success, scientists, the government, and the public must see the value in long-term planning and searching for answers to the profound questions of human existence.

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