A HUMANITY 3000 KNOWLEDGE WORKSHOP

When SETI Succeeds:
The Impact of High-Information Contact

Edited by
Dr. Allen Tough

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Astronomical Images

Page i A portion of the Arecibo Observatory, Puerto Rico. *Photo courtesy of the NAIC - Arecibo Observatory, a facility of the NSF. Photo by Tony Acevedo.*
Page iii A cluster of brilliant, massive stars known as Hodge 301 in the Tarantula Nebula. *Image credit: Hubble Heritage Team (AURA/STScI/NASA).*
Page v The majestic spiral galaxy NGC 4414. *Image credit: Hubble Heritage Team (AURA/STScI/NASA).*
Page vii Apollo Command and Service Module.
Page ix Illustration of Carl Sagan with Hubble Space Telescope in background. *Artwork by Paul Hudson.*
Page xi Keck II (foreground) and Keck I (background) in Mauna Kea, Hawaii. *Photo copyright 1998, Richard Wainscoat.*
Page 1 Galaxy cluster Abell 2218. *Image credit: Andrew Fruchter (STScI) et al., WFPC2, HST, NASA.*
Page 7 Apollo 10 view of Earth rising above the lunar horizon.
Page 33 A portion of the International Space Station.
Page 41 South Candor Chasma on Mars. *Part of a mosaic made from images acquired by both of the Viking Orbiters.*
Page 69 Satellite image of Earth. *Digital imagery © copyright 2000 PhotoDisc, Inc.*
Page 175 A section of the Milky Way.

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Foundation For the Future

July 2000

Dear Readers:

What is the status of humanity's Search for Extraterrestrial Intelligence (SETI)? How and when might contact occur? What might we expect in terms of positive and negative impacts from that contact? In the following pages you will find the most current thinking concerning the likely long-term impact of a dialogue between humankind and extraterrestrial intelligence.

Scientists and scholars throughout the world have identified extraterrestrial intelligence as one of the critical factors expected to bear significantly on the long-term future of humanity. In summer 1999, the Foundation For the Future sponsored a seminar in Hawaii dedicated to furthering our understanding of likely cultural impacts of such contact.

We are very pleased to present this book, which provides a record and summation of the Hawaii seminar, as well as several insightful papers written by scholars who took part in those discussions. I hope you will enjoy reading their thoughtful conclusions.

Sincerely,

Walter P. Kistler
President and Benefactor

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Table of Contents

Introduction

Report on:

A SEMINAR ON THE CULTURAL IMPACT OF EXTRATERRESTRIAL CONTACT

July 31–August 1, 1999
Kamuela, Hawaii USA

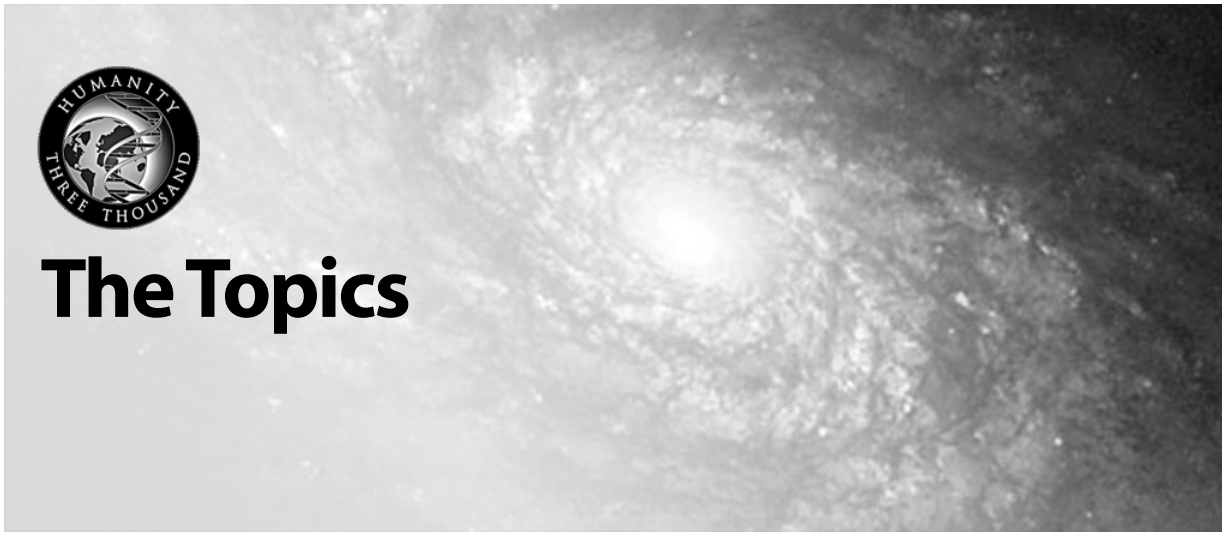
The Foundation For the Future is dedicated to the increase and diffusion of knowledge concerning the long-term future of humanity. In view of the likelihood that a key element of our future in the next thousand years will be contact with extraterrestrial intelligence, the Foundation—through the Knowledge Workshops of its Humanity 3000 program—sponsored a seminar in summer 1999 that brought together 16 participants with scholarly perspectives on the Search for Extraterrestrial Intelligence (SETI).

The seminar was organized and coordinated by Dr. Allen Tough, who has dedicated the past 20 years to research on ETI and the future of human civilization. Focused on long-range ramifications, the seminar emphasized the cultural impact several decades or centuries after dialogue between humankind and an extraterrestrial civilization commences. The seminar was held in conjunction with *Bioastronomy '99: A New Era in the Search for Life in the Universe*.

This report is called *When SETI Succeeds: The Impact of High-Information Contact*. It presents a comprehensive review of the potential impact that contact with a highly advanced intelligence will have on human civilization.

This report is rather unique in its format as well as its content. It is based partly on the ideas that emerged during the two-day seminar, and it includes brief written position statements that each participant brought to the seminar. But it also includes several powerful insights in additional in-depth papers written by several of the participants and by others.

This report, then, is neither a traditional seminar proceedings nor a traditional collection of papers. Instead, it combines the best features of both forms. In this way it provides fresh, lively insights into the long-term impact when SETI succeeds.



The Topics

Humanity's interaction with other civilizations in our galaxy is likely to have a greater impact for the long-term future of human civilization than virtually any other event in the current millennium.

This Humanity 3000 Knowledge Workshop focused on the potential impact of high-information contact with extraterrestrial intelligence in the following topic areas:

1. **Practical Information**
2. **Answers to Major Questions**
3. **Changes in Our View of Ourselves**
4. **Cooperation in Joint Galactic Projects**
5. **Significant Long-Term Effects That Are Primarily Negative**
6. **What Should Humanity Do Now to Maximize Positive Long-Term Impacts?**

The Participants

Ragbir Bhathal
University of Western Sydney

John Billingham
SETI Institute

Eric J. Chaisson
Tufts University

Bob Citron
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Kathleen Connell
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Paul Davies
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Steven J. Dick
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Ben Finney
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Albert A. Harrison
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Institute of Zen Studies

Allen Tough
University of Toronto

Douglas A. Vakoch
SETI Institute

Participant biographies are provided in Section VI.

Acknowledgements

Bob Citron, Executive Director, and Donna Hines, Deputy Director, Administration, from the Foundation For the Future, made the Hawaii seminar and this report possible. As a result of their constant encouragement and help, I found that organizing and chairing this seminar was a very happy experience.

Jill Tarter and I met with Bob Citron and Walter Kistler, founder and benefactor of the Foundation For the Future, in October 1998 (at the International Astronautical Congress in Melbourne) to work out a good fit between the core goals of the seminar and the core mission of the Foundation For the Future.

Karen Meech not only coordinated the logistics of the large Bioastronomy conference that followed our seminar, but also ensured that the Hapuna Beach Prince Hotel successfully met our seminar's needs. The participants enthusiastically agreed that the location and service were superb. Imagine meeting just steps from a sunlit courtyard for coffee breaks, and just a few more steps from the warm Pacific surf for after-hours recreation!

John Billingham prepared an immediate summary of the seminar for oral presentation at a plenary session of the Bioastronomy conference. The written version of his summary is included in this report.

Albert Harrison and Steven Dick prepared the superb document that forms the core of this report. They have captured all of the major ideas from the seminar papers and discussion, and have woven these together into a readable and informative chapter.

The inspiring and evocative cover painting by David Hines provides an excellent portal to the topic.

Congratulations to Jill Tarter for winning a box of Canadian maple sugar at the Hawaii seminar by being the first participant to figure out the source of this quotation: "If this discovery is confirmed, it will surely be one of the most stunning insights into the universe that science has ever uncovered. Its implications are as far-reaching and awe-inspiring as can be imagined. Even as it promises answers to some of our oldest questions, it poses still others even more fundamental." (Spoken by President Clinton after NASA's 1996 announcement of possible evidence of primitive microbial life in a rock from Mars, these words were also used in the movie *Contact*.)

Staff members of the Foundation For the Future responsible for the development and completion of this report include Jeff Holdsworth, Art Director; Jean Gilbertson, Publications Manager; Cathy Allen, Executive Assistant, and Ann Reid, Executive Assistant.

All of us appreciate the cooperation of the Astronomical Society of the Pacific, publisher of the proceedings for the much larger conference that immediately followed our seminar. That volume, edited by Guillermo Lemarchand and Karen Meech, is called *Bioastronomy '99: A New Era in Bioastronomy, Proceedings of a Conference held on the Kohala Coast, Hawaii, 2-6 August 1999*, ASP Conference Series 213.

Finally, I want to acknowledge the contributions of all of the seminar participants themselves. Their ideas provide the intellectual foundation for this report, and provide humanity with a fresh and profound understanding of just what sorts of impact might occur during the decades after human intelligence and extraterrestrial intelligence begin their dialogue.

Allen Tough
Seminar Coordinator

Overview

***Summarized below are the contents of each Section of the report,* When SETI Succeeds: The Impact of High-Information Contact.**

Section I, entitled "An Extraordinary Event," written by Seminar Coordinator Allen Tough, provides an introduction to SETI and to the six seminar topics.

Section II, entitled "Contact: Long-Term Implications for Humanity," by Albert A. Harrison and Steven J. Dick, is a comprehensive report on the seminar and a review of the SETI field, including the rationale and justification for the search, common assumptions about ETI, discussion of search outcomes, comments on the post-contact society, and what humanity's next steps should be.

Section III, entitled "Who Said What: A Summary and Eleven Conclusions," by John Billingham, captures the highlights of the seminar discussions addressing each of the key topics. This paper was presented by Billingham at the international conference *Bioastronomy '99: A New Era in the Search for Life in the Universe*, held at the same facilities in Hawaii immediately following the Humanity 3000 Knowledge Seminar on the Cultural Impact of Extraterrestrial Contact.

Section IV provides the one- to two-page statements written by participants before the seminar. Each statement addresses one of the key topics and served as a starting point for seminar dialogue.

Section V—"Powerful Insights: In-Depth Papers by Participants and Others"—is a collection of scholarly papers on important aspects of the search for extraterrestrial intelligence.

Section VI provides biographical information on the sixteen participants in the seminar.

Section I

An Extraordinary Event

Allen Tough

It is extremely unlikely that we are the only civilization in our galaxy. It may even contain dozens or hundreds of civilizations…

In recent years, scientists and the general public have realized that intelligent life may well be found throughout the universe. It is extremely unlikely that we are the only civilization in our galaxy. It may even contain dozens or hundreds of civilizations scattered among its 400,000,000,000 stars. If we receive a richly detailed message from one of these civilizations or engage in a lively dialogue, the effects on our civilization could be pervasive and profound.

Contact with intelligent life from somewhere else in our galaxy will probably occur sometime in humanity's future. It might take the form of a richly detailed radio or laser message from the distant civilization, for instance, or a super-intelligent probe that reaches our planet. Such contact might occur next year, or 20 or 30 years from now, or not for 100 years, or even longer.

Few events in the entire sweep of human history would be as significant and far-reaching, affecting our deepest beliefs about the nature of the universe, our place in it, and what lies ahead for human civilization. Seeking contact and preparing for successful interaction should be two of the top priorities on our civilization's current agenda.

Such contact will surely be an extraordinary event in all of human history. Over the next thousand years, several significant events will, no doubt, have a powerful, positive impact on human society. But making contact with another civilization will likely be the event with the highest positive impact of all.

A few hundred scientists, social scientists, artists, engineers, and technicians around the world are currently involved in the search for such contact—the search for extraterrestrial intelligence (SETI). This volume, *When SETI Succeeds*, examines the potential impact on human culture, science, philosophy, and society.

Any other civilizations in our galaxy are probably much older than human civilization. Two factors support this assumption. First, the vast majority of stars in our galaxy are much older than our Sun, many of them millions of years older. It follows, then, that any civilizations on planets revolving around those stars likely arose much earlier than our own civilization did. Second, it seems quite possible that some civilizations survive for a million years or even longer. If the civilizations in our galaxy range in age from a few thousand years up to a million years, then we are one of the youngest: by most definitions, human civilization is not much more than 10,000 years old.

Seeking contact and preparing for successful interaction should be two of the top priorities on our civilization's current agenda.

Because other civilizations in our galaxy are thousands of years older than human civilization, they have probably advanced in certain ways beyond our present level of development. Some civilizations pre-

sumably fail to survive once they discover nuclear weapons or other means of causing their own extinction, but surely others learn to cope successfully with such problems and then survive for a very long time. Some of them may be 100,000 years or even millions of years more advanced than we are (Tough, 1999).

A Comprehensive Report

When SETI Succeeds presents a comprehensive review of the potential impact that contact with a highly advanced intelligence will have on human civilization. This report is based partly on the insights of the various authors and on other literature. And it is based partly on the ideas that emerged during a unique two-day seminar in the summer of 1999.

That seminar, on the cultural impact of extraterrestrial contact, was generously sponsored by the Foundation For the Future because of its interest in the major factors that will affect human civilization over the next thousand years. Sixteen experts on the topic gathered together on the Kohala Coast of Hawaii's Big Island, just before the Bioastronomy '99 conference began at the same location.

This report, then, is neither a traditional "proceedings," nor a traditional review of the literature. Instead, it combines the best features of both forms. In this way it provides fresh, lively insights into the long-term impact when SETI succeeds.

SETI has not yet succeeded in detecting any repeatable evidence. But the range of strategies and the intensity of the efforts are growing rapidly, making success all the more likely in the next few decades. More than one strategy may succeed, of course, so that by the year 3000 we may well be engaged in dialogue with several different civilizations (or other forms of intelligence) that originated in various parts of our Milky Way galaxy.

The Focus: The Long-Term Perspective

Because of our society's focus on the immediate present and on the very short-term future, it is difficult to switch into a long-term perspective. As a result, most oral and printed discussions of contact focus on the immediate and short-term effects. In contrast, right from the beginning, my vision of this seminar emphasized the long-term perspective. As part of my responsibility for organizing the program and discussion, I prepared a set of instructions for the seminar participants, urging them to focus on the long-term effects of contact.

The short-term effects are likely to be chaotic, frenzied, unsettling…

Here are the exact words of those instructions:

The discussion will be sharply focused on the likely long-term impact of a dialogue between humankind and a highly advanced extraterrestrial civilization. Although the discussion will be fast-paced in an informal roll-up-our-sleeves working atmosphere, our time together is limited and therefore a sharply defined focus is necessary. Unfortunately we will not have time to discuss the short-term impact, the impact of detecting simply a dial tone with little other information, nor social science topics in general, but I hope other forums will be available for these topics. Long-term is emphasized because of the major differences between short-term and long-term effects of contact. The short-term effects are likely to be chaotic, frenzied, unsettling—perhaps marked by resistance and conflict, by extreme media reactions, and by political maneuvering or even warfare (military or covert). Although these effects are very important for the SETI field to study and prepare for, they are not the focus of this particular seminar. If handled well, presumably most of these short-term effects will fade within a few years. Our discussion here will focus on the potential effects on human civilization several decades or centuries after contact occurs.

High-Information Scenarios

If SETI succeeds, two types of contact are possible. One possibility is simply evidence that another advanced intelligence exists somewhere in the universe, with little information about its characteristics and no dialogue. One example is evidence of a Dyson sphere or some other major astroengineering project many light-years away, with no additional information about its creators. Another example is a radio message that arrives from many light-years away but is not successfully decoded even after many years of effort.

Because of recent progress in nanotechnology, artificial intelligence, and space exploration, we now realize that closeup contact with a small but super-smart probe is at least as likely a scenario.

The second possibility is contact that yields a rich storehouse of knowledge about the extraterrestrial intelligence and its history, technology, science, values, social organization, and so on. This could occur through an encyclopedic radio or optical message that we manage to decode. Because of recent progress in nanotechnology, artificial intelligence, and space exploration, we now realize that closeup contact with a small but super-smart probe is at least as likely a scenario. In fact, by monitoring our telecommunications, the probe will likely have learned our languages and be able to communicate with us quite effectively: no decoding necessary!

Since this seminar focused on contact as a high-impact event, my instructions to participants used the following words to emphasize high-information scenarios:

Because of the Foundation's interest in the factors that are especially likely to have a high impact on humanity, our discussion will assume that some sort of major information exchange or lively back-and-forth dialogue occurs between humans and some form of extraterrestrial intelligence. The particular scenario is not important in this seminar; it could be a rapidly translated encyclopedic message sent from 40 light-years away by radio or laser, for instance, or a small but extraordinarily intelligent probe sent by a civilization with technology 100,000 years ahead of ours. As Steve Dick noted in his Santa Cruz paper, "A 'dial tone' signal, only giving evidence of intelligence, will be quite different in impact from the decipherment of significant amounts of information" (Dick, 1995). We will, therefore, focus exclusively on the potential effects of high-information scenarios.

Viewing ourselves from an extraterrestrial perspective might be very useful in reducing our emphasis on differences and divisions among humans, and instead seeing ourselves as one human family.

The Long-Term Impact of Contact

This report examines five sorts of long-term consequences that could result from contact. To give you an overview before you read the next chapter, here is the core of each of the five.

1. Practical Information

We might well receive practical information and advice that helps our human civilization to survive and flourish. Possible examples include technology, transportation, a new form of energy, a new way of producing food or nourishing ourselves, a feasible solution to population growth, more effective governance and social organization, fresh views on values and ethics, and inspiration to shift direction dramatically in order to achieve a reasonably positive future. The message might also bring home to people the importance of eliminating warfare or at least eliminating weapons of extraordinary destruction. Viewing ourselves from an extraterrestrial perspective might be very useful in reducing our emphasis on differences and divisions among humans, and instead seeing ourselves as one human family.

2. Answers to Major Questions

We might gain new insights and knowledge about deep, major questions that go far beyond ordinary practical day-to-day matters. Topics in an encyclopedia-like message or closeup dialogue could include astrophysics, the origin and evolution of the universe, religious questions, the meaning and purpose of life, and answers to philosophical questions. We might receive detailed information about the other civilization (which might be deeply alien to us) and about its philosophies and beliefs. Similar information could be provided about several other civilizations throughout our galaxy, too. We might even receive a body of knowledge accumulated over the past billion years through contributions by dozens of civilizations throughout the galaxy.

What sorts of consequences will contact have for our religious ideas and institutions? Some religions may be deeply shaken by contact, or at least need to reexamine their set of beliefs. It seems clear, however, that humanity's religions have already flourished over many centuries despite a variety of scientific discoveries that conflict with religious views. And several religions have already incorporated the idea of extraterrestrial life. Although some religious leaders may denounce an extraterrestrial dialogue, most will surely embrace it as further evidence of God's infinite greatness.

3. Changes in Our View of Ourselves

Richly detailed information from an extraterrestrial civilization might transform our view of ourselves and our place in the universe, even our ultimate destination. We might gain a much deeper sense of ourselves as part of intelligent life and evolving culture throughout the universe—or at least part of a galactic family of civilizations. We might develop a deeper sense of meaning and connectedness to a universe filled with biology and intelligence. A new cosmotheology or global/cosmic ethic might arise, or a powerful secular movement of altruistic service to the universe and its long-term flourishing. Later in this volume, Steven Dick's paper discusses that theme.

Michael Michaud pointed out 22 years ago that "contact would be immensely broadening and deprovincializing. It would be a quantum jump in our awareness of things outside ourselves. It would change our criteria of what matters. We would have to think in interstellar, even galactic frames of reference. We would leave the era of Earth history, and enter an era of cosmic history" (Michaud, 1977).

In *The SETI Factor*, Frank White raised the possibility that SETI "may be an effort to achieve a new kind of connection with the universe, working within the framework that is acceptable to the Western scientific model. Perhaps SETI is an acceptable way for us to seek that reintegration, a feeling of connectedness which has been shattered by standing apart from the cosmos and examining it as something that is not alive, not intelligent, and separate from ourselves" (White, 1990).

4. Cooperation in Joint Galactic Projects

We might eventually play a role in some grand galactic project in art, science, philosophy, or philanthropy. Such projects might aim to solve fundamental mysteries of the universe, help other civilizations develop and flourish, or spread harmonious intelligent life throughout the galaxy.

In *The Extraterrestrial Encyclopedia*, Joseph Angelo has noted that contact "might lead to the development of branches of art and science that simply cannot be undertaken by just one planetary civilization but rather require joint, multiple-civilization participation across interstellar distances. Perhaps the very survival and salvation of the human race depends on finding ourselves cast in a larger cosmic role—a role far greater in significance than any human can now imagine" (Angelo, 1985).

Massive and rapid change could occur in the sciences…in business and industry…in the legal system…in the armed forces…

5. Long-term Negative Effects

If we incorporate extraterrestrial knowledge and advice into our human society, we may experience severe disruption, at least for a short time. We might suffer from enormous culture shock, temporarily feel inferior, or lose confidence in our own culture. Massive and rapid change could occur in the sciences if extraterrestrial science is deeply different, in business and industry if we learn about new processes and products, in the legal system if we move toward cosmic or universal laws, and in the armed forces and their suppliers if we eliminate the threat of war. Probably all of this should be regarded as simply the major cost we have to pay for incorporating new knowledge and possibilities. But will the short-term chaos and conflict be so severe that the negative consequences continue for decades or centuries?

Will our human culture (and even our genes) be obliterated by a more advanced civilization?

Will our science or philosophy "lose its nerve" when faced with far superior knowledge, and permanently retreat into trivia or resistance rather than embracing the new?

What other sorts of negative effects might be profound and long lasting?

What should humanity do now in order to maximize the positive long-term impact from an eventual dialogue…

What Next?

After exploring those five sorts of impact, the seminar participants turned to the question of "What next?" in their final session together. What should humanity do *now* in order to maximize the positive long-term impact from an eventual dialogue—in order to achieve the greatest possible benefits for our culture, science, worldview, and long-term future?

For me personally, the highlight of the seminar occurred during the exploration of this topic when Keiko Tokunaga, a young Buddhist priest, brought a fresh perspective to the discussion. Emphasizing the personal level, she gently pointed out the need for all of us to become better prepared for contact with an alien intelligence. Our own personal growth could

enable us to be more sensitive to the signals that we may be inadvertently sending out to extraterrestrial intelligence, for instance, and to reduce our ego and our defenses so that we become truly open to contact with something so alien—truly warm, welcoming, receptive, compassionate, and centered rather than scared or defensive or hostile.

With strength, courage, and a touch of whimsy, Keiko Tokunaga pointed out that perhaps some people in the room were already having the experience of being in contact with an alien—her! "Perhaps some of you respond to me as an alien, because I am not in your world of science or philosophy. Perhaps you look at me as some kind of another being, especially the way that I am dressed [as a Buddhist priest]. Your encounter here with me may be similar in some ways to your eventual encounter with ETI, whenever and wherever that occurs."

When asked what next steps I recommend in order to understand and prepare for the impact of contact, I always make three suggestions.

One, we need more research (focus groups and in-depth surveys, for instance) to understand the likely reactions of various cultural and religious groups in our society. Even raw data can be highly useful. For example, it is very instructive to read the verbatim responses of various religious leaders to Victoria Alexander's survey at http://www.accessnv.com/nids/articles/alexander/response_analysis.html.

Two, we need additional seminars to build on the results of the Hawaii seminar. As this report demonstrates, that seminar made a significant contribution to our understanding of the likely long-term impact of contact. But more thinking and discussion are clearly needed in order to reach a deeper and more cohesive understanding. In addition to the 1999 Hawaii seminar, three 1991–92 meetings on the cultural aspects of SETI provided a useful foundation for further thought. Those earlier meetings focused on SETI and history, human responses to contact, policy issues, and possible relationships between SETI and education, news, and entertainment (Billingham and others, 1994).

…prepare to communicate and negotiate with ETI in a friendly and cooperative manner, even if its behavior seems unfriendly.

Third, we need workshops that use role-playing to immerse the participants in the experience of contact. I experienced one useful model for such a workshop just two weeks before the Hawaii seminar. Called the second "Contact Planning" meeting and held in Denver, Colorado, this workshop was sponsored by the International Space Sciences Organization and organized by Kyle Pickford and Michael Lindemann. For me, there were three personal highlights. (1) The 23 participants offered a fascinating mix of backgrounds, beliefs, and competencies, but all became enthusiastically involved with the effort to anticipate just what might happen during the hours and days after contact with ETI. It was quite an experience to spend 48 hours immersed in contact! (2) We spent one afternoon in five groups: business, religion, science, government, and media/public. Each group role-played its behavior for each of eight scenarios. Although I have read lots of literature on post-contact behavior, this was the first time that I deeply grasped just how people in each of those categories may actually behave right after contact. Very sobering. (3) What can we do now to prepare? We spent the last few hours of the meeting generating and clustering various strategic planning possibilities. A large number of these ideas clearly fit into two clusters that I find very encouraging: (a) tell the general public the truth right away and (b) prepare to communicate and negotiate with ETI in a friendly and cooperative manner, even if its behavior seems unfriendly.

An Extraordinary Event

Each participant of the 1999 Hawaii seminar chose and thought about one of the six topics outlined above, and then summarized any resulting insights in a one- or two-page handout. When the seminar discussion reached that topic, we all took a few minutes to read the handout and then its author expanded on it. This procedure gave us a quick but thoughtful foundation for our discussion of each topic. The handouts are included in this report, along with the biographical sheet that each participant prepared.

During the past few years, the scientific search for extraterrestrial intelligence has become quite mainstream within science. Several strategies have already been implemented and more are being considered (Tough, 1999). Public interest is high. It now seems quite possible that our first contact with another civilization will occur within the next few decades. This first contact will, in turn, lead to redoubled efforts using a variety of strategies to achieve contact with additional civilizations.

Of all the positive events that occur during the next thousand years, this surely will have the most profound and pervasive impact on human civilization. It truly will be an extraordinary event.

References

Joseph A. Angelo, Jr. *The Extraterrestrial Encyclopedia: Our Search for Life in Outer Space*. New York: Facts on File, 1985.

John Billingham, **Roger Heyns**, **David Milne**, **Stephen Doyle**, **Michael Klein**, **John Heilbron**, **Michael Ashkenazi**, **Michael Michaud**, **Julie Lutz**, and **Seth Shostak** (editors). *Social Implications of the Detection of an Extraterrestrial Civilization*. Mountain View, California: SETI Press, 1994 (slightly revised 1999).

Steven J. Dick. "Consequences of Success in SETI: Lessons from the History of Science." In **G. Seth Shostak** (editor), *Progress in the Search for Extraterrestrial Life*. ASP Conference Series, Volume 74, 1995.

Michael A. G. Michaud. "The Consequences of Contact." *AIAA Student Journal*, Winter 1977-1978: 18-23.

Allen Tough. "The Array of Search Strategies." Paper IAA-99-IAA.9.1.06 presented at the 50th International Astronautical Congress, Amsterdam, October 1999. Revised version is included in this volume. Also available at http://members.aol.com/AllenTough/strategies.html.

Frank White. *The SETI Factor: How the Search for Extraterrestrial Intelligence Is Changing Our View of the Universe and Ourselves*. New York: Walker, 1990.

Section II

Contact: Long-Term Implications for Humanity

If extraterrestrial intelligence exists…its discovery may not be so much of a "wild card" as a high probability —perhaps inevitable—event.

Albert A. Harrison
University of California, Davis

During the next millennium we may not only establish a permanent human presence throughout our solar system, but also begin interstellar migration.

Steven J. Dick
United States Naval Observatory

INTRODUCTION

Confirmation of the existence of extraterrestrial intelligence (ETI) is one of the major scientific discoveries that could instantly alter the course of society and have profound cumulative effects on humanity for all time. Confirmation has yet to occur, but changing views of the universe, a parade of scientific discoveries, and themes in popular culture have led to the widespread belief that "we are not alone." Many people expect that some day we will find incontrovertible evidence of intelligent extraterrestrial life.

Since earliest recorded history, humans have wondered about the possibility of intelligent life among the stars (Dick, 1982). Only in recent centuries, however, have we been able to pursue this problem with the sophisticated techniques required (Crowe, 1986, 1994; Dick, 1996; Guthke, 1990; Shostak, 1998). In the 17th through 19th centuries, theory and observation indicated that the same physical laws apply in all places and at all times. In the 20th century, growing evidence pointed to the conclusion that the laws of biology are universal also. If this is so, then life, including intelligent life, may have evolved in nearby solar systems.

As we attempt to forecast humanity's long-term future, the possibility of contact between human and extraterrestrial intelligence requires careful thought. Australian astronomer Ray Norris (1998) points out that our ability to conduct radio telescope searches continues to increase dramatically, and estimates a 50–50 chance of a confirmed detection within the next ten years. This estimate is based on only one of many possible search strategies. If extraterrestrial intelligence exists, given a thousand-year time perspective and burgeoning technology, its discovery may not be so much of a "wild card" as a high probability—perhaps inevitable—event.

The scientists who formulated SETI, the scientific search for extraterrestrial intelligence, were keenly interested in how people would react to "contact," or incontrovertible evidence that we are not alone in the universe (Finney, 1999; Morrison, Billingham, and Wolfe, 1977; Swift, 1990). Most past discussions of the impact of contact (Berenzden, 1973; Billingham et al., 1999; Harrison, 1997; Morrison et al., 1977; US Congress, 1961) were predicated on the microwave search strategy, and emphasized people's initial reactions to the discovery of extraterrestrial life.

The present essay extends this tradition. Based on a symposium sponsored by the Foundation For the Future on the Island of Hawaii in July 1999, our essay draws heavily on the ideas of the participants as well as on the literature that we cite. In keeping with the goals and objectives of the Foundation, our discussion encompasses a range of search strategies, and emphasizes the long-term consequences: how contact with a communicative civilization might shape humanity over the next thousand years.

Rationale and Justification for the Search

Estimates of the number of extraterrestrial civilizations in our galaxy rest upon an elegant but simple heuristic known as the Drake Equation. This states that the number of extraterrestrial civilizations existing simultaneously with our own depends upon a combination of physical, biological, and social variables (Drake and Sobel, 1992). These are the number of suitable stars in our galaxy, the fraction of those stars that have planets, the fraction of those planets that give rise to life, the fraction of life forms that evolve into technologically advanced civilizations, and finally the average longevity of advanced civilizations. (Longevity is important because it affects the chances that civilizations will exist simultaneously.)

In essence, as we proceed through the Drake Equation we eliminate sites that do not host extraterrestrial civilizations that coincide with our own. People who desire a positive search outcome hope that despite the many points for elimination, the resulting number of civilizations will be large. Since Drake formulated his equation in 1961, almost all findings support the "many inhabited worlds" hypothesis. These include discoveries that planets are common rather than rare in other solar systems (Croswell, 1997; Goldsmith, 1997; Marcy and Butler, 1998; Marcy et al., 1999); that complex organic molecules are commonly found in comets and in giant clouds where stars and planets form; and that the initiation of life may be a "cosmic imperative" that depends upon reliable principles of self-organization rather than nearly impossible chance events (Davies, 1998; de Duve, 1995; Kauffman, 1995). As suggested by the evaporation of the Cold War, societies may survive their own technological adolescence and achieve very old age with the result that many advanced societies exist at the present time. Despite growing circumstantial evidence, we have yet to confirm the existence of any extraterrestrial life.

There are strong justifications for continuing, indeed accelerating, the search. Professional astronomers have, in essence, a commission to keep an eye on the universe. Even as astronomers are obliged to inventory stars and the rest of the physical universe, they must now join with a variety of other disciplines to survey the biological universe (Dick, 1996). Their responsibilities include looking for evidence of cosmic life in all of its forms, ranging from fossilized single-celled organisms through technologically advanced civilizations.

During the next millennium we may not only establish a permanent human presence throughout our solar system, but also begin interstellar migration. As we prepare to move beyond our solar system over the next few centuries, it will be essential to understand the nature and distribution of life within our part of the galactic neighborhood.

Depending on what we find, our discoveries could be crucial for averting disasters ranging from back-contamination and disease through conflict with extraterrestrial spacefarers. The sheer discovery of any form of life would have profound effects on philosophy, science, and religion. The ability to communicate freely with a technologically and perhaps spiritually advanced civilization would intensify and augment those effects, altering our culture in both straightforward and subtle ways.

As we look to the distant future, we should realize that the dominant microwave search strategy is only one way that we could discover extraterrestrial life (Tough, 1999). At some point we may switch to active SETI (sending encoded signals rather than passively receiving them), or major advances in such areas as transportation and communication may give rise to new search strategies. New scientific discoveries could generate scientific interest in strategies (such as UFO studies) that are now largely discredited or, like planetary archaeology, seem unlikely to work. We must even be open to the possibility that contact has occurred in the past and we are living with the consequences of this contact. Right now, not one of these strategies has yielded scientific proof.

At the conceptual level, our search for extraterrestrial life is based on a hunger for knowledge and a desire to find new purpose in the universe.

At the conceptual level, our search for extraterrestrial life is based on a hunger for knowledge and a desire to find new purpose in the universe. At the procedural level, our search depends upon our current understanding of interstellar travel and communication and the technologies that are available to us. While we may expect interest in ETI to persist, we can expect search strategies and technologies to change, and with these the nature of the post-contact world.

Common Assumptions about ETI

Despite widespread expectations that the discovery of ETI will have an enormous impact on humanity in AD 3000, only with very broad strokes can we paint a picture of the future. The consequences of contact for our descendants will depend upon the nature of ETI culture; the specifics of the contact scenario; and human psychology, institutions, and cultures.

Perhaps the greatest deterrent to accurate predictions is that since scientists have yet to observe ETI we can only guess what it will be like. Furthermore, attempts to make such guesses are fraught with hazard. We are sensitive to cross-species and cross-cultural variability on Earth. How much greater could this variability be if we were to extend our observations to biological entities whose genetic and cultural backgrounds have nothing in common with our own? Another risk is our tendency to anthropomorphize, that is, wrongly impute human characteristics to nonhumans and even inanimate objects. There are many hypotheses about ETI, but until we actually make contact, we will not know which (if any) of these hypotheses are correct.

There are at least three ways that these hypotheses have come about. Some reflect a process called *imaginative production* and express human wishes and fears. Imaginative production is evident in preconceptions of benevolent space brothers arriving to solve Earth's problems, and in evil space invaders who want to take over our planet. Some of these images are contemporary renditions of the angels and devils that people have imagined since much earlier times (Thompson, 1991). These images can be very powerful and have been used to good effect in science fiction (Billingham et al., 1999). Michael Michaud eloquently expressed the role of psychological factors in our thinking about ETI:

In our thinking about alien intelligence, we reveal ourselves. We are variously hostile, intolerant, hopeful, naïve: influenced by science fiction, we see the aliens as implacable, grotesque conquerors, or as benign, altruistic teachers who can save us from ourselves. Usually we think of them as superior to us in some way: either their miraculous but malevolently applied technology must be overcome by simpler virtues, or we must accept them as gods who will raise humanity from its fallen condition. Here we display fear, insecurity, wishful thinking, defeatism, even self-loathing, everything but the calm maturity appropriate for our emergence into the galactic community. We are not ready (Michaud, 1974, 33).

Reverse engineering is a second process that generates expectations about ETI. We begin by acknowledging that ETI *could* be almost anything: a giant gas bag, creatures reminiscent of those portrayed in *Alien* or *Star Wars* movies—perhaps even free-floating consciousness. However, we then note that our search procedures will not lead us to all conceivable life forms, only a small subset—such as life forms that transmit microwaves. Once these constraints are in place, we can infer what ET "must" be like, just as we might make an inference about an automobile engine on the basis of its acceleration and top speed. Compared to the process of imaginative production, which is almost entirely emotional, reverse engineering has elements of rationality and logic.

Neither reverse engineering nor the search for universal principles of behavior can give us more than an educated guess about ETI…

Universal principles of behavior are the third avenue to generating hypotheses about ETI. If successive discoveries imply universal principles in the physical and biological sciences, it is conceivable that there are universal principles in the behavioral sciences also (Harrison, 1993, 1997). Perhaps there are deep laws of individual and social behavior that hold true for all species, all times, and all cultures. If so, our knowledge of biological and social entities on Earth gives us a starting place for organizing our thinking about intelligent life elsewhere. Although Earth is only one case, nested within it is a multitude of examples—millions of species, thousands of cultures, hundreds of nations spanning a written history extending back over 5,000 years. Neither reverse

engineering nor the search for universal principles of behavior can give us more than an educated guess about ETI, but they help move us beyond the sheer fantasy of imaginative productions.

What are the chances that we could identify, never mind understand, such a society? It might be much easier for prehistoric man to grasp cellular telephones, computers, lasers, and jet transports.

Perhaps the most common expectation is that ET civilizations will be technologically advanced (White, 1990). Given present search procedures, we are unlikely to encounter a civilization that is below our current technological level, since such a civilization is unlikely to use powerful radios, engage in space travel, or undertake other activities that we can detect. It seems statistically unlikely that we would encounter a civilization that is exactly at our level of technological maturity; hence, we expect to encounter civilizations that, compared to us, are technologically advanced. Astronomer Ray Norris (1998) calculates that the average civilization may be *two billion years* older than our own. Human experience suggests that technological advances accelerate over time; we have seen more technological advances during the last one hundred years than in the preceding two million years. What are the chances that we could identify, never mind understand, such a society? It might be much easier for prehistoric man to grasp cellular telephones, computers, lasers, and jet transports.

In our attempts to envision ETI science and technology we must be wary of slipping from science to science fiction. As we look into the future, we should ask if our projection conflicts with known theories and facts. Years of conditioning by science fiction may lead us to expect technologies that are not only beyond our own current grasp, but are forever beyond anyone's grasp.

We should distinguish between technologies that are possible in principle (but beyond our current engineering capabilities) and those that conflict with known laws of physics. For example, at the turn of the 20th century there was no scientific principle that precluded humans from flying beyond the speed of sound, but 50 years had to pass before we had the necessary technology. Similarly, it may be possible in principle to construct a wormhole to facilitate travel between remote parts of the universe, but it is currently beyond our capability to do this. Or, we may be able to alter the perception of the passage of time through space travel at relativistic speeds, but never exceed the speed of light.

There are two ways by which technology that currently strikes us as impossible may become available to an advanced civilization or to ourselves later on. One possibility is that as we continue to collect and refine data, seemingly impossible technologies will prove consistent with our current laws of nature (Haisch, Rueda, and Puthoff, 1998). The other possibility is that our current scientific framework is faulty or incomplete. True, science has progressed rapidly during the past century or two, but another two billion years or so would leave ample time for improvement. Past discoveries took us beyond Newtonian dynamics to relativity. Will future discoveries take us beyond relativity? We must walk a fine line here. On the one hand, we must avoid assumptions that confuse the public about such matters as interstellar or time travel, or divert our attention from proven options. On the other hand, we would do well to remember the overworked patent officer who, at the turn of the 20th century commented that everything that could be patented had been patented.

Another expectation is that ETI will be prosperous. This extrapolation is based on the association between technological development and quality of life on Earth. Despite millions of hungry people, the average person, at least in technologically advanced societies, eats better and lives better than his or her ancestors, even 50 years ago (Berry, 1996). The amount of discretionary income—that is, money not required for subsistence—has risen steadily to approximately 40 percent and will rise further in the first decades of our new millennium. The ability to tap the immense resources of space should contribute to ET's wealth.

Many people expect ET to have full control of its technology, show sensitivity to its environment and…to be peaceful.

A third common assumption is that ETI's civilization will be stable. It will not have succumbed to runaway technology, environmental disasters, or war. Many people expect ET to have full control of its technology, show sensitivity to its environment, and, as we shall see, to be peaceful.

Another common assumption is that extraterrestrial societies will be willing to share information with Earth. Giovanni Vulpetti suggests that acting

under a cosmic imperative, intelligent and self-aware societies will explore the universe. As a part of the natural course of social evolution, such societies will feel compelled to diffuse high-level life outside of the areas where they originated (Vulpetti, 1998). Allen Tough points out that interactive communication would allow ETI to satisfy its own curiosity, especially in the humanities and social sciences where it may be interested in comparative data (Tough, 1998b). An outward orientation would allow ETI to detect potential dangers (such as astrobiological hazards, war-like societies, and problematic alliances), and form collaborative partnerships (Tough, 1998). Moreover, ETI may be willing to share information in order to perpetuate its values and endow its ideas with a degree of immortality (Harrison, 1993, 1997). Historical precedents on Earth show that there is no guarantee that a technologically advanced society would reach outward (Matloff, Schenkel, and Marchan, 1999), but SETI social scientists find many reasons that ETI will be forthcoming.

Perhaps some ETI societies will be interested in sharing their ideas and others won't. It is the former societies that would help shape humanity in 3000, and it is the former societies that are likely to aggregate into a large supranational entity known informally as a Galactic Club (Bracewell, 1975).

OVERVIEW OF SEARCH OUTCOMES

One thousand years from now the Search for Extraterrestrial Intelligence will be associated with one of three outcomes. These are: (1) no evidence of extraterrestrial intelligence, (2) confirmation of the existence of extraterrestrial intelligence but with little or no additional information, and (3) confirmation of the existence of extraterrestrial intelligence coupled with significant, perhaps rich and detailed information about our interstellar neighbors. Under the third outcome, we may have entered into interactive communication and perhaps earned membership in the Galactic Club.

If we view these outcomes as sequential stages, right now we are 40 years into Stage 1 (no evidence of extraterrestrial intelligence). We do not know if and when we will enter Stage 2, or how long we would remain in Stage 2 before entering Stage 3, or even if we will enter Stage 2 before entering Stage 3 (which could occur if our initial contact is with a member of the Galactic Club). A thousand years from now, we could be at any stage of the search process.

If the search continues for centuries, perhaps to the dawn of the next millennium, then we will live with the implication that we are alone in the universe.

No Confirmation

If the search continues for centuries, perhaps to the dawn of the next millennium, then we will live with the implication that we are alone in the universe. We will conclude that the circumstantial evidence assembled during the 20th century was misleading. Ben Finney suggests that if we do not find ETI, we ourselves may be encouraged to spread the universe with intelligent life:

However sobering [no confirmation would be] for cosmic evolutionists, those interested in human space expansion would certainly take the apparent absence of extraterrestrials in our galactic neighborhood as a green light for humanity spreading throughout that region. Let us further imagine that through learning how to settle in and around various planets and smaller bodies of our solar system and the development of powerful space drives and multigeneration spaceships, humans would eventually be able to migrate to nearby star systems and found viable communities there. Then frustrated would-be students of independently evolved extraterrestrials would have the opportunity to study how our descendants evolve culturally and biologically as they scatter through space… (Finney, 1999)

Would we ever concede that we are alone in the universe? Given that beliefs in extraterrestrial life have persevered for centuries, it is doubtful that all citizens of our solar system would accept this conclusion. As new generations are born, as new search rationales are developed, and as new search technologies come on line we might expect sporadic searches into the indefinite future.

…a standard SETI detection scenario: our interception of a carrier wave or "dial tone" from somewhere else in the galaxy.

Confirmation

At the end of a thousand years, we may have detected unequivocal evidence of ETI but have few or no additional details. This is a standard SETI detection scenario: our interception of a carrier wave or "dial tone" from somewhere else in the galaxy. Another way that unadorned confirmation could come about

is through some types of optical detections: for example, patterns of energy use suggestive of a Type III civilization (Kardashev, 1964) or of an interstellar rocket exhaust. Or, we could discover an alien probe or artifact that we could not understand.

Maybe we will intercept a communication that has high information content but that is indecipherable to us. Given that our two civilizations may be separated by millions of years of evolution, translation and interpretation could be very difficult. Perhaps whole careers and institutes will be devoted to these processes, but with very little progress and very little impact on our descendants' daily lives. How well could we communicate with humanity of the year 3000, much less with even more advanced beings from entirely different genetic and cultural backgrounds?

There may be ethical as well as linguistic barriers to communication. Among the many reasons listed for our current "absence of evidence" are that ETI civilizations consider it unethical to alter the course of a developing civilization, or consider it desirable to preserve some civilizations for future study (Ball, 1973). Our ability to learn from ETI may depend on their perception of our readiness to acquire advanced information or to meet entrance-level requirements for the Galactic Club. We must be prepared for the possibility that we are not considered worth talking to, or that we will receive limited information that does not put the continuity of our physical, scientific, and moral evolution at risk.

Despite the fact that we may have little or no information beyond knowledge that the other civilization exists, confirmation would have two profound implications. First, it would tell us that we are not alone in the universe, that the rise of intelligent life is not a unique event. This, by itself, could have a major impact on our philosophy, science, religion, and views of ourselves. Second, confirmation would tell us that civilizations can survive their period of technological adolescence and achieve a level of technology that makes interstellar communication possible. It would strengthen hope that we can work our way through population growth, environmental decline, war, and the other threats that cloud humanity's future.

Perhaps a probe that has been studying us for years will know our language and communicate immediately in forthcoming and detailed ways.

Confirmation and Information Exchange

Instead of an information-poor "dial tone" type of signal, we might receive an "information-rich" signal that is easily understood by us. Earth's first contact might be with a highly experienced civilization that has procedures for communicating with civilizations such as our own. Perhaps they will teach us a universal language, or send a multilayered communication that includes different levels of complexity geared to different recipients. Perhaps a probe that has been studying us for years will know our language and communicate immediately in forthcoming and detailed ways.

If first contact is relatively uninformative, we will not be content with the sheer fact that we share the universe; we will work very hard to learn more. As a result of many years of hard work, we may partially if not fully decode the information. Discovery of life of any type, ranging from an indisputable fossil on Mars to a distant Type III civilization, would accelerate the search process and perhaps lead to the detection of different civilizations with which we could communicate. ETI encountered late in the search process may help us communicate with otherwise mysterious civilizations that we had detected earlier. In a thousand years, we may have considerable knowledge of many different extraterrestrial life forms and cultures.

On the whole, our ability to enter into a rich and varied dialogue with ET will depend on several factors. One will be the availability of interactive communication technologies such as translating supercomputers. Presumably it will be easier to communicate with a probe that is already within our solar system, or with a civilization that has communication technology that exceeds the speed of light, than with a civilization whose messages take years to reach us.

Ultimately, our ability to enter into full interactive communication will depend on our respective similarities and differences. ETI's information-processing capacities may be so great that we cannot keep up. Given an objective reality, humans and ETI may have such different sensory and information-processing systems that they evolve contrasting conceptions of reality. If reality is socially constructed, or in

the eye of the beholder, the lack of a common reference point may make it impossible to communicate.

At the heart of the matter is shared knowledge. Possibilities include a complete overlap in knowledge (Case 1), partial overlap in knowledge (Case 2), and no overlap in knowledge (Case 3). It will be increasingly difficult to communicate as we decrease the proportion of shared knowledge. We tend to assume Case 1 or Case 2, perhaps because if Case 3 proves true, communication would be impossible. We have already encountered many situations that fall within the very broad Case 2 category (for example, when cultural and linguistic barriers make it difficult to communicate with someone from another society) and even some Case 3 situations (for example, certain dead languages, and people whose pathological states make it impossible for them to communicate verbally).

It may be that we would uncover important differences, if, for example, they had difficulty explaining to us their concepts of space and time.

If and when we try to communicate with ETI, we may believe our dialogue is based on objective reality. Yet our "understanding" may be based more heavily on our own culture, on our collective unconscious, or on other sources that are shared by humans but have little or no basis in ETI's construal of the universe. A test "conversation" might be necessary to determine if our two societies have similar epistemologies or "ways of knowing." It may be that we would uncover important differences, if, for example, they had difficulty explaining to us their concepts of space and time. This should make us very wary of the possibility of further communication. Or, maybe each species can see only a tiny slice of reality; trying to communicate by sharing different "slices" of reality could be frustrating and confusing. If their message originates from very far away, we will learn about their past, not their current circumstances. If information arrives via a probe, our understanding may be based on a time capsule from a long-dead civilization.

If we are lucky, we will not be stymied by such problems. If we are unlucky, humanity in 3000 may have had as much as a thousand years to work around them. At the dawn of the Third Millennium, if multiple contacts have occurred, humanity's primary task may be to synthesize the knowledge of many worlds. This itself raises some interesting questions, given our problems integrating terrestrial knowledge in our current information age.

POST-CONTACT SOCIETY

Short-term effects of contact will be measured in days, weeks, and months. Long-term effects will be measured in decades, centuries, and perhaps millennia. Short-term effects will be evident in sharp and intense focus in the media, organizations scrambling to redefine themselves and cope with a new reality, and collective behavior. Long-term effects could permeate all aspects of our culture and its institutions. Yet we should not take "an assumption of maximum impact" (White, 1990) for granted, because major scientific discoveries have not necessarily impacted average people who are grappling with the problems of everyday life. It may be that the only people who are really interested are academics and the intellectual descendants of those who are now involved in SETI.

If contact is delayed for centuries, it will impact people who may be very different from us. Recent years have seen enormous changes in philosophy, science, and popular beliefs. Certainly, we expect that, compared to people who believed that the Sun circles the Earth, who never heard of evolution, and who never read science fiction, the people of today would respond very differently to ETI. Similarly, the people of tomorrow may have values, interests, and technologies that differ substantially from our own and for this reason react to ETI in ways that we cannot imagine.

According to Freeman Dyson, on a time scale of a thousand years, we can predict neither technology nor politics (Dyson, 1997). He expects that a thousand years from now, there will still be a diversity of languages, cultures, and religions. Humanity's migration to the high frontier will make it possible to preserve, even expand diversity—in essence, vast physical distances among populations will prevent conflict among very dissimilar peoples. Both natural selection and genetic engineering will increase the genetic differences among people, and will have initiated the process of speciation, the division of our species into many varieties.

Dyson adds that the human population (broadly defined) will reach staggering size. Our current two percent per year growth could continue if we spread out within the solar system. By his calculations, this rate of growth, over a thousand years, would

"increase our population and resources and living space by a factor of five hundred million" and there would still be ample reserves for continued growth.

A thousand years from now, first contact with new extraterrestrial civilizations could occur so regularly as to evoke little notice…

Long before that time, we will be capable of modifying our bodies, our own existence. The human genome will be completely mapped. There will be a meld of biotic and abiotic parts, creating organisms endowed with the capacity to thrive in the current lethal and improvident environments of outer space. Bioengineered hybrids may set forth on interstellar flights or undertake new kinds of searches for extraterrestrial life. A thousand years from now, first contact with new extraterrestrial civilizations could occur so regularly as to evoke little notice, apart from latter-day anthropologists and government bureaucrats.

ETI's impact on us will depend on the specific scenario that reveals ETI's presence. The interception of an impersonal broadcast from a neighboring galaxy will have less effect than the discovery of a probe within our solar system. Low-level electromagnetic communication could have very little effect on us because of the steady stream of terrestrial global problems inevitably confronting humankind.

In a recent discussion of astrobiology and SETI, Harrison proposed a fourfold classification system for detection scenarios (Harrison, 1999b). He began by noting that the NASA Astrobiology Program and SETI share interests in life in the universe, but that there are also important differences. Astrobiologists lean heavily towards the preliminary terms in the Drake Equation (stars, planets, habitability, initiation of life) and tend to search for life's precursors and for simple forms of life within our solar system. SETI scientists' interests extend to the final terms of the Drake Equation (evolution of intelligence, longevity) and seek advanced technological civilizations elsewhere in the galaxy. Thus, astrobiology and SETI differ along two major dimensions: where they concentrate their search (within or outside of our solar system) and the level or complexity of the living system that they seek (simple or complex). Combining the two levels of the two dimensions that differentiate astrobiology and SETI yields four detection scenarios. These were assigned the working titles of *Distant Dust* (distal and simple), *Microbes on Mars* (proximal and simple), *ET Calling* (distal and complex), and *Space Visitors* (proximal and complex). This classification captures the weakest possible case (evidence of life's precursors in distant galaxies) and the strongest possible case (robot probes, UFOs, and extraterrestrial visitations) as well as the intermediate cases favored in astrobiology and SETI.

The unfolding of any of these detection scenarios would represent a great scientific discovery and could have profound effects on our intellectual and emotional lives. Nonetheless, it should prove more challenging easing humanity through some of these scenarios (*Space Visitors* and *ET Calling*) than others (*Microbes on Mars* and *Distant Dust*). Furthermore, each scenario has different implications for our science and technology, our religion and arts, and our everyday lives. This framework was designed as a useful heuristic for organizing various hypotheses about long-term and short-term reactions to human life. It should be useful also for developing scenario-contingent strategies for managing contact and its aftermath.

Let us sharpen our focus on a future world where we are able to learn about extraterrestrial life forms and cultures. In an informal survey of approximately 200 people from 12 countries, Allen Tough (1997) asked, "If a radio dialogue with an extraterrestrial civilization occurs someday, what questions do you hope to ask, and what topics do you hope we discuss? From this wise, knowledgeable civilization, what do you want to learn most of all?" This resulted in over a thousand questions addressing everything from everyday practical matters to profound questions about science, religion, and the arts.

We imagine ETI as having made technological advances that we seek in our own future…

Practical Information

Tough's respondents hoped that through communicating with advanced extraterrestrial societies we will gain practical information that will help us solve contemporary problems, improve the quality of human life, and secure our own future as a species. We imagine ETI as having made technological advances that we seek in our own future: increasingly miniaturized and powerful information processing devices; cheap and inexhaustible sources of power; gentle chemical procedures that replace the surgeon's scalpel; workable means for interstellar travel; pro-

longed life; and cyborgs endowed with near-immortality. Perhaps we will be coached in faster-than-light communication, interstellar travel, and other technologies that appear at the cusp between science and science fiction. If contact leads to the transfer of technology, and if we understand how to use this technology and are able to cope with the full range of environmental, social, and psychological consequences, we may become empowered to solve some of our biggest problems, improve the quality of human life, and accelerate our own evolution.

Interaction with many ETI societies would expose us to unprecedented levels of diversity and stimulation. Over time, knowledge gained from an extraterrestrial civilization could shape human leisure-time or recreational activities. For example, at some point people may embrace extraterrestrial costumes, dances, foodstuff, and customs. At first, these might be mimicked at "trendy" social events. Theme parks or museums could convey a sense of what it might be like to live within ETI society. Amusement park rides could be based on ETI conveyances (even as imagined spaceships shape many amusement park rides today). And, if interstellar travel proves to be much less daunting than it appears right now, then it is conceivable that in a thousand years extraterrestrial societies could become desirable tourist destinations. Already, there are energetic efforts to develop space tourism, including suborbital and orbital flights, space hotels, and luxury cruises around the moon.

…information that is practical to them may or may not be practical to us, especially if they were radically different from us, such as would be the case if they were "machine intelligence."

On the other hand, we might question whether or not advanced civilizations would have, or at least use, some of the technology that we impute to them. For example, Dyson spheres and omnidirectional beacons may be avoided because they constitute needless expense, squander resources, and manufacture pollution as well as being irrelevant to their life forms. Additionally, we may not be judged "ready" to receive such information. After all, would you give a child the secret code of ballistic missiles just so he or she could enjoy playing with them? Finally, information that is practical to them may or may not be practical to us, especially if they were radically different from us, such as would be the case if they were "machine intelligence." Their ideas may seem very "academic" to us, depending on the problems that confront us at that future time.

Perhaps the most exciting prospect is that we will learn how ET civilizations survived their technological adolescence. Perhaps they will have a developed empirical field of study that can define critical bottlenecks in civilizational advances and elaborate ways of navigating them (Tough, 1986). In the very long run, the challenge will be outliving one's star, by building one's own "world" or using giant transports to migrate to another solar system. As far as we can tell, there are no phenomena suggestive of astroengineering in the vicinity of stars about to become red giants.

Answers to Major Questions

Information from ETI may help us grapple with some of the greatest scientific and existential questions of all time. We, and they, may have a bias towards expecting scientific discourse in part because advanced technology is a prerequisite for interstellar communication and in part because science is a convenient reference point for languages that transcend different cultures. On the other hand, the primacy that we accord math and logic may reflect the fact that on Earth the search is conducted by physical scientists. If we restrict our discourse to science, we will eliminate broad spectra of human activities: philosophy, humanity, religion, and the arts.

Science

The discovery of extraterrestrial life would have profound implications for physical, biological, and social science. This discovery would either validate or challenge our beliefs in the wide-scale applicability of our own scientific principles. One view is that although ETI will necessarily have to deal with the same physical universe that we do, their science may be unrecognizable because they will come from different environments, will have different methods of sensing their environments, and will apply different techniques to different scientific topics (Rescher, 1985). Another view is that ETI will think like we do despite their different origins. They will be subjected to the same general space, time, and materials constraints that we are, and hence forced to devise simple and effective ways of thinking about the universe. As a result, their science will be easily recognized by us (Minsky, 1985).

Post-contact humanity may be privy to partial or full answers to questions about such things as the origin and fate of the universe…

Contact with ETI may expose us to new metaphysics and epistemologies. Post-contact humanity may be privy to partial or full answers to questions about such things as the origin and fate of the universe and the course of evolution and of civilization. We dream of learning "comparative cosmologies," contrasting theories of the ultimate origin of the universe. We dream also of learning the mathematical theory unifying all known forces of nature, or perhaps a theory of the superstrings or a unified theory of science of a type that we have not yet conceived.

Ben Finney points out that one of the reasons that the social sciences lack the maturity of the physical sciences is that so far we have had only one opportunity to study the development of consciousness, intelligence, and culture (Finney, 1999). That is the opportunity available on Earth. He points out that astronomy, for example, would have not progressed very far if astronomers had been forced to develop a theory of planetary evolution based solely on knowledge of our own planet. We need extraterrestrial civilizations "to introduce us to an array of possibilities and variations beyond our experience, and also to shock us out of such parochial views as regarding ourselves as the summit and final goal of evolution…."

Information about other civilizations would confer opportunities for comparative scientific studies of cultures, life forms, and psychologies. By the year 3000, under an information-rich detection scenario, we may have assembled a database containing hundreds, perhaps thousands of societies that endured from decades to millions or billions of years. We might have, for tomorrow's social scientists, the equivalent of anthropology's Human Relations Areas Files that facilitate cross-cultural studies for anthropologists. Historians would be able to do quantitative research on comparative civilizations.

Multiple opportunities, notes Finney, could move us in the direction of consilience, or the unification of knowledge (Wilson, 1998). So far, only physics and chemistry have achieved consilience to any appreciable degree. The chance to study extraterrestrial civilizations may help us build bridges among the physical sciences, natural sciences, social sciences, and humanities. Finney adds that SETI is one of the endeavors led by physical and natural scientists that has welcomed the participation of social scientists and humanists.

Spirituality is not inconsistent with science, and it is evident in discussions of design, order, and beauty in the universe.

Religion

We draw a distinction between spirituality and organized religion. Spirituality is an almost mystical sense of purpose and meaning in the universe, perhaps accompanied by feelings of awe, reverence, and transcendence. Spirituality is not inconsistent with science, and it is evident in discussions of design, order, and beauty in the universe. Spacefarers have reported spiritual experiences after viewing the Earth from a distance. These "overview effects" often include a sense of transcendence, oneness with the cosmos, and universal brotherhood. For example, in an interview with Frank White, astronaut Eugene Cernan reported:

When I was the last man to walk on the moon in December 1972, I stood in the blue darkness and looked in awe at the Earth from the lunar surface. What I saw was almost too beautiful to grasp. There was too much logic, too much purpose—it was just too beautiful to have happened by accident. It doesn't matter how you choose to worship God… He has to exist to have created what I was privileged to see (Eugene Cernan, quoted in Frank White, 1987, p. 26).

Astronaut Ed Gibson stated: *You can see how diminutive your life and concerns are compared to other things in the universe. Your life and concerns are important to you, of course. But you can see that a lot of the things that you worry about don't make much difference in an overall sense. The result is that you enjoy the life that is before you; you don't sweat the next milestone.… It allows you to have inner peace* (Ed Gibson, reported in White, 1987, p. 43).

Organized religion often includes social structure, highly articulated and sometimes inflexible belief systems, specific loyalties, and group rituals. Discussions of SETI and religion typically center on organized religion and emphasize concerns about sects that are characterized by high rigidity and disagreement with science. In some cases, narrow religious beliefs hold sway over objective evidence and, in this way, obstruct science. Because of this, it is tempting to expect that ETI will have moved beyond religion and that science will dominate their value system.

One might argue that longevity, a requirement for their civilization to overlap with ours, is inconsistent with organized monotheistic religions typical of Earth. Despite their positive side, such religions are also responsible for long-lasting warfare and destruction. Religious warfare, in turn, can lead to the destruction of a civilization. Hence, the absence of competing religious sects would be one more factor contributing to longevity. Yet this would not preclude spirituality.

When we review the basic principles of the religions that attract broad segments of the world population (Buddhism, Christianity, Hinduism, Islam, and Judaism), we find certain similarities. In a study of this, Douglas Vakoch (1999a) began with a pool of 200 principles drawn from the world's religions. He gave a sample of these principles to research participants and, on the basis of their responses, organized them into 13 clusters. Examples of these clusters include giving and helping, forgiving, positive actions, humility, thanksgiving, and positive attitudes. Whether or not similar principles evolve in ETI societies, knowledge of them would help give ETI a comprehensive view of humanity.

Will we be able to recognize and understand the ethics of an advanced society, or that of machine intelligence?

Contact with an extraterrestrial society could expose us to ethical principles developed by creatures that are very different from us. Will we be able to recognize and understand the ethics of an advanced society, or that of machine intelligence? As it stands, we often have difficulty understanding each other's ethics. If we can recognize ETI ethical principles, in what ways (if any) will they correspond with principles already developed on Earth? Longevity may imply a highly established code of ethics that centers on the perpetuation of individuals and all components of the natural environment.

Knowledge of extraterrestrial religious beliefs could result in a super-religion that encompasses multiple intelligent societies. Another possibility is that some ETI views will, in a sense, validate the basic tenets of some terrestrial religions. This could strengthen terrestrial religions that have shared views, but perhaps spark conflict with religions that maintain opposing views. Especially worrisome is the possibility that ETI beliefs will conflict with major world religions. Conflict may be particularly likely if extraterrestrials have a monotheistic or Adamist-type religion that differs on key points with terrestrial monotheistic religions.

The mere possibility of "saintly" aliens could eventually force a radical rethinking of Christian theology, and may cause a split in the church towards support for SETI. Even if their religion prevails, it could take generations for humans to be absorbed into their religions. Conflict would depend less on the objective properties of ETI religion than on how people interpret and reinterpret it. Various religions would look to their own past for guidance.

Surveys suggesting that religious leaders (Alexander, 1998) and followers (Ashkenazi, 1990) take a relaxed view of the possibility of ETI may be misleading. Many religions are geocentric and homocentric. This is especially true of Christianity. From the Christian point of view, the discovery might be "to the Glory of God," but there will be no consensus. On the whole, we will be challenged by the sheer discovery of extraterrestrial life; even a single bacterium on Mars would have implications for some fundamentalists. The alternative—that God became incarnate on planet after planet—has an air of absurd theatricality to it. Organized religions, however, have the capacity to change in response to new discoveries, even if historically the response has been slow. When the alternative is extinction, there is strong incentive for rapid change.

We are moving in the direction of a "cosmotheology" that accommodates a universe full of life.

Steven Dick (2000a) notes that growing belief in a biological universe is a worldview, not just another theory or hypothesis. This, by itself, is forcing us to rethink our theology. We are moving in the direction of a "cosmotheology" that accommodates a universe full of life. Among the principles of that cosmotheology are that humanity is neither physically nor biologically central to the universe; that humanity is at best somewhere midway in the great chain of intelligent beings; and that we must evolve a reverence and respect for life that includes all of the species in the universe. In addition, cosmotheology fosters a radically different conception of God—a God of the entire universe, a God whose roots are found in cosmic evolution. Dick writes, "With due respect for present religious traditions whose history stretches back four millennia, the natural God of cosmic evo-

lution and the biological universe, not the supernatural God of the ancient Near East, may be the God of the next millennium." Since we are accelerating our own progress into space and increasing our chances of encountering ETI, cosmotheology may have transformed humanity by the year 3000. ETI also will be aware of the biological universe; perhaps cosmotheology will become a shared religion.

Politics and Law

In his seminal work *Living Systems*, James Grier Miller points out a trend towards increasingly larger systems (Miller, 1978). In human history we see a shift from small communities to cities and nations, and now interstate political systems. Thus, some European city-states and principalities first joined together into nations recently have become part of the European Union. This tendency to form increasingly large sociopolitical units is noted in discussions of world government (Schenkel, 1999) and of the Galactic Club (Bracewell, 1975). The potential advantages of joining together include aggregated resources and peace.

Miller views supranational systems as relatively recent developments. Their evolution is slow and not inviolate: consider the fragmentation of states accompanying the dissolution of the Soviet Union. At this point, most supranational entities—such as the United Nations—exert only spotty control over constituents' lives. Still, movement towards supranational entities is a continuation of billions of years of evolution towards larger, more complex social systems. It points in the direction of world government and even larger sociopolitical systems.

Peter Schenkel sees two ways that we on Earth could unite to solve our planet's problems (Schenkel, 1999). The less painful is to minimize the differences among the peoples of the world and increase our efforts to develop a world government. The more painful course is for the survivors of a nuclear holocaust or other disaster of human making to find themselves compelled down the road to unification. Surviving societies that are older than ours will have followed one of these two paths and have established a stable government, eliminated war, and developed positive relationships with other species. Schenkel hypothesizes that contact with such an advanced society will inspire Earth's superpowers "to abandon ruinous rivalry and tilt the scales for a peaceful world government" (Schenkel, 1999, p. 7).

An extended legal framework that encompasses… all nations on Earth…human societies dispersed throughout the solar system and ETI elsewhere, may govern humanity by the year 3000.

An extended legal framework that encompasses not only all nations on Earth, but also human societies dispersed throughout the solar system and ETI elsewhere, may govern humanity by the year 3000. Such laws could assure orderly progress of humans into space and regulate interstellar affairs. The challenge of international law—to find a framework that is acceptable to diverse people who live under very different circumstances—will be magnified many times over as we struggle to organize radically different and widely separated species.

Simplicity rather than complexity must characterize any legal framework promulgated for galactic application. To survive, it must consist of a few principles that are at a sufficiently high level of abstraction that they can be creatively adapted to diverse "local" populations and conditions. To draw an analogy from United States law, we expect that this legal framework would bear a closer resemblance to the US Constitution than to state laws or local ordinances. An interstellar legal framework may be offered to us if we encounter civilizations that have already formed a supranational entity or Galactic Club. Or, we ourselves may contribute to its development.

Knowledge about extraterrestrial societies will allow us to evaluate Francis Fukuyama's (1992) hypothesis that the ascendance of liberal democracies on Earth rests on deep or universal principles. Some of those who venture a guess suggest that ET civilization will be peaceful, since, as noted briefly in our discussion of "Assumptions about ET," warlike societies may earn low scores on the longevity factor.

Despite frightening images of extraterrestrials and talk of evil empires, Harrison theorizes that most advanced civilizations are peaceful rather than belligerent (Harrison 1996, 1997). This thesis rests upon convergent evidence that relations among nations on Earth are becoming less warlike. First is the shift from autocratic forms of government that resolve problems through force to democratic forms of government that seek peaceful, negotiated solutions to problems (Russett, 1993). Second is a decrease in the frequency and intensity of war (Fukuyama, 1992; Keegan, 1994; Mueller, 1998), accompanied by

increased interest in nonlethal alternatives (Alexander, 1999). Third, mathematical models and game-theoretic research show that nations that refrain from belligerence and enter into defensive pacts are ecologically superior (last longer) than societies that follow aggressive foreign policies (Axelrod, 1984; Cusack and Stoll, 1994). This does not violate the principle of survival of the fittest. The aggressive skills that assure the survival of wild animals in the jungle are not the same skills that promote a society's survival within even larger social systems.

This type of analysis, which draws on understanding life on Earth to forecast life elsewhere, is subject to two major qualifications. First, we must be sensitive to the internal validity of the analysis. Do the data demonstrate a powerful trend, or are they nothing more than random variations that appear important because they happen at our particular point in history? Second, even if these data reflect powerful and pervasive laws of behavior on Earth, we must be cautious about extrapolation to societies that we know nothing about.

Would ET art be discernible, much less understandable to us…would it be attractive to porpoises and whales?

The Arts

All societies on Earth have both creative and performing arts, and, if we are willing to include oral traditions, a literature. These serve both an expressive and communicative function, and play on the intellect and emotions of the audience. Our emphasis on science should not obscure the possibility that ETI will have a creative flair. By the year 3000 ETI may have influenced all of the creative and performing arts. Perhaps we will be delighted by radically new art forms, either developed by ETI or collaborative projects jointly developed by ETI and humans. Perhaps human art will receive critical acclaim in other worlds.

Would ET art be discernible, much less understandable to us? Would ETI art be too complex, or different, for us to appreciate? Would ETI music validate our ideas of music from space, and would it be attractive to porpoises and whales? Will the limited number of basic plots that account for all human fiction account for all ETI fiction as well?

John Barrow is among those whose work hints that art may have universal components (1995). This is because some of the attributes that equip us for survival also nudge us in the direction of comprehending art. For example, Barrow notes that planets with conditions conducive to the evolution of life also promote good color vision. Knowledge of ETI art forms will help us evaluate theories that there are universal principles of aesthetics, including a strong relationship between music and mathematics. Indeed, in the movie *Close Encounters of the Third Kind*, humans communicated with extraterrestrial spaceships by means of tones and chords.

Even if principles of beauty are not universal, notes Douglas Vakoch, it might be possible for one civilization to teach its aesthetics to another (Vakoch, 1999b). This would require establishing a common medium—if ETI has poor vision, for example, it might be difficult to communicate pictorially—and finding ways to factor in culturally based artistic conventions. Maori artistic conventions, for instance, involve representations of people that are integrated into abstract forms. Unlike the Maori, visitors from other societies usually see beautiful abstract forms but do not understand that these forms represent people.

Through some combination of universals, analogies, and relationships, we might… help another civilization develop a sense of appreciation for our graphic arts, our sculptures, and our music.

Our strategies for communicating our science may be adapted for communicating our art. Vakoch points out that one way to convey our concepts of chemistry would be through transmitting at frequencies corresponding to a combination of spectral lines associated with a specific element. The same basic technique could convey some of our ideas about music. In this case, we could transmit at multiple frequencies that correspond to the tones that constitute well-tempered polyphonic music (von Hoerner, 1974). Through some combination of universals, analogies, and relationships, we might be able to help another civilization develop a sense of appreciation for our graphic arts, our sculptures, and our music.

Changes in Our Views of Ourselves

Post-contact society is likely to affect our views of ourselves in at least three ways. First, it will speed awareness that we are part of the biological universe (Dick, 1996). Contact, even under minimum detec-

tion scenarios, is likely to accelerate our views of ourselves as part of cosmic man or "interstellar humanity," to extend the terminology of Olaf Stapleton's "interplanetary man" (Dick, this volume). Many other factors—such as our progress in spacefaring—will contribute to our consciousness of the cosmos.

Second, knowledge of relationships among extraterrestrial subpopulations could help us gain insight into intergroup relations on Earth. We may learn, for example, from how ETI societies treat different societies as well as their own subpopulations. This discovery could cause us to reflect on how we ourselves treat people from different cultures and subcultures. By seeing how ETI manages diversity, we may learn new models for group relations on Earth.

Almost a century of work in psychology and sociology shows that other people's treatment of us shapes our views of ourselves. People who are treated as competent and worthwhile individuals tend to develop high self-confidence and perform well. Self-confidence and success tend to feed upon each other and generate an upward spiral of events. People who are treated as inferior and incompetent lose self-confidence and motivation, and perform poorly. Low self-confidence and poor performance also feed on each other, in this case creating a downward spiral.

A very large and important question is how advanced societies would treat us. Will they consider us equals, protégés, or inferiors?

A very large and important question is how advanced societies would treat us. Will they consider us equals, protégés, or inferiors? Despite technological superiority, would they maintain a sense of respect towards younger societies, and would they allow such societies to put their best foot forward? Under a high information-exchange scenario, ETI's openness, tolerance, understanding, and ability to help younger societies to gain strength would be important to us in many ways, including their contribution to our views of ourselves.

Whether or not ETI makes advanced technology available to us could be important psychologically as well as materially. Withholding advanced technology from us could be interpreted as a sign that we have failed to pass muster as well as a source of frustration and possibly tensions between the two civilizations. Offering ETI technology to us could contribute to a sense of competence and mastery, providing that we considered ourselves in control of the new technologies and understood their operation. This sense would be enhanced if we were able to see new applications or find ways to improve it. We could be affected adversely if we felt controlled by the technology or didn't really understand how it worked.

We need to address the possible adverse effects of contact—feelings of inferiority, loss of internal sense of control, learned helplessness and the like—through studies of caste systems, colonies, subjective determinants of self-esteem, and the preservation of identity following culture contact.

One such risk is domination, whether resulting from military subjugation or misguided attempts to impose their superior ways on less-advanced societies.

Risks and Concerns

Contact with powerful societies poses certain risks in addition to possible challenges to our self-confidence. One such risk is domination, whether resulting from military subjugation or misguided attempts to impose their superior ways on less-advanced societies. A perfect civilization could take pity on a poor, struggling civilization such as our own, uplift it, and in the process destroy our unique properties.

Dominance may be a natural, indeed inevitable, stance of any advanced life form. Drawing on simplistic notions of survival of the fittest, it is easy to argue that advanced life elsewhere in the cosmos will tend to control other life. Yet discussions of contact have downplayed the possibility of military subjugation. Immense interstellar distances would make it extremely expensive and difficult, if not impossible, to conduct interstellar warfare. Furthermore, we expect that many of the justifications for war will be absent (for example, an advanced spacefaring civilization would have plenty of unoccupied land for the taking). And, as repeatedly noted, many have speculated that societies with great longevity have advanced beyond war.

…the differences in technologies could be far greater than that between slingshots and thermonuclear bombs.

Of course, if these analyses are wrong, and both the physical and sociological barriers to interstellar travel evaporate, subjugation could be a risk. Given

their vast experience and highly evolved weapons systems, our contemporary military would not seem to offer much of a defense. If the discrepancy is measured in millions of years of technological development, the differences in technologies could be far greater than that between slingshots and thermonuclear bombs.

Subjugation would not necessarily require actual physical contact between their civilization and ours. As an alternative, they could deploy proxies on Earth to do their bidding. A powerful group of proxies could have the knowledge, power, and technology to control humanity, even as colonial troops controlled natives less than a century ago. People on Earth may lose the will to fight the proxies if they do not have the technology and self-confidence to succeed.

Another clear risk is culture shock, the import of technology and ideas that are so radical that they disrupt our value system and pose severe threats to social order. Culture shock occurs when technology outpaces the human capacity to adapt. Again, we must point to the great discrepancy between the two cultures. We expect ETI to be several rungs ahead of us on the ladder of civilizations (farming, industry, nuclear, computing, etc.). It is likely not just a matter of their being one step ahead of us, but many steps, each step representing hundreds or thousands of years. It could take a long time to grasp—never mind assimilate—such a radically different culture.

Possible Intercivilization Projects

Human history is studded with projects that have required immense amounts of financial and material resources and cutting-edge technologies. Such "megaprojects" (Harris, 1996) have included the pyramids, Stonehenge, the Suez and Panama canals, landing people on the Moon, and the "chunnel" that links England and France. These efforts require such a stretch of the imagination and such massive investments of resources that they seem almost impossible until they are done. In the case of ancient megaprojects such as the pyramids and Stonehenge, some people continue to invoke extraterrestrial intervention, despite the fact that engineers have mapped Earthly explanations.

Possibilities include…directed panspermia to create additional islands of life…perhaps even the creation of designer universes to create a "multiverse."

Imagine, then, the magnitude of the projects that might be undertaken by a group of advanced civilizations, including human civilization, sharing information and working in concert. Possibilities include comparative studies based upon a sharing of information, vigilance against Von Neumann self-replicating probes and other potential threats, directed panspermia to create additional islands of life, assistance with planetary engineering, and in the remote future perhaps even the creation of designer universes to create a "multiverse" (Rees, 1997; Smolin, 1997).

Interstellar collaboration could allow different societies to utilize their distinctive strengths and compensate for their idiosyncratic weaknesses. Presumably, by virtue of ecological niche and historical circumstances, different societies will have different intellectual and material resources and will have made uneven progress in different areas of endeavor. For example, a society that early in the course of its history found evidence of other civilizations within its solar system may have made rapid advances in rockets and spacecraft, while another society, threatened by a series of near-calamities, may have progressed dramatically in environmental protection. Societies with complementary strengths could find many ways to collaborate. If communication were possible, a society with brilliant theoreticians might show a society with the necessary natural resources, technicians, and laborers how to make a workable starship.

THE NEXT STEPS

The past century has been marked by growing evidence for the "many worlds" hypothesis and increasing enthusiasm for the idea that "we are not alone." We have the reason and the technology to expand the search. At the same time, we must prepare ourselves for the possibility that the search will be successful. This includes finding ways to communicate with ETI, better assessing the impact of detection on humanity, and developing a reply policy.

Accelerating the Search

Confirmation of extraterrestrial intelligence could come about in any of a number of ways, but given our known laws of nature and current technology, some search procedures seem more promising than others. At present, the favored approaches of most scientific searchers are radio SETI, which involves using radiotelescopes to detect electromagnetic patterns that are of extraterrestrial but intelligent origin, and optical SETI, based on searching other segments of the electromagnetic spectrum for laser communications or signature patterns of energy use.

Radio astronomers could increase the chances of success further by building an observatory on the Moon…

Proponents of these dominant strategies note that moving information around the universe is incredibly more economical than moving matter, and that whereas radio and optical signals move at the speed of light, spaceships or probes can move at but a tiny fraction of that speed. From this perspective, expanding the search means involving more radiotelescopes, engaging them in the search a greater percentage of their time, including more areas of the sky in the survey, and scanning a greater number of channels. Radio astronomers could increase the chances of success further by building an observatory on the Moon, and analyzing anomalous data that are normally locked in bottom desk drawers.

We can expand the search further by bringing new search strategies on line. For example, we might try looking for small robot probes (Tough, 1998a, 1998b). As a result of advances in rocketry and miniaturization, we are able to send small, sophisticated interplanetary probes that collect and return much more scientific data than could their larger and more expensive predecessors. Whereas seminar participants expressed little enthusiasm for the existence of self-replicating probes, it is conceivable that following remote detection of intelligent life on Earth, a highly advanced civilization could send a probe to our region. To the extent that this is plausible, it would be worthwhile to broaden the search to look for probes or other artifacts in our solar system.

Gregory Matloff and associates raise the intriguing possibility of ETI spaceships or habitats within our solar system (Matloff, 1999; Matloff, Schenkel, and Marchan, 1999). He suggests that, as their stars leave the main sequence and expand towards the giant phase, residents of neighboring solar systems could unfurl giant solar sails and set forth on world ships to our own solar system (Matloff, 1999). Such a journey could be measured in centuries rather than millennia: since life emerged in Earth's seas, hundreds of other stars have come within one or two light-years of our Sun (Matloff et al., 1999). Stars may pass within this range every 300,000 years or so.

If ETI silently orbits our Sun, and has done so for millennia, it would be up to us to initiate contact.

Certain features make this scenario more attractive than others suggesting that ETI is hiding within our solar system. Solar sails are more consistent with our current understanding of physics than are some of the other means envisioned for interstellar travel (Matloff et al., 1999). We do not have to wait for breakthrough propulsion to explain how ETI got here. Furthermore, Matloff's hypothesis is testable. A particular type of infrared signature and the properties of the orbit could tip off the presence of an alien habitat within our solar system (Matloff et al., 1999). Finally, this hypothesis raises many provocative questions about managing contact. If ETI silently orbits our Sun, and has done so for millennia, it would be up to *us* to initiate contact. Why have they remained silent, and how would they react if we tried to communicate with them?

Generally, the possibility of face-to-face encounter is left to science fiction writers and UFOlogists. Given our present level of knowledge, a face-to-face encounter would depend upon both interstellar travel and life support systems that could keep the spacecraft inhabitants alive under all-but-impossible conditions. Furthermore, unless one wishes to strengthen the assumptions by presuming that ETI will set forth in vast armadas, given the vastness of space a chance encounter would be all but impossible. Most reports of encounters with extraterrestrial entities or their artifacts are dismissed as misidentification of natural phenomena (planets, airplanes), deliberate hoaxes, or hallucinations. Given this, scientists see such reports as a waste of time. If they still have interest, they are likely to be deterred by ridicule from the intellectual community. The underlying reason that many SETI scientists are unwilling to consider the possibility of ETI in our solar system, writes Michael A. G. Michaud, is "fear that their enterprise will be discredited by association with UFO advocates" (Michaud, 1998, p. 174).

If we become capable of faster-than-light travel, for example, it is a good bet that a much older civilization would also be capable of this feat.

We see two areas in which massive changes in our own science could lead to rapid adjustments in our search strategies and perhaps force us to rethink the consequences of contact. The first of these would be developments in breakthrough propulsion physics, which could facilitate interstellar travel. If we become capable of faster-than-light travel, for example, it is a good bet that a much older civilization would also be capable of this feat. Speculation that "they" could appear in our solar system would be much less far-fetched.

The second revolutionary development would be breakthroughs in mental telepathy, leading to a reassessment of consciousness as a vehicle for interstellar communication. Freeman Dyson suggests that, in a thousand years, humans may become more interested in mental activities, perhaps experimenting with radiotelepathy, communication through means that are presently unavailable to us, and creating, in effect, a larger entity, a true group mind (Dyson, 1997). Could we ourselves be part of an even greater consciousness, one that includes beings not like us? Could we at some point—perhaps following additional evolution—find ourselves communicating with creatures from other places, other times? Perhaps rightfully we tend to put such suggestions on an equal footing with reports of a reincarnated Elvis Presley in the parking lot at the local mall. Yet, parapsychologists are employing tight experimental methodology, including double-blind procedures, to put remote viewing, mental telepathy, and related phenomena on a firm scientific footing (Radin, 1997). Certainly, success rates have been high enough to generate spirited discussion in mainstream psychology journals—and to attract research support from national security agencies, the military, and even the business community (Radin, 1997). Asked in 1992 why SETI did not use some sort of altered state of consciousness as well as radiotelescopes to search for extraterrestrial intelligence, MIT physicist Philip Morrison responded that consciousness was "messy" and that he and his associates were having enough trouble with their equipment as it was without adding consciousness into the mix (Mack, 1999, p. 27).

Messy indeed. Most of the carefully conducted research suggests that psychic abilities at best produce only a small performance edge—for example, boosting chance performance of 25% "hits" to something on the order of 35% "hits," a small but highly reliable gain given metanalyses of scores of studies, each encompassing an enormous number of trials. Given the small magnitude of these effects, parapsychologists suspect that people's expectations and wishes would completely overpower any psychic communications that might emanate from many light-years away. Nonetheless, there *are* acceptable ways to validate claims of psychic contact with extraterrestrial beings, such as by soliciting information that is not known by us but can be verified using present scientific procedures. For example, any "ET" that is "channeling" information to someone could draw our attention to an astronomical event that we had not yet noticed but that we could confirm with our telescopes. So far, no such claims have been verified.

As a corollary of expanding the search, we should make ourselves a more attractive target for ETI. For example, if we suppose that an extraterrestrial civilization were to monitor Earth (using either remote or up-close surveillance techniques) with the intent of self-manifestation following signs of humanity's "readiness," then we could try to signify this. This might be accomplished, for example, through self-preparation or an open invitation such as the "Invitation to ET" that a group of 60 people, primarily scientists, has placed on the internet.

Increased knowledge of intelligence and behavioral diversity on Earth will position us better to understand ETI.

Understanding Extraterrestrial Life

Increased knowledge of intelligence and behavioral diversity on Earth will position us better to understand ETI. Psychologists, animal behaviorists, and other researchers have already conducted studies that would be of some use for understanding extraterrestrial intelligence, but it is doubtful that many have thought of their work in this context. Black and Stull (1977, p. 100) suggest a direction for such studies:

Our goals should be (1) to catalog and classify behavioral patterns and cultural differences; (2) to determine how these are related to the environment, physiology, and evolutionary history of each species studied; (3) to determine what traits, if any, appear common to all intelligent animals; (4) to gain experi-

ence in communication and other extraterrestrial species; and (5) to develop theoretical models that will allow extrapolation to extraterrestrial cultures, and allow us to evaluate at least semi-quantitatively the uncertainties in such an extrapolation. To the extent that this might enable us better to understand human behavior, it could result in one of the most important benefits of the SETI program.

There is a promising model for extrapolation from terrestrial to extraterrestrial life (Harrison, 1993, 1997) and it is James Grier Miller's Living Systems Theory or LST (Miller, 1978). Terrestrial and extraterrestrial life reside in the same universe. They are constructed of the same elemental building blocks, and governed by the same natural laws. The same assumptions (empiricism, determinism, monism) and methods that make it possible to conduct scientific studies of humans should be equally forceful when applied to ETI.

Any theory that is potentially applicable to ETI must have a broad perspective and have wide-scale applicability on Earth. It must offer proven principles that are extrapolated easily to new situations. LST is a universal theory of behavior in the sense that it cuts across species, forms of behavior, and historical epochs. An outgrowth of Open Systems Theory, with its widely known concepts of inputs, throughputs, outputs, feedback, homeostasis, and entropy, LST is an interdisciplinary framework that integrates all of the biological and social sciences from cellular biology to international relations. LST is biological, social, evolutionary, and applicable to individual organisms as well as a spectrum of social entities.

…there are parallel structures and processes as we move up the scale from the cell to the organization of societies.

According to LST, after life originated on Earth 3.8 billion years ago, it evolved from single-celled organisms to increasingly complex biological and social forms. These are, in ascending order: cells, organs, organisms, groups, organizations, communities, societies, and supranational systems. In the course of this evolution certain structures and functions maintained their identities, although specific manifestations changed. LST proposes that the same terms and principles can describe systems at each level, although higher-order systems may have distinctive emergent properties that are not found at lower levels. Consequently, complex systems of different scales can be disassembled into the same constituent subsystems and analyzed in terms of the same concepts and relationships. Thus there are parallel structures and processes as we move up the scale from the cell to the organization of societies. Living systems comprise 20 specialized subsystems that have distinctive structures and process matter, energy, and information. Such reductionistic building blocks seem plausible for unknown life forms.

Harrison applied a simplified version of LST involving two generic processes (matter-energy and information) to three system levels (individual, society, and supranational system) (Harrison, 1993, 1997). He used this framework to organize past hypotheses about ETI, and generate new ones. Many of the hypotheses advanced by astronomers, astrobiologists, and other SETI scientists are fully consistent with LST and are occasionally expressed in terms that are reminiscent of LST terminology. It is not entirely coincidental that Davoust (1991, p. 72) defines life as a "complex, organized open system" and that Seielstad (1989, p. 140) describes subsystems, systems, and suprasystems as a set of nested Russian dolls. Living systems theorists and SETI scientists are interested in the same phenomena and apply similar intellectual tools. Researchers from both traditions are accustomed to thinking in terms of energy, matter, and information; in terms of interconnections and systems; and in terms of microcosm and macrocosm.

As Molton (1989) points out, in the absence of probes and radio signals we are limited to what we can deduce from ourselves and our terrestrial experience, and without a logical framework we will have only random data. We can deduce a great deal from ourselves, and LST is a logical and credible framework for organizing our thinking.

Will attempts to anticipate ETI be so much wasted effort if ETI doesn't exist, or is never found? By considering the possible natures of the universe, we come to understand the actual nature of the universe. Similarly, by considering the possible nature of ETI we may understand more fully the characteristics that make us what we are (Ruse, 1985, p. 71):

Exploring the possibility of life elsewhere in the universe is full of philosophical interest. Such exploration puts a bright light on our own powers and limitations…. By speculating on what other life forms would be, we see more clearly the nature and extent of our own knowledge. Such fairy-story telling does not prove anything empirically that we do not already know, but it does force us to think again about ourselves from a novel perspective.

Our current limited success in communicating with chimpanzees and dolphins bodes ill for successful communication with off-world beings.

Preparing Communication Strategies

How can we hope to communicate with an advanced and distant society whose languages have nothing in common with ours? How can we communicate with a radically different species? Our current limited success in communicating with chimpanzees and dolphins bodes ill for successful communication with off-world beings.

Further research on interspecies communication would expand our overall knowledge of behavior as well as contribute to SETI (Baird, 1987). Similar advantages might be gained from studies of people who for neurological or psychological reasons have extreme difficulty communicating with other humans.

We should also accelerate research on interstellar languages. This work was initiated by mathematicians and physical scientists, who suggest that logic, mathematics, and the physical world offer shared reference points that will facilitate human-ET communication (Freudenthal, 1985; DeVito and Oehrle, 1990). Learning one another's languages via radio could involve very long and repetitious sequences of messages with the two cultures trading facts that they both already know long before moving the discussion into broader areas such as art, history, and social science. Yet there may be ways to speed the process of acquiring a mutual language or to initiate discussion outside of physics and math. As already noted, psycholinguist Douglas Vakoch is working on means to communicate spiritual principles (Vakoch, 1999a) and aesthetics (Vakoch, 1999b). Additionally, we might entertain the possibility of translating supercomputers, working at the highest levels of logic and currently known as "theorem proving."

Anticipating the Post-Contact World

Contact with an extraterrestrial civilization is not preordained, but it could occur at any time and with the speed of light. Contact could be a high-impact event, and, as such, it deserves serious prior thought. Anthropologist Ashley Montagu presents the case well (Berenzden, 1973):

I do not think we should wait until the encounter occurs; we should do all in our power to prepare ourselves for it. The manner in which we first meet may determine the character for all our subsequent relations. Let us never forget the fatal impact we have had upon innumerable peoples on this Earth—peoples of our own species who trusted us, befriended us, and whom we destroyed by our thoughtlessness and insensitivity to their needs and vulnerabilities.

By developing a reply policy before the fact, we will maximize our chance of framing a message that preserves our security…

We need preparation *before* confirmation of extraterrestrial intelligence. For example, it would be useful to develop reply strategies prior to intercepting an initial message. By developing a reply policy before the fact, we will maximize our chance of framing a message that preserves our security, has the support of broad segments of the population, and (if interactive communication is available) encourages a favorable response. In the absence of advance planning, anyone who has access to a powerful transmitter may attempt to speak in behalf of humanity.

Advanced preparation must proceed beyond the usual tiny groups of search advocates. Different people look to different types of leaders to ease humanity through detection and its aftermath, so it makes sense to involve politicians, military leaders, business leaders, and religious leaders as well as scientists in the planning effort. Since contact will involve all of humanity, planning groups should have broad international representation. It might make sense for the United Nations to be involved, or to convene a World Council.

Often we hear that when it comes to extraterrestrial intelligence, the only thing that we can expect is the unexpected! For this reason, it makes sense to plan for many different contingencies. Our planning efforts should include a range of search technologies (radio SETI, optical SETI, interstellar probes), openness to many different forms of intelligence, and an awareness that contact could unfold in many different ways. For example, the consequences for humanity would be very different if ETI were located in the solar system rather than in a remote part of the galaxy, or if recognition of ETI's existence took the form of a sudden insight or a slow dawning awareness. Other variables include "the other's" technological capabilities, whether or not ETI took a familiar or unfamiliar form, and our perception of ETI's perceived posture (benevolent, neutral, malevolent) toward humankind.

Failure to plan could exact a substantial price.

Failure to plan could exact a substantial price (Harrison, 1999a). The less planning, the more stress detection will place on human decision-makers. If there are few time pressures, the result may be "defensive avoidance," symptomatized by ignoring potentially important information, procrastinating, disowning responsibility, and "passing the buck" (Janis and Mann, 1985). We might expect some agencies to simply retreat beyond a veil of secrecy, "sit on the matter," and engage consultants who are better known for their demonstrated loyalty to the agency than for their expertise in shaping post-contact civilization. While these agencies dither, self-appointed groups may attempt to manage relations between human and extraterrestrial life.

On the other hand, if there are intense pressures to "do something," the response is likely to be one of hypervigilance, rather than defensive avoidance. This consists of panicky, ineffective decision-making (Janis and Mann, 1985). Under this intense pressure, decision-makers are likely to see only a small part of the overall picture. They focus on some cues and ignore others. It becomes difficult to explore a full range of alternatives and think through all of the implications. They turn first to those solutions that have worked in the past, and, once having chosen a course of action, stick with it despite growing evidence of a mistake. Hypervigilant people do not make sufficient allowance for contingencies, nor make complete plans for implementing their decisions.

Despite the advantages of planning for low-probability but high-impact events, we see very little activity. In many quarters, there is strong reluctance to take the possibility of "contact" seriously. This is understandable. Only recently have scientists assembled evidence that we may encounter intelligent extraterrestrial life. Many leaders in science, government, and industry are either unaware of this evidence or fail to appreciate its credibility. Decades of unverified reports (including honest mistakes, delusions, and deliberate hoaxes) have tainted views of the search enterprise and cooled receptivity on the part of those who should lead the effort. Even individuals who have strong personal interests may refuse to discuss the topic openly because of expected adverse reactions from their colleagues. The possibility of encountering ETI must be acknowledged more widely, and more scholars need to be brought into the loop. Panelists consider it important to involve scholars with strong backgrounds in futures studies, decision theory, decision analysis, game theory, and utility theory, as well as a broad range of social sciences and humanities (see "The Role of the Social Sciences in SETI," this volume).

…the humanities provide us with a vast set of social experiments useful for any assessment of potential impacts of contact.

Keeping in mind that human response will be scenario-specific, and that some scenarios seem more likely than others do, several areas are ripe for systematic study. First, the humanities provide us with a vast set of social experiments useful for any assessment of potential impacts of contact. Although direct physical, cultural contacts are one form of analogue often cited, the long-term impact of high-information contact provided by electromagnetic signals is more analogous to intellectual contact between terrestrial civilizations. Particularly relevant is the transmission of knowledge from the ancient Greeks to the Latin West via the Arabs in the 12th and 13th centuries (Dick, 1995), an event that led to the European Renaissance. More generally, if one accepts the claim that the biological universe is very different from the physical universe, we can study the effect changing worldviews have had on society (Dick, 1995). We can also ask how humans have reacted to past false alarms of extraterrestrial life, whether the canals of Mars, Orson Welles' broadcast of *War of the Worlds* in 1938, the mistaken belief that quasars and pulsars were interstellar navigation beacons, and reports of UFOs (Harrison, 1997). Such analogies, cautiously used, can serve as a starting point for discussion of likely similarities and differences between terrestrial and extraterrestrial experiences.

Human imagination is a rich resource for studying the implications of contact. The best science fiction gives us detailed potential scenarios for different modes of contact, ranging from *War of the Worlds* on the negative side to Arthur C. Clarke's *Childhood's End, Rendezvous with Rama* and *2001: A Space Odyssey* on the positive side. Novels such as Stanislaw Lem's *Solaris* raise yet another scenario that must be considered: contact with intelligence so different from us that it remains beyond our understanding.

If we, in fact, encounter a technologically advanced and communicative society, then the diffusion of science and technology will be a central issue.

Many of the planning efforts so far have been geared to managing the short-term response, which may range from complete apathy to rioting mobs. So far, less attention has been paid to the long-term effects of contact. If we, in fact, encounter a technologically advanced and communicative society, then the diffusion of science and technology will be a central issue (Harrison and Elms, 1990). What more can history tell us about the introduction of advanced technologies into relatively stable "disadvantaged" cultures? What are the variables that determine the acceptance or rejection of new ways? What about the problem of "culture lag," a situation that arises when the rate of technological change exceeds the rate of cultural change, with the result that there is a growing gap between technology and its human users? Massive advances in technology can create problems as well as solve them. For example, technologies that lead to the extension of the human lifespan by many years could also generate monumental environmental, economic, and psychological problems.

Reply Policy

More thought should be given to reply policy; that is, how the Earth might respond if ETI were detected. Most of the preliminary work was conducted by SETI scientists, oftentimes in committees of the International Academy of Astronautics (Michaud, 1998). In keeping with the dominant radiotelescope search paradigm, it has proceeded under the assumption that ETI will be light-years away and unaware of our existence. Under this particular scenario, we might be able to proceed at a leisurely pace, holding our reply until we are confident that we are on safe footing.

…if we do choose to reply, who replies?

Reply policy rests on three fundamental issues. The first is, should we reveal our presence to an extraterrestrial civilization? Even if "most" advanced civilizations are peaceful and beneficent, we won't know for sure about any *individual* civilization and, if ETI doesn't already know of our existence, the safest course might be to maintain a low profile. Second, if we do choose to reply, who replies? As socially enlightened members of the international scientific community, many scientists believe that the response should be made in behalf of humanity as a whole, so supranational systems such as the United Nations loom large in the discussions. Third, what should we say? The goal here is to frame a response that guarantees our own security, reassures "the other," and sets the stage for sharing knowledge.

There are two reasons why we need to develop a reply policy before actual contact. First, a leisurely pace seems less appropriate following detection of ETI in our solar system than following interception of a dial tone at a distance. Second, even if ETI is light-years away, any individual with access to a powerful transmitter may choose to reply and may retain complete control over the message. This could create an erroneous but powerful first impression that would govern the course of future relations. To forestall this possibility, Donald E. Tarter suggests that duly designated authorities should reply instantly. In the first reply the authorities would identify themselves, state that additional information will be forthcoming, and that in the interim ETI should ignore messages from all other parties (Tarter, 1997).

…hundreds of years (or more) may pass between the time that we make our presence known and the time that we receive a response.

Closely related to the issue of reply policy is that of active SETI: deliberately proclaiming our presence to an unknown civilization. As a result of our use of energy or powerful radar broadcasts, another civilization may be aware of us already. However, deliberate action on our part should increase our visibility. If our current passive strategy is successful, we can allay lingering insecurities by simply not responding. If active SETI is successful, we may find ourselves drawing the attention of an unwelcome acquaintance. Another concern with active SETI is that hundreds of years (or more) may pass between the time that we make our presence known and the time that we receive a response. A response that would delight us today may be less welcome to humanity in the year 3000.

By the dawn of the 21st century, there had been several *ad hoc* radio broadcasts and even discussions of launching a private interstellar probe. Perhaps these efforts have a very low probability of success. Nonetheless, since any one of these could affect both present and future generations, there would be an

advantage if humanity as a whole, perhaps operating through the United Nations, were able to regulate such efforts. This is unlikely because of the large number of legal and technical problems that would have to be solved in order to do this. Free speech is a part of many cultures, and given current technology it would be difficult if not impossible to suppress "rogue" broadcasts.

By the year 3000, as a result of some mixture of careful planning, trial and error, and accident, humanity may have worked through the issues of active SETI and reply policy. We speculate that at that time humanity may be quite comfortable interacting with ETI, and not at all worried about reply policy or active SETI.

Developing Educational Programs

Advanced preparation should include educational programs for preparing people for the possibility of contact. SETI provides a wonderful "hook" for engaging people in science. Properly designed educational programs can enhance people's understanding of astronomy and life sciences, as well as acquaint them with SETI and its possible aftermath. The SETI Institute's "Social Implications" report (Billingham et al., 1999) devoted close attention to this and looked to broad partnerships including planetaria and libraries as well as schools, colleges, and universities. This report also described how SETI scientists could work with the news and entertainment media to educate people and help shape public opinion. A multimedia approach can help, for example, by using the visual arts to make the extraterrestrial presence real but in nonthreatening ways.

Several education efforts are already underway. The SETI Institute's "Life in the Universe" curriculum is noteworthy in part because it is under translation into different languages to make it more accessible to the world's population. The SETI Australia Centre also has a large educational component. Relevant also are the websites and outreach programs maintained by the NASA-Ames Astrobiology Institute.

Specific target populations include the media, opinion leaders, and children.

Specific target populations include the media, opinion leaders, and children. The media must be highly informed so that it can provide high-quality coverage even in the event of rapidly unfolding developments. Politicians, scholars, business magnates, military officers, and other opinion leaders must be informed, because they will help shape the reactions of the many people who look to them for guidance. Children are important because it is they who will carry on the search, and their generation may be the first to experience the full impact of contact. As a useful spin-off, educational efforts aimed at children will help them separate science and fiction, and nudge them toward careers in science and technology.

In addition to reaching individuals, we need to reach organizations and institutions that will have much to do with managing contact and its aftermath. These include intelligence-gathering organizations, legislative and regulatory bodies, the military, the media, and professional organizations of all sorts.

Preparing Ourselves Spiritually and Psychologically

Those of us in the SETI community are self-anointed to lead the search and help manage the consequences. But are we prepared personally? According to Zen, everyone is an enlightened individual. Are we truly ready to encounter an "alien mind"? As long as we quibble among ourselves, can we consider ourselves ready for contact?

Those of us engaged in the SETI enterprise spend substantial time addressing purely scientific issues and intellectualizing the impact of contact. Perhaps it would be useful to supplement these efforts by developing inner strengths to brave confirmation and the post-contact world.

If we can't relate to our fellow human beings, how can we expect to understand beings from another part of the galaxy?

Taking our cue from the Buddhist tradition, we might spend more time in self-contemplation, becoming more at ease with ourselves and one another. If we can't relate to our fellow human beings, how can we expect to understand beings from another part of the galaxy? The qualities we seek are openness to new experience, comfort with ourselves, and sensitivity and compassion for others.

CONCLUSION

No one is sure whether or not ETI exists, and, if it exists, whether or not it will be detectable to us.

Nonetheless, growing circumstantial evidence and accelerating search technologies have marked the past four decades. Those who are willing to guess when contact will occur couch their estimates in decades, not in centuries or millennia. If their guesses prove accurate, humanity in the year 3000 will have long since discovered extraterrestrial life.

The impact of the detection of extraterrestrial life will depend upon the nature of ETI, the unfolding of the contact scenario, and the people involved. If in fact ETI meets optimistic expectations (advanced, beneficent, communicative), we speculate that following an initial period of confusion and consternation, interstellar relations will be marked by three stages. During Stage 1, humans will have strong, positive attitudes towards ETI. This will stem in part from the benefits of receiving ETI's largesse and in part from a human tendency to become emotionally enamored of older, wiser, richer, and more powerful individuals. Inevitably, at some point, ETI will fall short of our descendants' expectations. Perhaps ETI will not have the information that they want, will not be inclined to come to humanity's rescue, or will reveal something that we interpret as a serious flaw in their character or society. Or perhaps some of ETI's advice won't work, or will have hidden, undesirable consequences.

Stage 2, then, will be predominated by suspicion, cynicism, and negative emotions—all proportional to the height of the expectations generated earlier. However, if interaction continues, Stage 2 also will pass. As future generations of humanity gain more experience, they will develop a more complex picture of ETI and enter Stage 3. At that point, people will no longer view ETI as gods or devils, but as complex creatures with unique patterns of strengths and weaknesses. Humanity in the year 3000 may have mature, Stage 3 relations with many different ETI civilizations.

REFERENCES

Alexander, John (1999). *Future War: Non-Lethal Warfare in the Twenty-First Century* (St. Martins Press, New York).

Alexander, Victoria (1998). "The Alexander UFO Religious Crisis Survey." http://www.anv.net/nids/articles/alexander/survey/_religion.html (National Institute for Discovery Science, Las Vegas).

Ashkenazi, Michael (1992). "Not the Sons of Adam: Religious Response to ETI," *Space Policy*, *8*, 341-350.

Axelrod, Robert (1984). *The Evolution of Cooperation* (Basic Books, New York).

Baird, John (1987). *The Inner Limits of Outer Space* (The University Press of New England, Hanover, NH).

Ball, John A. (1973). "The Zoo Hypothesis," *Icarus*, *19*, 347.

Barrow, John (1995). *The Artful Universe* (Clarendon Press, Cambridge, UK).

Berenzden, Richard (1973). *Life Beyond Earth and the Mind of Man* NASA SP-328 (National Aeronautics and Space Administration, Washington, DC).

Berry, Adrian (1996). *The Next 500 Years: Life in the Coming Millennium* (W. W. Freeman and Company, New York).

Billingham, John; **Heyns, Roger**; **Milne, David**; et al. (1999). *Social Implications of the Detection of an Extraterrestrial Civilization* (The SETI Institute, Mountain View, CA).

Black, D. C., and **Stull, M. A.** (1977). "The Science of SETI," in **Morrison, Phillip**; **Billingham, John**; and **Wolfe, John**, eds. (1977). *The Search for Extraterrestrial Intelligence*. NASA Special Publication SP 419 (National Aeronautics and Space Administration, Washington, DC), 93-120.

Bracewell, Ronald (1975). *The Galactic Club: Intelligent Life in Outer Space* (San Francisco Books, San Francisco).

Crosswell, Ken (1997). *Planet Quest: The Epic Discovery of Alien Solar Systems* (The Free Press, New York).

Crowe, Michael (1986). *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell* (Cambridge University Press, Cambridge; Dover reprint, 1999).

Crowe, Michael (1994). *Modern Theories of the Universe: From Herschel to Hubble* (Dover, New York).

Cusack, Thomas R. and **Stoll, Richard A.** (1994). "Collective Security and State Survival in the Interstate System," *International Studies Quarterly*, *38*, 33-59.

Davies, Paul (1998). *The Fifth Miracle: The Search for the Origin of Life* (Penguin Press, London).

Davoust, Emmanuel (1991). *The Cosmic Water Hole* (MIT Press, Cambridge, MA)

De Duve, Christian (1995). *Vital Dust: Life as a Cosmic Imperative* (Basic Books, New York).

DeVito, C. L., and **Oehrle, R. T.** (1990). "A Language Based on the Fundamental Facts of Science, *Journal of the British Interplanetary Society*, *43*, 561-568.

Dick, Steven J. (1982). *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant* (Cambridge University Press, Cambridge).

Dick, Steven J. (1995). "Consequences of Success in SETI: Lessons from the History of Science," in **G. Seth Shostak**, ed., *Progress in the Search for Extraterrestrial Life* (Astronomical Society of the Pacific, San Francisco), 521-532.

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

Dick, Steven J. (1998). *Life on Other Worlds* (Cambridge University Press, Cambridge).

Dick, Steven J. (2000a). "Cosmotheology," in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and its Theological Implications* (Templeton Press, Philadelphia).

Dick, Steven J., ed. (2000b). *Many Worlds: The New Universe, Extraterrestrial Life and its Theological Implications* (Templeton Press, Philadelphia).

Doyle, Stephen G. (1996). "Post Detection Global Institutional Arrangements." Paper presented at the 47th International Astronautical Congress, (Beijing, China, October).

Drake, Frank and **Sobel, Dava** (1992). *Is Anyone Out There?: The Scientific Search for Extraterrestrial Intelligence* (Delacorte Press, New York).

Dyson, Freeman (1997). *Imagined Worlds* (Harvard University Press, Cambridge, MA).

Finney, Ben (2000). "Consilience and the Unity of Knowledge." In Guillermo Lemarchand and Karen Meech (editors), *Bioastronomy '99—A New Era in Bioastronomy, Proceedings of a Conference held on the Kohala Coast, Hawaii, 2-6 August, 1999*, ASP Conference Series 213. Reprinted in this volume.

Freudenthal, Hans (1985). Excerpts from "Lincos: Design of a Language for Cosmic Intercourse," in **Edward Regis, Jr.**, ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, New York), 215-228.

Fukuyama, Francis (1992). *The End of History and the Last Man* (Avon Books, New York).

Goldsmith, Donald (1997). *Worlds Unnumbered: The Search for Extrasolar Planets* (University Science Books, Sausalito, CA).

Guthke, Karl (1990). *The Last Frontier: Imagining Other Worlds from the Copernican Revolution to Modern Science Fiction* (Cornell University Press, Ithaca, NY).

Haisch, A., **Rueda, A.**, and **Puthoff, Hal** (1998). "Advances in the Proposed Electromagnetic Zero-Point Field Theory of Inertia." Paper presented at the 34th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, (Cleveland, Ohio, July).

Harris, Philip R. (1996). *Living and Working in Space*, Second Ed. (Wiley-Praxis, Chichester, UK).

Harrison, Albert A. (1993) "Thinking Intelligently About Extraterrestrial Intelligence: An Application of Living Systems Theory," *Behavioral Science*, *33*, 189-217.

Harrison, Albert A. (1996). "On the Relative Preponderance of Belligerent and Peaceful Civilizations: Implications for SETI." Paper presented at the 47th International Astronautical Congress, (Beijing, China, October).

Harrison, Albert A. (1997). *After Contact: The Human Response to Extraterrestrial Life* (Plenum, New York).

Harrison, Albert A. (1999a) "Confirmation of ETI: Initial Organizational Response." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Harrison, Albert A. (1999b). "Proximity, System Level, and the Human Response to Extraterrestrial Life." Paper presented at Cultural Implications of Astrobiology Symposium, (NASA–Ames Research Center, November).

Harrison, Albert A., and **Elms, Alan C.** (1990). "Psychology and the Search for Extraterrestrial Intelligence," *Behavioral Science*, *35*, 207-218.

Janis, Irving L., and **Mann, Leon** (1985). *Psychological Analysis of Conflict, Choice and Commitment* (The Free Press, Homewood, IL).

Karadashev, Nicolai (1964). "Transmission of Information by Extraterrestrial Civilizations," *Soviet Astronomy, 8*, 217, reprinted in D. Goldsmith *The Quest for Extraterrestrial Life* (University Science Books, Mill Valley, CA), 136.

Kauffman, Stuart (1995). *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity* (Oxford University Press, New York).

Keegan, John (1994). *A History of Warfare* (Vintage Books, New York).

Mack, John E. (1999). *Passport to the Cosmos* (Crown Publishers, New York).

Marcy, Geoffrey W. and **Butler, R. Paul** (1998). "Detection of Extrasolar Giant Planets," *Annual Review of Astronomy and Astrophysics*, *36,* 57-97.

Maruyama, M., and **Harkins, A.** (1975). *Cultures Beyond Earth: The Role of Anthropology in Outer Space* (Vintage Books, New York).

Matloff, G. L. (1999). "Interstellar Solar Sailing: Comparison of Five Candidate Sail Materials." Paper presented at the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Matloff, G. L., **Schenkel, P.**, and **Marchan, J.** (1999). "Direct Contact with Extraterrestrials: Possibilities and Implications." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Michaud, M. A. G. (1974). "On Communicating with Aliens." *Foreign Service Journal*, June, 33-40.

Michaud, M. A. G. (1998). "Policy Issues in Communicating with ETI," *Space Policy*, *14*, 173-178.

Miller, James Grier (1978). *Living Systems* (McGraw-Hill, New York).

Minsky, Marvin (1985). "Why Intelligent Aliens will be Intelligible," in **Edward Regis, Jr.**, ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 117-128.

Molton, P. M. (1989). "An Experimental Approach to Extraterrestrial Life," *Journal of the British Interplanetary Society*, *42*, 423-429.

Morrison, Phillip, **Billingham, John**, and **Wolfe, John**, eds. (1977). *The Search for Extraterrestrial Intelligence*. NASA Special Publication SP 419 (National Aeronautics and Space Administration, Washington, DC).

Mueller, John (1988). *Retreat from Doomsday: The Obsolescence of Major War* (Basic Books, New York).

Norris, Ray P. (1998). "Can Science Survive a SETI Detection?" Paper presented at the International Conference on SETI in the 21st Century, UWS Macarthur, (Sydney, Australia, October).

Norris, Ray P. (1999) "How Old Is ET?" Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October). Reprinted in this volume.

Radin, Dean (1997). *The Conscious Universe: The Scientific Truth of Psychic Phenomena* (HarperEdge, San Francisco).

Rees, Martin (1997). *Before the Beginning: Our Universe and Others* (Addison-Wesley, Reading, MA).

Rescher, Nicholas (1985). "Extraterrestrial Science," in **Edward Regis, Jr.**, ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 83-116.

Ruse, M. (1985). "Is Rape Wrong on Andromeda?" in **Edward Regis, Jr.**, ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 43-78.

Russett, Bruce (1993). *Grasping the Democratic Peace* (Princeton University Press, Princeton, New Jersey).

Seielstad, George A. (1989). *At The Heart of the Web: The Inevitable Genesis of Extraterrestrial Life* (Harcourt Brace Jovanavich, Boston).

Schenkel, P. (1999). "Contact with ETI: Implications for a New World Order." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Shostak, Seth (1998). *Sharing the Universe: Perspectives on Extraterrestrial Life* (Berkeley Hills Books, Berkeley, CA).

Shostak, Seth (1998). "The Lifetime of Intelligent Civilizations." Paper presented at CONTACT XV, (Santa Clara, CA, March).

Smolin, Lee (1997). *The Life of the Cosmos* (Oxford University Press, Oxford).

Swift, David (1990). *SETI Pioneers* (University of Arizona Press, Tucson, AZ).

Tarter, D. E. (1997). "Security Considerations in Signal Detection." Paper presented at the 48th International Astronautical Congress, (Milan, Italy, October).

Thompson, Keith (1991). *Angels and Aliens: UFOs and the Mythic Imagination* (Addison-Wesley, Reading, MA).

Tough, Allen (1986). "What Role Will Extraterrestrials Play in Humanity's Future?" *Journal of the British Interplanetary Society*, *39*, 491-498.

Tough, Allen (1991). *Crucial Questions About the Future* (University Press of America, Lanham, MD).

Tough, Allen (1997). "What People Hope to Learn from Other Civilizations." Paper presented to the 48th International Astronautical Congress, (Turin, Italy, October). *Acta Astronautica*, in press.

Tough, Allen (1998a). "Interstellar Probes Within SETI, 1960-1998." Paper presented to the 49th International Astronautical Congress, (Melbourne, Australia, September–October).

Tough, Allen (1998b). "Small, Smart Interstellar Probes," *Journal of the British Interplanetary Society*, *51*, 167-174.

Tough, Allen (1999). "A Long-Term Perspective on Interstellar Contact." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

U. S. Congress (1961). "Proposed Studies on the Implications of Peaceful Space Activities for Human Affairs." Report of the Committee on Science and Astronautics, U. S. House of Representatives, 87th Congress, First Session, prepared for NASA by the Brookings Institution (U.S. Government Printing Office, Washington, DC).

Vakoch, D. L. (1999a) "Communicating Scientifically Formulated Spiritual Principles in Interstellar Messages." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Vakoch, D. L. (1999b). "The Aesthetics of Composing Interstellar Messages." Paper presented to the 50th International Astronautical Congress, (Amsterdam, the Netherlands, October).

Vakoch, D. L., and **Lee, Y.** (1997). "Reactions to Receipt of a Message from Extraterrestrials: A Cross-Cultural Empirical Study." Paper presented to the 48th International Astronautical Congress, (Turin, Italy, October).

Von Hoerner, S. (1974). "Universal Music?" *Psychology of Music*, *2*, 18-28.

Vulpetti, G. (1998). "On the Viability of the Interstellar Flight." Paper presented at the 49th International Astronautical Congress, (Melbourne, Australia, September–October).

White, Frank (1990). *The SETI Factor.* (Walker and Company, New York).

White, Frank (1987). *The Overview Effect* (Houghton Mifflin, Boston).

Wilson, E. O. (1998). *Consilience: The Unity of Knowledge* (Knopf, New York).

Section III

Who Said What: A Summary and Eleven Conclusions

John Billingham
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…there are a number of ways of searching for extraterrestrial intelligence (SETI)…any of these might be successful, at any time into the future…

Introduction

This seminar, organized by the Foundation For the Future, took place on July 31 and August 1, 1999, in the same location as the Bioastronomy '99 Conference. It focused on the long-term implications of a potential dialogue with an extraterrestrial civilization. The following topics were addressed in a discussion format:

- The impact of any practical information and advice that we receive.
- The impact of new insights, understanding, and knowledge about major questions that go far beyond ordinary, practical, day-to-day matters.
- The impact of a transformation in our view of ourselves and our place in the universe.
- Any other significant impact or effects, either positive or negative.
- What should humanity do NOW in order to maximize the positive long-term impact from an eventual dialogue—in order to achieve the greatest possible benefits for our culture, science, worldview, and long-term future?

The coordinator of the seminar was Allen Tough, University of Toronto.

Bob Citron opened the meeting by saying that the Foundation For the Future is interested in how our collective culture will respond to contact over the coming millennium.

Allen Tough opened the discussion by noting that there are a number of ways of searching for extraterrestrial intelligence (SETI), and that any of these might be successful, at any time into the future, in making an unequivocal detection. One consequence could then be a deluge of information from a society far in advance of ours. Some early studies have addressed what might be the immediate and near-term effects of the discovery. But Tough observed that the major impact would probably develop over decades, or centuries, and could have a profound effect on the evolution of our own civilization into the future. He therefore invited the participants to leapfrog over the near future and consider possible consequences of the detection over a thousand years by examining, in a group discussion format, the topics given above.

Topic 1 dealt with the impact of any practical information and advice that we receive. Claudio Maccone noted that they could have mastered superluminal string theory, unifying all known forces of nature, and would therefore know how to harness the huge energies connected with the zero-point field, and how to achieve faster-than-light travel. We should

therefore be ready to decipher such information by theorem-proving and other advanced techniques. If it were then possible to create wormholes, we could revolutionize interstellar communication and achieve a much more rapid dialogue. This would be a practical impact of extraordinary importance. Jill Tarter asked why we should communicate through the wormholes with photons rather than baryons, that is, spaceflight of the type envisaged in Sagan's novel *Contact*. Maccone said that photons were a great deal easier. John Billingham recalled Oliver's calculation of the energy needed to transfer a certain amount of information by spaceflight was 10^{40} greater than that needed for electromagnetic waves.

Guillermo Lemarchand argued that advanced societies, having long since passed their level of technological adolescence, would have a high level of "cosmo-ethics." This would mean that they themselves would be unlikely to attempt ecologically threatening projects like Dyson spheres or 10^{26} Watt omnidirectional transmitters, and that they would not want to pass on to emerging civilizations the knowledge of how to achieve such unrewarding endeavors. Therefore, they would likely pass information to us, or to other civilizations, in stages, so that there would be time to absorb and assimilate the knowledge in discrete increments. In other words, they would have chosen deliberately not to put our evolution and societal life expectancy in danger.

Therefore they will not transmit to us until they have detected us. If this is correct, we will only be able to receive from a distance $R_t < 35 + T_f/2 + \tau$ light-years, where R_t is the distance at any time t in the future, T_f is that time t expressed in years, and τ is the time the society needs to analyze our behavior and degree of evolution. So in 2053, with $\tau = 5$, the distance $R_t = 67$ light-years. Lemarchand concluded that Project Phoenix is best suited to get a high information content under these circumstances. (Note: This is rather a pessimistic scenario in that we will not hear from anyone, except for leakage, beyond R_t, and success in the near future would be achieved only if there were civilizations close to us.)

In the discussion that followed, Douglas Vakoch noted that this scenario assumes that ETI ethics are something like our own, and asked about the dependence of ethics on one's biology. Or if they have gone beyond the stage of biology to artificial intelligence, what then? Tough said it would be interesting and important to learn what their ethics actually are. Eric Chaisson said the ethics issue is huge. We have to develop our own, rather than from ETI, and if we do it right, we will survive. But Tarter said it is most important for us to receive information about ways of surviving one's technological infancy.

…ETI might not have the same motives and behaviors as we do. They may be developing along a different evolutionary pathway and have no interest in contacting others.

It was agreed that ETI might not have the same motives and behaviors as we do. They may be developing along a different evolutionary pathway and have no interest in contacting others. On the other hand, should they be interested in communicating with us, one of the most important practical results of contact would be the knowledge that it is possible to survive far beyond our own level of evolution, and perhaps how they did it.

Topic 2 addressed new insights: knowledge and understanding of the big questions and mysteries of the universe that go far beyond practical day-to-day matters. Against the background of epistemology and objective knowledge, Steven Dick asked whether we and ETI perceive the universe in the same way. There are three alternative cases:

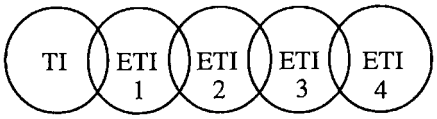
Case 1 holds out hope for easy dialogue and agreement. Case 3 implies such complete separation of sentience or mental processes as to prevent dialogue, or the mutual examination of objective knowledge.

The problem of objective knowledge bears on the possibility of communication, on the role of language, and on those aspects of the universe that have the possibility of verification.

The problem of objective knowledge bears on the possibility of communication, on the role of language, and on those aspects of the universe that have the possibility of verification. Knowledge must be distinguished from belief, which may have no basis in the objective world; one would not expect extraterrestrial religious belief, for example, to take the same form as on Earth, though the existence of God may be an objective question. If contact is successful, a major task over the next millennium will be to syn-

thesize the knowledge of many worlds. The nature of this task will depend greatly on which of the three cases above turns out to be most common among galactic civilizations. Ben Finney said that the better we understand each other's jokes, the closer we will be to Case 1.

Vakoch drew up a fourth case for overlaps of objective knowledge:



Case 4

Finney observed that this is known in anthropology as a *dialect chain*. (Note: It is possible that our first contact with ETI may be like Dick's Case 3, but that with further discoveries of additional ETIs, one might achieve understanding and dialogue through these additional ETIs, each of whom has Case 2 overlaps with the others and us. Or we may learn from ETI No. 1 about all the others even though we have not detected the others ourselves.)

Tarter reminded everyone that any ETI we detect will likely be far older than we are. She listed some implications as follows: First, it is possible to survive one's technological infancy. (Note: This now reappears as an answer to a major fundamental question as well as important practical new knowledge.) Second, they may have a well-developed empirical field of study that can define critical bottlenecks and elaborate different ways through them. Third, they may have survived the red giant phase of their star. Fourth, their longevity is at odds with organized monotheistic religions typical of Earth. Fifth, there may be something like a universal religion, and there will be a highly established code of ethics. Sixth, they may tell us how it is possible to change from the primitive "My God versus your God" conflicts on Earth to a more stable universal understanding.

Lemarchand raised the question of religious issues in connection with the long-term impact of the discovery of ETI. He pointed out that all religions on Earth have common "Principles of Fraternity." On top of these is often superimposed the ritual dogmas of individual church power structures, sometimes resulting in control by an elite. If we learn that an ETI species has different or no thoughts about God, this will not generate reactions or conflict except among those terrestrial religions that are fanatical about their dogmas. But if we learn that there are some universal "Principles of Fraternity" like the universal laws of physics, then Lemarchand imagines a stimulating revolution of the most positive kind in terrestrial thinking about religion as a whole.

…in the Buddhist sutras there is some evidence that contact has already occurred.

In the discussion of these Topic 2 papers there was some agreement on the untoward effects of the aggressive and autocratic aspects of the Adamist religions. Albert Harrison said that the revolution in religious thought could well be a slow process, especially if the information from ETI came in slowly. Keiko Tokunaga noted that in the Buddhist sutras there is some evidence that contact has already occurred. Vakoch pointed out that ethics could evolve differently for ETIs who might live for 100,000 years, and that the corollary is that the emergence of universal ethics (as an extension of the global ethics envisaged by Chaisson) might facilitate great longevity for individuals and species as a whole.

Case 3 scenarios were envisaged for ETIs whose biological evolution has been quite different. For example, said Vakoch, how would we understand ETIs whose main means of communication was olfaction? Dick quoted Kuhn's opinion that we can easily talk past each other if we have different paradigms. Finney elaborated, with the example that we might have had a Case 3 situation at this meeting if post-modernists had been present. Lemarchand reminded us that Piaget said that the circles would eventually merge.

Tarter quoted Dawkins' firm belief that evolution on Earth is the end result of predator/prey relationships. Billingham felt that a majority of exobiologists would postulate the same for ETI, up to our stage of evolution today. But Dick said different ET environments could lead to different pathways for ETI evolution. Vakoch thought that evolutionary stories could be the basis for interstellar messages.

Tarter said that the major fundamental question is whether ETI exists: detection of their signal would provide the answer. Everyone agreed that the knowledge that they had achieved great longevity was another answer to the fundamental, as well as practical, question as to whether long-term survival is actually possible.

Topic 3 was concerned with changes in our views of ourselves. Paul Davies focused on the fact that religion is already being transformed by the prospect of

the existence of ETI. While theologians may express a relaxed view of the possibility of ETI, they may be hiding some deep concerns because of the geocentric or homocentric nature of many religions, especially Christianity, vulnerable because of the unique position of Jesus Christ as God incarnate. The shock will be worse if ETI turns out to have achieved, by directed evolution, a more spiritual or saintly state far beyond ours.

Finney imagined a crisis in the middle of the Third Millennium. SETI would already have been successful, the field of comparative exosemiotics would be maturing, and Tsiolkovsky biospheres would be capable of cruising to the stars at 0.3 c. But the sobering news on the interstellar communication channels is that many star systems are occupied by advanced ETIs who do not want us, have little interest in us, and are not inclined to give us tutorials. Whither now, self-anointed *Homo sapiens*?

While enthusiasts paint rosy pictures, they rely on the hope that ET will treat us as equals…

Harrison asked some interesting new questions about social comparisons, identity, and self-esteem a millennium after the discovery of ETI. While enthusiasts paint rosy pictures, they rely on the hope that ET will treat us as equals, that we will continue to compare ourselves with one another, and that our changing cultures will retain distinctive elements. But the opposite of all of these could dominate. We should study historical analogs further, searching especially for positive outcomes of contact in the areas of the amicable co-existence of caste systems, positive lessons from the colonial experience, subjective determinants of self-esteem, and preservation of identity following contact between cultures.

Gender parity was taken by Kathleen Connell as a specific question of the societal impact of an extraterrestrial cultural exchange. Specifically, would ETIs embody a different gender construct? In turn, would a radically different gender model positively impact the existing disparity in human society? Connell listed variations in genderism that ETIs may manifest. Her conclusion was that some social inequities, such as gender-based disparities, may be integrated only by the introduction of off-home-planet genetic paradigms and role modeling.

There was much discussion of the remarkable change in our view of ourselves over the last few hundred years. Before that, as Davies said, human beings were thought to have been created by God and to occupy a central position in the universe. Today that view has largely disappeared. Chaisson called it a remarkable U-turn in everything from the Big Bang to intelligence. Tarter said it was now reasonable to think that we are actually made of star stuff. (Note: One wonders whether similar dramatic changes may await us in the coming millennium with or without the advent of contact with ETI.) Harrison cautioned that the transition was not exactly smooth, and we should examine the bumps in the curve. Billingham referred to the discovery of the lost knowledge of the ancient Greek civilization in the Moorish civilization in Spain in the 12th century. There are two points here: The first is the stimulus this gave to the start of the Renaissance. The second is the analogy with our discovery of new knowledge from ETI. (If there is any reality to the analog, then contact with ETI could bode well for a new Enlightenment for us.) Dick agreed with the importance of the discoveries in Spain, but cautioned against predicting the future from perceived analogs with the past.

Connell said that some people believe that SETI has elements of a secular religion. Billingham asked if "secular religion" was not an oxymoron. Baseball, said Finney, has been described as a secular religion. Tarter said SETI has indeed been accused of being a secular religion. But SETI people are hard-nosed scientists who are prepared to accept that we are alone if that could be proved. So our beliefs are subject to test, and change on the basis of hard evidence, which is not the case for religions.

Topic 4 covered long-term effects that are primarily negative. For the sake of argument, Chaisson postulated no positive effects from contact with ETI over the coming millennium. For electromagnetic contact, there will be a small cadre of academics publishing on ETI in cyberspace journals, but the vast majority will be consumed with the continuing travails of life on Earth. Physical contact would be much worse, and lead to a neo-Darwinian subjugation of our culture by theirs. Advanced societies might dominate the less advanced, just as has happened in many cases on Earth.

…it could be the end of civilization as we know it.

Ragbir Bhathal agreed. ETIs would want to control the resources of the universe for their own ends, just as has happened on Earth. Physical contact is not actually necessary, because proxies can be installed

by ETI, just as the Soviet brand of Communism relied on home-grown dictators in East Asia. The culture shock will be severe and disruptive, and our institutions will fail. So it could be the end of civilization as we know it.

Tarter noted that the real impact might be to trivialize the severe differences between humans. Lemarchand noted that President Reagan said that a hostile ETI could unite us like nothing else. Lemarchand also made the important point that their domination of us may be the natural order of things. Davies was worried that bad guys might actually prevail. Connell warned that evolving into a monotheistic culture might threaten democracy and the rule of law.

Topic 5 explored the really practical question of "What can we do now?"

Vakoch pleaded for a recognition that long-term impacts of a dialogue with ETI may be determined to a significant extent by our initial response. We would do well to ponder all the issues in advance. Special attempts should be made to construct messages ourselves, not just in terms of mathematics and science, but in the arts. Musical intelligence is a candidate, witness the paper by Von Hoerner on three of four alternative scales of possibly universal significance. Do not forget the Buddhist question: "What is the sound of one hand clapping?" Perhaps part of the message should itself be a work of art. Billingham said that we should attach an asterisk saying that this is not the real thing. Vakoch said it could be argued that the asterisk might go on the science and math saying it was not the real thing. He concluded by saying we should look for ways of opening up barriers so that Case 3 situations might be nudged towards Case 2 and then to Case 1.

Tough worried that if they are here, they may be in Case 3 because there is no contact. Davies reminded everyone that worldviews can change dramatically in 100 years, witness the arrival of the Information Age. Vakoch said that we should be sure to use environmental phenomena, such as pulsar locations, as common reference points so that those, at least, are in Case 1.

Citron emphasized that over the next thousand years we will be modifying our own existence and capabilities. We may gradually move towards some type of humanoid machinery, or machine intelligence, endowed with great longevity. How will this help us to detect ETI, or to conduct a dialogue with ETI? Davies pointed out that genetic engineering may be used to eliminate criminal or antisocial behavior, and that the distinction between nanotechnology and biotechnology will soon disappear. Further, ETI will already have done all this.

There was much concern about what we might do, and what they might have already done, to species behavior. For example, will the exploration gene be deleted, enhanced, or left as it is in humans of today? Citron and others hoped that positive aspects of human behavior would be programmed into cyborgs, if there are cyborgs, so that it is not lost. Davies proposed a Committee on Urges, to examine what should be done with each. Tarter reminded everyone that it may be possible in the future to teleport the complete intelligence of a human being.

Tough presented arguments for augmenting SETI in five areas:

1. Pursue a variety of means for searching the solar system and our planet for physical evidence of an extraterrestrial object or its effects.
2. Invite contact through invitations to ETI on the World Wide Web.
3. Encourage contact by becoming sufficiently prepared.
4. Search for evidence of astroengineering projects and their by-products.
5. Use radio and optical SETI to detect artificial signals.

He has already signed up a group of 40 SETI scientists for Item 2.

Finney said we should pursue an archeological search for artifacts in the solar system. Lemarchand encouraged everyone to spread the word about SETI signals buried in astronomers' existing data, perhaps squirreled away in their bottom drawers. Tarter agreed we should systematize such retrospective searches. Maccone envisaged searching for an ETI probe in a sphere of radius 550 AU from the Sun—which might be the location of their communication antenna at the gravitational focus of the Sun.

Billingham argued for an expansion of the current small group studying the societal issues surrounding the contact scenario. Bring on board additional experts in all the disciplines to stimulate discussion. Vakoch will serve as the Institute's focal point for collecting names of good candidates. At the moment we are 25 years behind the SETI physical scientists and engineers in achieving respectability. He passed around the first publication of the SETI Institute's SETI Press, entitled *Social Implications of the Detec-*

tion of an Extraterrestrial Civilization,[1] put together some years ago by the Workshops on the Cultural Aspects of SETI. This was a group of distinguished scholars from most of the disciplines involved in SETI and Society. One of their recommendations was to conduct a broader international conference on SETI and Society, funds for which are now being sought. Billingham said also that most of the existing references on SETI and Society are included in the new SETI Press publication, and in Harrison's book *After Contact,*[2] and in the publications of Dick,[3] Michaud,[4] and others at the seminar.

In the discussion that followed, many suggestions were made for augmenting the SETI and Society base. These are included in "Contact: Long-Term Implications for Humanity," by Dick and Harrison. [See Section II, this volume.]

…we should do more to prepare for a dialogue by becoming more receptive, breaking away from our individual egos, using our basic intuition, becoming more compassionate, and finding places where contact could be made.

The final paper was given by Tokunaga and dealt with the significance, in terms of Zen Buddhism, of how we send signals to each other, and how we receive and interpret them. This has major importance for our own interactions here on Earth. There are still different ways of looking at the world here—witness the different conceptual frameworks of Buddhism and the Western world. Could some of these differences be analogs of what we might expect in encounters with ETI? In any event, we should do more to prepare for a dialogue by becoming more receptive, breaking away from our individual egos, using our basic intuition, becoming more compassionate, and finding places where contact could be made. She said it was important to resolve our own differences. Perhaps this is why we have not heard from them. She described the cycles of life in the Buddhist philosophy, and left open the possibility that one could include extraterrestrial life. ETI is clearly not excluded in Buddhism.

Tarter asked how the news of a detection would be received in the Buddhist temple. Tokunaga said there would be a wide range of reactions depending on individual perceptions and intuition. The results of the encounter will depend on who you are. Finney wondered if they would really want to contact us, given all our current problems. Tokunaga noted that Tarter wants an answer to the question, "Are we alone?" and everyone seems to be pining for contact. In the Buddhist view, the eating of garlic is forbidden, because it is considered to cloud the mind. Perhaps our group should follow suit and then be able to come up with some clearer ideas and insights.

In closing the meeting, Tough said that detection would be a major event of the next thousand years, and that we should continue to search and to examine the long-term impact of detection.

Citron said that this topic might be worth repeating, with follow-up discussions in two or five years.

Conclusion

This meeting was conducted in a brainstorming format, and did not attempt to cover all aspects of the long-term societal implications of contact. Areas that will surely be explored in future meetings are: social attributes and context over the years before, during, and after detection; the desirability, or not, of transmitting from Earth, either after we have detected ETI or *de novo*; interstellar languages; political and institutional processes and arrangements for trying to reach consensus on transmissions from Earth; and more details of the role of education and the media.

In those areas that were discussed, some general findings emerged:

1. A detection would have profound practical and long-term implications for our civilization.

2. At the very least, we would have answered the question, "Are we alone?"

3. The ETI we detect will likely be much older than we are, proving that a civilization can achieve longevity.

4. We may be faced, either gradually or rapidly, with a flood of information from an advanced civilization.

5. This information may be difficult to comprehend, either because it is so advanced, or because it is a totally different epistemological frame of reference, or both.

6. We should prepare for detection by further studies involving people from many walks of life, by closer self-examination, by education, and by the pursuit of the topic in bodies such as UNESCO and COPUOS, or by the establishment of a World Council.

…the course of subsequent dialogue could be deeply influenced by the composition and tenor of our first message.

7. We should consider the content of a transmission to ETI with great care, since the course of subsequent dialogue could be deeply influenced by the composition and tenor of our first message.

8. We should continue studying historical analogs of contact, but not rely on them as predictors of the future. We should analyze analogs involving the positive consequences of a less advanced society communicating with a more advanced society, especially where there is no physical contact.

9. The implications for religions on Earth are already being felt before contact, and may be of great import for a long time after contact. It is possible that fraternal principles found in most terrestrial religions may have been blended into a universal code of ethics by ETI.

10. Over the next millennium we will develop increasing ability to control our own evolution, and may see the advent of cyborgs and machine intelligence. Hopes were expressed that we will not lose desirable characteristics, for example, altruistic or exploration genes, in the process. We should be prepared for ETIs to have gone through such evolutionary steps long ago.

11. The millennia after contact could be a normal evolutionary phase for citizens and civilizations of the universe.

References

[1]**Billingham, J.**, et al. (1999). *Societal Implications of the Detection of an Extraterrestrial Civilization* (SETI Press, Mountain View, CA).

[2]**Harrison, A.** (1997). *After Contact: The Human Response to Extraterrestrial Life* (Plenum Press, New York).

[3]**Dick, S.** (1996). *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge University Press, Cambridge).

[4]**Michaud, M.** and **Tarter, J.**, Eds. (1989). Special Issue of *Acta Astronautica: SETI Post-Detection Protocol* (Pergamon Press, Oxford, UK).

Paper presented at the conference *Bioastronomy '99: A New Era in the Search for Life in the Universe,* August 2-6, 1999, Kohala Coast, Hawaii.

Section IV

Participants' Statements

Prior to convening for the workshop, participants were asked to prepare one- to two-page statements to present as handouts during the session. These brief papers, each related to one aspect or another of the cultural impact of extraterrestrial contact, reflected the participants' early deliberation on the topics and served as starting points for the group discussions. The topics were as follows:

1. **Practical Information**
2. **Answers to Major Questions**
3. **Changes in Our View of Ourselves**
4. **Cooperation in Joint Galactic Projects**
5. **Significant Long-Term Effects That Are Primarily Negative**
6. **What Should Humanity Do Now to Maximize Positive Long-Term Impacts?**

Following are the participants' statements.

Superluminal Strings Theory: What ETI May Teach Us

Claudio Maccone
Alenia Spazio

…humanity must then be ready to decipher such a message telling us about superluminal strings theory and its technological outreaches.

Suppose that at least one of several galactic civilizations broadcasts intentional signals to signal its own existence. Leakage from that civilization is not taken into account in the following considerations. Then, either 1) they *do* know about humanity, or 2) they don't.

In Case 1, they also know about our stage of technological development, so they may choose to narrow-beam only *aimed information* (i.e., no *Encyclopedia Galactica* stuff). In Case 2, they have not the least idea—or only very vague ideas—about how much science and technology a civilization receiving the signal has developed *on the average*. This case is ruled out here because it seems obvious that they would waste too much energy in broadcasting signals that may not pay off much. Therefore, Case 1 is the appropriate case for all stars encompassed in a sphere centered around the Sun with a radius of about 100 light-years away from the Sun (where our own radio leakage has reached so far).

Let us investigate this "realistic case" now. They know that we know about:

1. Special and general relativity.

2. Quantum physics at the level that it overlaps relativity only in part (Dirac theory).

3. Spaceflight science capable of exploring this solar system only, but not capable of reaching other stars.

They then decide to teach us:

1. The mathematical theory unifying all known forces of nature, a theory of the superstrings type that we shall provisionally name "superluminal strings."

2. Based on that theory, the technology to master the huge energies connected with the zero-point field.

3. Spaceflight science, "*Star Trek*-like," enabling us to bend space-time at will and to such an extent that faster-than-light (FTL) phenomena can be achieved and mastered without contrast with general relativity. Wormholes are examples of that, but they are not the only example.

In summary, humanity must then be ready to *decipher* such a message telling us about superluminal strings theory and its technological outreaches. This deciphering task would be best accomplished by "translating computers" working at the highest levels of logic (currently called "theorem proving"). These research fields seem thus to be what deserves the greatest research effort.

…reception and transmission of FTL signals, rather than any FTL spaceflight itself, are going to be the keynote of the long-range cultural impact of contact.

Once superluminal strings theory is mastered, the gradual creation of more and more "wormhole-like alleys of information" around the Sun would revolutionize interstellar communications, making them become fully FTL. Thus, we believe that, in contrast to the FTL spaceflights through wormholes described in the movie *Contact*, reception and transmission of FTL signals, rather than any FTL spaceflight itself, are going to be the keynote of the long-range cultural impact of contact.

Implications of Contact with ETI Far Older than Humankind

Jill Tarter
SETI Institute

…the ETIs (or their robotic emissaries) will be far older than we. This follows from even the simple degenerate form of the Drake Equation…

The scenario Allen has set for us—detection of an extraterrestrial intelligence, sufficiently soon that our discussions have any relevance to our own society as it will be then—guarantees that the ETIs (or their robotic emissaries) will be far older than we. This follows from even the simple degenerate form of the Drake Equation ($N \leq L$, where **N** is the number of currently communicative civilizations in the Milky Way and **L** is the longevity of the communication methodology in years). For our primitive technology to succeed in a detection in the near future, **N** must be large, which can happen only if **L** is large. At the SETI Institute, the next 20 years will probably be required to explore systematically a million nearby stars (and indirectly, a number of background stars). Success during the million-star search requires that $N \geq 4 \times 10^5$, or an average longevity $L \geq 4 \times 10^5$ years.

Perhaps they will have a well-developed empirical field of study that can define the critical bottlenecks and elaborate several different ways through them.

This longevity has many implications:

- It is possible to survive one's technological infancy. Perhaps they will have a well-developed empirical field of study that can define the critical bottlenecks and elaborate several different ways through them.
- The real challenge is surviving one's star. Perhaps we will learn how they did it.
- However, there are few who do so. This conclusion is consistent with the state of observational astronomy. There have been no detected phenomena in the vicinity of stars about to become red giants, or red giants, novae, or supernovae that might be interpreted as astroengineering. It may be possible to preserve a civilization from the impending death of its star, but it is difficult to understand how this might happen without some observable consequences. It's possible that the consequences could be there, and we've just missed them, but nothing has hit us in the eye yet.
- Their longevity is inconsistent with organized monotheistic religions typical of Earth. Such religions are responsible for the longest lasting warfare and destruction we have witnessed.
- There may be something like a universal religion that integrates the existence of intelligent life forms with a fully developed cosmology. There will be no sects, as religious warfare would be the result, and that is inconsistent with longevity.
- There will be a highly established code of ethics that centers around the perpetuation of individuals (or a colonial entity), and all components of the natural environment.
- They may tell us how it is possible to transition from the "My God vs. Your God" conflicts of 20th century Earth to a more stable universal religion/understanding. Or perhaps humans are the only species that started out on the wrong path.

Extraterrestrials and Objective Knowledge

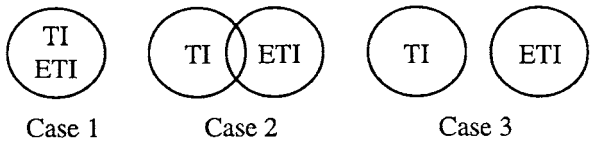
Steven J. Dick
U.S. Naval Observatory

The basic question is, "Do humans and putative extraterrestrials perceive the universe in the same way?"

In the concluding chapter of *The Biological Universe*, I remarked very briefly about the compatibility of extraterrestrial and terrestrial science. "If comparison is possible," I wrote, "one wonders whether the long-sought 'objective knowledge' might be found at last by gleaning the common elements remaining after processing by many sensory and mind systems independently evolved throughout the universe" (Dick, 1996). With few exceptions (Minsky, 1985; Rescher, 1985), no one has taken up the fundamental problem of objective knowledge in the extraterrestrial context. Here I offer a few thoughts for discussion, because this may be one of the major questions that could be answered by extraterrestrial contact in the next millennium, and in fact may significantly affect our chances of contact.

The problem of objective knowledge is one of the oldest problems of philosophy, and forms a branch of that field known as "epistemology," the nature, origin, scope, and limits of human knowledge. Hume, Kant, and many other classical philosophers had much to say about the relation between the mind and external reality, as do modern philosophers. Nor is this an abstruse academic argument; the current "science wars" embody the question in the form of postmodernism and the social constructionism debate, one element of which claims that science, like everything else, is socially constructed, and thus that there is no objective knowledge. While this seems to me absurd in the terrestrial context, the epistemological question takes on new meaning in the context of extraterrestrial biologies and minds.

Contact with extraterrestrial intelligence would provide a major insight into the question of objective knowledge on a universal, not just a terrestrial, scale. The basic question is, "Do humans and putative extraterrestrials perceive the universe in the same way?" There are three cases in comparative terrestrial and extraterrestrial perception: 1) complete overlap, 2) partial overlap, and 3) zero overlap, graphically shown as follows:



On one level, these sets may be taken to represent terrestrial and extraterrestrial knowledge, but more deeply they represent terrestrial and extraterrestrial ways of perceiving. Case 1, in which ETI perceives the same electromagnetic spectrum as we do, processes the information in the same way, and comes to the same conclusions, holds out hope for easy dialogue and objective agreement. Case 2, in which there may be differences to a greater or lesser degree in sensory organs and mental processes, implies some common basis for dialogue. In Case 3, with no senses or mental processes in common, there may be no possibility of dialogue or objective knowledge.

If contact is successful, a major task over the next millennium will be to synthesize the knowledge of many worlds.

The problem of objective knowledge bears on the possibility of communication, on the role of language, and on those aspects of the universe that have the possibility of verification. Knowledge must be distinguished from belief, which may have no basis in the objective world; one would not expect extra-

terrestrial religious belief, for example, to take the same form as on Earth, though the existence of God may be an objective question. If contact is successful, a major task over the next millennium will be to synthesize the knowledge of many worlds. The nature of this task will depend greatly on which of the three cases above turns out to be most common among galactic civilizations.

References

Dick, Steven J. 1996. *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge University Press: Cambridge), pp. 549-550.

Minksy, M. 1985. "Why Intelligent Aliens Will Be Intelligible," in Edward Regis, Jr., ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 117-128.

Rescher, N. 1985. "Extraterrestrial Science," in Edward Regis, Jr., ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 83-116.

Social Comparison, Identity, and Self-Esteem

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Among the commonly accepted assumptions about "contact" is that ET will come from a society that is much older and more technologically advanced…

Among the commonly accepted assumptions about "contact" is that ET will come from a society that is much older and more technologically advanced than our own. We are admonished not to view ourselves as special or holding a privileged place in the universe because in the course of doing so we succumb to the "Anti-Copernican Conceit." While we are at least "mediocre," we expect to encounter a civilization far older than our own, perhaps by millions or billions of years. We are warned that ET's science will be like magic to us, or perhaps the relationship between ET and us will be analogous to the relationship between humans and slugs. It is one thing to imagine this in the abstract; it is another thing to experience this profound discrepancy. How many of the scientists who urge us to accept mediocrity would respond with awe, reverence, and humility after being put out of business by researchers from another laboratory?

This raises existential questions, which we can approach from the viewpoint of psychological research. There is a vast empirical literature on the variables associated with positive, can-do attitudes and self-esteem, the extent to which a people feel capable, worthwhile, and good about themselves.

1. Altercasting and the Social Construction of Self. Sociological theories of self stress the importance of self–other interactions. In essence, the way that other people define us, as evidenced in their expectations and reactions, affects our sense of identity or the way that we define ourselves. Such self-definition may be based on class membership, as would be the case for people who are beneficiaries or victims of cultural or racial discrimination.

2. Social Comparison and Frames of Reference. How we feel about ourselves depends upon with whom we compare ourselves. In essence, this is a "size of frog/size of pond" issue. For example, whether or not a dentist feels good about herself may depend on whether she compares herself with more successful physicians or less successful pharmacists.

3. Self-Efficacy, Locus of Control and Spheres of Control, and Proactive Personalities. These three closely related variables describe the extent to which people believe that they have control over their physical, interpersonal, and sociopolitical environments. People who understand what they are doing and believe that they can determine their personal outcomes try harder and succeed more than people who see themselves as ineffective.

When more technologically advanced societies meet less technologically advanced societies, it is the less technologically advanced societies that are the most likely to change.

4. Cultural Integrity and the Preservation of Identity. When more technologically advanced societies meet less technologically advanced societies, it is the less technologically advanced societies that are the most likely to change. For those of us who prize diversity and tradition, this could result in a loss of identity.

Given a high rate of information exchange, we should hope that: (1) ET will treat us as equals; (2) we will continue to compare ourselves with one another; (3) we will retain a sense of control over our environments; and (4) although our culture will change, it will retain distinctive elements. However, we could encounter one or more of the following: (1) ET conveys a sense of superiority; (2) we make invid-

ious comparisons between ourselves and ET's "super race," (3) ET somehow limits our choices or we become dependent on advanced technology that we don't really understand; and (4) human culture is no longer distinctive but a cheap imitation ("cargo culture") of what we see as ET's superior culture. Such undesirable conditions could give rise to the following:

1. Learned Helplessness: If ET constrains our choices, solves our problems for us, or gives us access to technology that we don't really understand, we may feel that nothing we do makes much of a difference and then give up trying.

2. Loss of Identity: If we abandon distinctive human culture, we may define ourselves as second-rate members of a larger, somewhat uncomfortable galactic culture.

3. Feelings of Inferiority: Learned helplessness and invidious comparisons with superior beings could lead to crime and to immature, attention-seeking behaviors.

4. Depression: This sometimes follows from learned helplessness, loss of identity, and feelings of inferiority coupled with anger that is displaced inward since it is not safely directed towards the more powerful ET civilization.

The die will be cast within a few decades and, we might expect, strengthened over the ensuing centuries. Enthusiasts write most discussions of post-contact humanity and, indeed, it may be that the discovery that we are not alone in the universe, coupled with the interplay of extraterrestrial and human culture, will yield positive results. Nonetheless, we must consider the psychological "down side" of contact with a vastly superior culture. To do this, we might expand our search for historical prototypes and conduct new studies on the following:

1. Caste Systems: These should be studied to identify those conditions under which castes, if any, live amicably and without adverse psychological consequences.

2. Colonies: Although we do not expect that Earth will be "colonized," there may be certain characteristic elements, for example, laws established and enforced by distant government(s). What positive lessons, if any, can we learn from the colonial experience?

3. Subjective Determinants of Self-Esteem: Many people who, by objective standards, "do not seem to have all that much going for them" do fine. What may we learn from them?

4. Preservation of Identity following Culture Contact: What are some models of post-contact culture preservation and how might these be applied in the wake of contact with an extraterrestrial civilization?

Transformations in Spirituality and Religion

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…we would most likely be dealing with beings who are far in advance of us not only technologically and scientifically, but also, in the general sense, spiritually.

Religion is one subject that would not only be transformed by contact with advanced extraterrestrial communities, but is already being transformed merely by the prospect of the existence of such communities. Most surveys show that theologians and ministers of religion take a relaxed view of the possibility of extraterrestrials. They do not regard the prospect of contact as threatening to their belief systems. However, they are being dishonest. All the major world religions are strongly geocentric, indeed homocentric. Christianity is particularly vulnerable because of the unique position of Jesus Christ as God incarnate. Christians believe that Christ died specifically to save humankind. He did not die to save "little green men."

This species specificity has already caused discomfort in relation to animal rights, but in the case of extraterrestrial beings, there would arise a very serious problem. For example, it is reasonable to suppose that in advanced communities, genetic engineering would have been used to eliminate strongly criminal and antisocial behavior. In making contact with extraterrestrials, we would most likely be dealing with beings who are far in advance of us not only technologically and scientifically, but also, in the general sense, spiritually. Are we to suppose that humans are theologically favoured over and above these "saintly" beings?

The alternative—that God became incarnate on planet after planet—not only has an air of absurd theatricality to it, it is also a heresy in Catholicism. Even if contact is unsuccessful, the mere possibility of the existence of "saintly" extraterrestrials will eventually force a radical rethinking of Christian theology, and could cause a split in the Church towards support for SETI.

The search for life elsewhere carries a more fundamental implication for religion. Four hundred years ago Bruno was burned at the stake for suggesting the existence of other inhabited planets. At that time, human beings were thought to have been created by God and to occupy a central position in the universe. Today that worldview has largely disappeared. To those who accept that life on Earth arose naturally, the theological situation has dramatically reversed. It is atheists who now prefer to believe that life is the product of a stupendously improbable accident (Jacques Monod was most explicit on this topic). This is because contingency is the opposite of purpose (as Stephen Jay Gould has stressed in support of atheism). Therefore, atheism fits most comfortably with the nonexistence of extraterrestrials and a pointless universe ruled by blind and purposeless forces. By contrast, if life emerges more or less automatically on many Earthlike planets as the result of inherently bio-friendly laws of nature, then descriptions like "design" and "purpose" once more seem appropriate to some (as Christian de Duve has pointed out). Atheists see biological determinism—the view that life is an inevitable consequence of physics and chemistry given suitable conditions—as an attempt to smuggle in the guiding hand of God in the guise of physical law.

Not all atheists are consistent in their thinking on this issue, however. Richard Dawkins, a strong advocate of atheism, seems comfortable with the possibility of extraterrestrial life, even of an advanced nature.

If life were discovered elsewhere, even at the level of bacteria, establishing a panspermia mechanism would become a key priority for atheists.

In my view, atheists can consistently believe in extraterrestrial beings only if they accept the panspermia hypothesis, since that combines the assumption of life forming purely by chance against enormous odds, with its widespread prevalence in the universe. (Note that the converse need not be the case: Fred Hoyle, for example, combines a type of theism with panspermia, but only at the price of divine interventionism.) If life were discovered elsewhere, even at the level of bacteria, establishing a panspermia mechanism would become a key priority for atheists.

Crisis at Mid-Millennium: A Report from the Year 2600

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…during the 26th century critical breakthroughs were made in constructing viable biospheres from asteroids…

During the first century of the new millennium, two grand endeavors initiated in the previous century began to bear fruit. The first human settlements were established beyond Earth (but still in the Solar System) and radio signals originating from elsewhere in the galaxy were confirmed as coming from intelligent sources. Although these developments were denounced by some naysayers, by and large the realization that we could live off Earth and that we were not alone served to invigorate the human spirit.

However, during the centuries that immediately followed, progress in both space colonization and understanding the meaning of the radio signals was agonizingly slow. Developing thriving, self-reproducing communities proved much more difficult than expected, and deciphering signals from unknown sources baffled generations of would-be translators. Finally, during the 26th century critical breakthroughs were made in constructing viable biospheres from asteroids, as Tsiolkovsky had originally proposed, and in applying consilient techniques to the new field of comparative exosemiotics.

…our neighbors would probably not invite physical visits, much less colonial intrusions.

That's when the real crisis for humanity hit. Space colonizers were no longer satisfied with spreading just within the Solar System. With the new Tsiolkovsky biospheres, powered by vacuum-energy drives to cruising speeds of upwards of .3c, hundreds of inviting star systems beckoned to multigenerational voyagers. At last interstellar migration was within humanity's reach! Countering this expansive euphoria, however, was sobering news from the exosemioticians. Many of the star systems around us seemed to be already occupied, though whether by intelligent biologs, machines, or cyborgs was in dispute. Furthermore, the impression gained from the sketchy and incomplete translations was that our neighbors would probably not invite physical visits, much less colonial intrusions. Furthermore, analyses of texts from several star systems suggested that their occupants already knew of our existence, but considered us to be so minimally advanced as to be hardly worth their consideration, much less tutorial outreach. Whither now, self-anointed *Homo sapiens*?

The Role of Artists in Post-Contact Self-Identity

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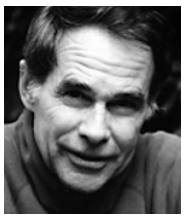

…artists will embrace the experience of contact and explore the relevance of that initial contact… to our collective self-identity.

Artists have always played a vital role in shaping our cultural identities. This role is not merely cognitive, for the arts do far more than instruct or interpret. At their most meaningful level, the arts provide powerful life experiences that are a rich amalgam of perceptual, cognitive, emotional, and perhaps spiritual or psychic aspects of human consciousness. The arts have always (in Western societies, at least) served the purpose of heightening awareness of our mythic self-identity, helping both to illustrate and to create an awareness of shared human values. Perhaps in this regard the arts share some purpose with religion. Unlike religion, however, the arts have never quarreled with science. And at least during the 20th century, the arts have shared with the sciences the intellectual adventure of exploring the new and unknown.

I make this introduction because I feel sure that from the moment of first contact with an ETI (barring total social disintegration or worse), artists will embrace the experience of contact and explore the relevance of that initial contact and its long-term content to our collective self-identity. Indeed, artists may prove more resilient to the impact of initial contact with an ETI than members of some other professions who are locked into more rigid identities.

The questions of what art is, and what subject matters and techniques are appropriate for art, are fundamental to 20th century aesthetics and have a bearing on post-contact art. What new forms of expression may arise to meet the challenge of seeing ourselves as part of a cosmic citizenry? Is there an ET art and are we capable of identifying it as such and appreciating it? Are artistic collaborations with extraterrestrials possible? Is there a cosmological aesthetic? (It may seem so since there appears to be a qualitatively unique aesthetic appreciation shared by all human beings that is fundamental both to art and to scientific intuition. If extraterrestrials are technological beings, they may experience some form of similar aesthetic appreciation.) Might artists be more capable of recognizing ET art than other members of our society? These questions, of course, presuppose certain conditions: that communication is possible and that extraterrestrials desire to communicate.

Perhaps the phenomenon of UFOs, if it represents an alien intelligence, is some form of extraterrestrial art project involving the human species…

Contact, however, may not occur exclusively through such technological prostheses as radio or optical telescopes. It is at least conceivable that contact may also be transmitted directly through the minds of humans. Indeed, contact may be occurring now. Perhaps the phenomenon of UFOs, if it represents an alien intelligence, is some form of extraterrestrial art project involving the human species (or perhaps a sort of koan leading the public to gradual enlightenment about alien existence). Whether UFOs are alien or not, it seems safe to say that for humans the range of artistic experience—encompassing as it does today such forms as Happenings, Installations, Performance Art, and site-specific "Earth Art," all unimagined a century ago—will be expanded further as a result of contact with extraterrestrial intelligence.

As an artist, I find exciting the possibility of humans deriving inspiration from alien art forms, or of some form of human/alien collaboration in the arts. Collaborative efforts in the arts may precede

such efforts in the sciences or other intellectual disciplines. While we may not initially have the wisdom, knowledge, or technology to share ventures in the sciences or economic spheres, we have a storehouse of species-specific myths and aesthetic/emotional capacities that may be unique to our evolutionary development on this planet and hence of great value to an extraterrestrial audience. I take heart that we in 21st century Western societies can have so much appreciation of the "primitive" art forms of indigenous peoples and in the fact that an understanding of the cultural content of such art actually augments its expressive power for us. The basic value of art seems to lie beyond matters of technological prowess or sophisticated scientific understanding. An extraterrestrial culture that may initially find us scientifically unimportant may also find in our human spirit unique opportunities for interspecies involvement.

Human Analogues May Portend ET Conduct Toward Humanity

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The history of Earth civilizations will be mirrored in the civilizations in other parts of the universe.

If it is assumed that the laws of physics and biology are the same here as elsewhere in the universe, then the evolution of life in all parts of the universe would have progressed from the simple to the complex. In the process Darwin's philosophy would have been uppermost. Almost everything in the universe would fall under the control of the most fit, most intelligent, and the strongest. The needs of this group would be justified on rational arguments and philosophies—*rational* being defined by the group to suit its own purposes and agendas. This has been the history of human civilizations throughout the ages. There is no *a priori* reason that ETI civilizations will be any different. They would also want to control the resources of the universe or other galactic civilizations for their own ends. The history of Earth civilizations will be mirrored in the civilizations in other parts of the universe.

SETI literature normally ascribes attributes of goodness, humaneness, and a general willingness of ETI civilizations to assist the less advanced civilizations. From a Darwinian perspective, this will not necessarily be the case. This is very well illustrated by an analogue from planet Earth. At the end of the 18th century an advanced civilization landed in Australia and confronted the Aboriginal peoples of Australia. The advanced civilization had passed through the hunter and gatherer stage and the agricultural stage, and was, at the end of the 18th century, at the height of its technological development. It was at a stage where it could move over the entire oceanic and terrestrial space on Earth. When the advanced civilization arrived in Australia, there was a gap of over 10,000 years between the technologies of the advanced civilization and that of the Aboriginal peoples. Rather than treating the Aboriginal peoples in a civilized and humane manner, the advanced civilization took over their lands and in Tasmania the Aboriginal population was wiped out. It was one of the greatest genocides in the history of human civilization.

…the culture shock we will experience will be extremely disruptive and continue for several centuries…

Will a much more advanced civilization do the same with us if and when they discover planet Earth within a thousand years from now? If a discovery and physical contact are made with ETI civilizations in the distant future, the culture shock we will experience will be extremely disruptive and continue for several centuries. Our institutions will be incapable of handling the crisis and it may be the end of human civilization, as we know it today.

This has been the case with the Aboriginal peoples in Australia. They are still recovering from the contact they made with a technologically advanced civilization at the end of the 18th century.

Let us look at another scenario. It may be the case that an advanced civilization need not actually make physical contact with us. ETI civilizations could use human proxies on Earth to do their bidding through high-technology intelligent probes and the galactic internet. Thus a powerful group of human proxies may be given the knowledge and technology by ETI for the control and manipulation of human populations for political and social agendas of the ETI civilization. Again, we have human analogues for this scenario. If this happens, human civilization will be in for a long culture shock and it may not recover from the disruption of its institutions.

Null or Negative Effects of ETI Contact in the Next Millennium

Eric J. Chaisson
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…electromagnetic (indirect) contact will probably have negligible effect on us, and physical (direct) contact will probably be harmful to us.

Every productive meeting needs an *agent provocateur.* Since I cannot be sure, looking at the list of attendees, that we have one among us, I shall assume that role until otherwise deposed.

My hypotheses are that there will likely be no positive effect from contact with ETI during the next thousand years. Yes, it would be nice to know if ETIs exist in space; the "commission" that astronomers have from the public to keep an eye on the universe demands that we strive to inventory cosmic life in all its forms, just as we do for matter and radiation. However, in the long run, electromagnetic (indirect) contact will probably have negligible effect on us, and physical (direct) contact will probably be harmful to us.

Should contact with ETI be limited to electromagnetic means, and there be little chance of ETI traveling to Earth (or us to their home) within the next millennium (owing largely to light-speed restrictions), then the impact of ETI on our civilization will be minimal, perhaps virtually zero, given the steady stream of "in-house" global problems inevitably confronting humankind while pushing out along the arrow of time. Of course, we shall study ETIs' signals, decipher their messages, perhaps even learn some things from them (since any ETI initiating contact with us will be, essentially by definition, more advanced and knowledgeable than we). Earth's academics will publish scholarly analyses of ETI data in the specialized cyberspace journals; commentators will propagate opinions among the bits and bytes of the new Net; and the media hype of each new ETI finding and its cultural vicissitudes will cause the mainstream press of the third millennium to resemble the tabloid press of the late-second millennium. But indirect contact alone will likely be of meaningful concern only to a small minority of Earth's citizens—essentially an ensemble of future people statistically indistinguishable from those currently interested in SETI. As long as contact remains solely electromagnetic, Earth-based global issues of (mostly) our own making will dominate our lives, indeed drive our future evolution during the next thousand years.

…dominance is likely to be the natural, indeed perhaps inevitable, stance of any advanced life form.

Should contact with ETI be physical, even as a mere ceremonial visitation, then the impact could be large and negative for our species. I refer to the universality of physical and chemical phenomena in the cosmos, and by extension to the subjects of biology and its allied behavioral sciences. In short, if neo-Darwinism (or some version of it) holds cosmically, meaning that competition is at least part of any complex being's methodology, then it is not inconceivable that they (who will be, again, more advanced than we are) would dominate us. Not that they would "come and eat us"—though they might; we do, in fact, consume many other, "lesser" species—and not that their alien posture toward us would be overtly hostile. Rather, dominance is likely to be the natural, indeed perhaps inevitable, stance of any advanced life form. It is just as reasonable to argue that advanced life, anywhere in the cosmos, will tend to control other life (as well as controlling matter and radiation locally) if given the opportunity and if in physical contact, as it is to suggest that positive consequences will result from our detection of and interaction with extraterrestrial intelligence.

Pursuing Five Strategies for Achieving Contact

[Abridged Version]

Allen Tough
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Five strategies are especially promising…humankind should put major thought and resources into all five…

If highly intelligent life has evolved elsewhere, how might scientists detect it? Five strategies are especially promising. Because of all the positive consequences that contact will likely produce, as noted throughout the seminar, humankind should put major thought and resources into all five strategies.

Because a highly advanced civilization, thousands of years beyond our technology, could readily send small but extremely smart probes to monitor our society and telecommunications, we should try to detect such probes:

1. Pursue a variety of means for searching the solar system and our planet for physical evidence of an extraterrestrial object or its effects.

2. Invite contact through invitations to ETI on the World Wide Web.

3. Encourage contact by becoming sufficiently prepared.

In the search for extraterrestrial intelligence or technology, there is also a good chance of detecting evidence from many light-years away:

4. Search for evidence of astroengineering projects and their by-products.

5. Use radio and optical SETI to detect artificial signals.

Additional discussion of all five strategies, and the reasons for widening the array of strategies, can be found at http://members.aol.com/AllenTough/strategies.html.

The SETI field is united by its common aim of detecting irrefutable scientific evidence of genuine extraterrestrial intelligence. To maximize the chances of success, the wisest approach is to encourage and support all five strategies. The benefits to humankind could be extraordinary.

[The full paper is available in Section V of this volume, pages 115–125.]

What Can We Do Now?

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SETI Institute

This first impression may set the tone for subsequent dialogue, and in fact, may determine whether or not there will even be further communication with ETI.

The long-term impact of dialogue with an extraterrestrial civilization may be determined to a significant extent by our initial response. This first impression may set the tone for subsequent dialogue, and in fact, may determine whether or not there will even *be* further communication with ETI. For example, even a reply message with completely benevolent intentions might be misinterpreted. Some people, for instance, might want ETI to help us overcome some of our greatest threats to survival as a species, such as nuclear war. But how can we make sure that another civilization understands that we are seeking friendly guidance and not being threatening (by showing that we have nuclear weapons)? Given the high stakes, we would do well to ponder these issues in very concrete terms long before we have the opportunity to reply.

One of the standard premises of SETI policy is that decisions following confirmation of the existence of ETI should be made on behalf of humankind, with decisions not being made by a single nation or other small group. It is often assumed that access to a signal will lead to access to the message. However, given the linguistic challenges we may encounter in attempting to understand a message from another species, even having the full "text" of a message may not guarantee that it could be comprehended by all interested parties.

Contact via information-rich signals may be particularly likely to lead to discrepancies between what different groups of people know about the message: some may know much, while others know little. To cite an example from fiction, in the movie *Contact* the initial "layers" of the message were relatively easy to understand, but the more complex parts took considerable effort. Ultimately the code was broken, not by a UN task force, a group of academics, or a government intelligence agency, but by a giant corporation with significant resources. It is conceivable that even if the contents of a message were made public, only large groups with significant power and resources could understand them. One benefit of increased attention to message-making prior to signal detection is that we may be better prepared for informed, open discussion and analysis of messages that we may receive in the future.

We might, for example, construct messages… that are themselves works of art.

We should also become more open about the range of forms that a reply message might take. Most people who have considered the matter seriously enough to draft messages themselves have backgrounds in mathematics, the physical sciences, or engineering. It is only natural that the content of their messages has reflected the same disciplines. There has been some speculation that messages from another civilization may contain information about their cultures, philosophies, and arts. But there have been no attempts to construct such messages ourselves. We might, for example, construct messages that are intended not merely to convey information about our existing forms of art, but instead send messages that are *themselves* works of art. If some day we decide to focus on math and science in reply messages, we should do so with the conscious recognition that this would provide a very truncated view of human concerns.

Spreading the Word

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SETI Institute

…the recruitment of eminent and respected thinkers in all the fields relevant to the topic, and the involvement of specialists in decision theory…

Two areas are selected below from the many that could be discussed. They are the recruitment of eminent and respected thinkers in all the fields relevant to the topic, and the involvement of specialists in decision theory and related fields in the challenges we face. It should be noted that Al Harrison has written a thoughtful paper, covering all aspects of the "What Next?" question, which should be required reading for us and for these two groups as they emerge.

At the moment, serious issues of the cultural impact of contact have been discussed by only a handful of key people who, to their credit, have come to recognize the significance of the questions that are being raised. It is important that we seek to include additional thinkers in the years to come. One group is especially important. This is composed of the people who are recognized by their peers as being at the top of their own disciplines, especially in the academic world. They are those who are sought after, worldwide, to be prominent advisors to many organizations, whose publications are the finest, whose original contributions are notable, and who have received honors and awards for their work. A good example is the late Roger Heyns, one-time Chancellor of UC Berkeley and an eminent social psychologist. Exciting the interest of such leaders could be viewed as elitist. This could be good, because of their enormous importance in our own cultural evolution. But it should not prevent us from growing, or harnessing, in parallel, great communicators like Carl Sagan, who can spread knowledge and discussion to people from all walks of life.

In many universities there are departments or divisions focused on decision theory, decision analysis, game theory, and utility theory. These techniques are seldom used in the real world, yet they offer approaches that can offer clearer insights into the complexity of the issues we face.

Speculations on the First Contact

[Abridged Version]

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The existence of very advanced technological civilizations is highly conditioned by very large societal lifetimes.

Based on a hypothetical distribution of advanced technological civilizations in the galaxy, Sebastian von Hoerner (1961) estimated that the civilizations we will find will probably be much older than we are, and they will be more advanced. He considered that our chance of learning from them might be the most important incentive for our search. According to these ideas and due to the large interstellar distances, the extraterrestrial contacting signals would already contain high-information messages (including an introduction to a language). There might be some *speaking* and *listening*, but *mutual exchange* of knowledge would be rather limited because of the long time scale involved.

Shklovskii and Sagan (1966) and Sagan (1973, 1980) took all these original ideas and extended them into the concept of *Encyclopedia Galactica*. They imagined that a hypothetical network of civilizations in the galaxy compiled all the accumulated knowledge from each independent evolutionary history and put it at the disposal of the emerging technological societies. After the detection of an extraterrestrial message, they foresaw big technological gains, hints, and leads of extraordinary value. They speculated about all sorts of scientific and technological results, ranging from a valid picture of the past and future of the universe through theories of fundamental particles to whole new biologies. They also made conjectures that we might learn from the views of distant and venerable thinkers of the deepest values of conscious beings and their societies. Finally, the most speculative and seductive argument to pursue in the search for extraterrestrial signals is that we can obtain information that may help us to solve our political, social, or environmental global crises and thereby pass through our *technological adolescence*.

These dreams have dominated the scientific and popular literature over the last 40 years, including most of the presentations made in this workshop. Very little discussion took place around the basic hypotheses behind these ideas.

The purpose of this essay is twofold: The first purpose is the introduction of restrictions to some of the original hypotheses about the technological characteristics and intentions of the extraterrestrial civilizations. The second is the construction of different communication scenarios, based on the inclusion of ethical and artistic *universal* principles. To do that, we will analyze the proposed characteristics of the extraterrestrial supercivilizations that would have the hypothetical capability to send interstellar messages with high-information content. We will present a series of theoretical and empirical arguments to reject the concept of advanced civilizations transmitting omnidirectional signals in a full-time mode. In this way, we will place a limit on the detectability of these high-information messages. Then we will comment on the life expectancy of our contemporary terrestrial civilization, with special emphasis on the consequences generated during the last 50 years of the nuclear era. The present state of planet Earth and its long violent human history create an urgent need for a deep and strong ethical, societal mutation. Otherwise, our species will become extinct.

All technological civilizations that already have passed through their technological adolescence and have avoided their self-destruction (by misuse of advanced technologies or by environmental degradation of their home planet) must have developed ethical rules to extend their societal life expectancy. In

doing so, they must have learned how to respect the natural evolutionary times of other beings in the universe. To build this scenario, we will introduce the concept of *Lex Galactica*, based in Kantian ethical principles, as hypothetical guidelines for advanced civilizations in how to contact emerging societies. If the advanced galactic civilizations are unable to check the level of technical and ethical evolution of the possible recipients of their signals, they will be unable to send high-information-content messages due to *Lex Galactica*. Using these alternative boundary conditions, we will discuss different contact scenarios and their possible message characteristics. We will consider the possibility that the first message from an advanced technological society would include some extraterrestrial artistic manifestation.

The existence of very advanced technological civilizations is highly conditioned by very large societal lifetimes. Analysis of the history of our incipient technological human society shows that we are facing the dangerous technological adolescent era, when our civilization can became extinct in the following 30 to a thousand years. Probably, most technological civilizations have to pass through a similar adolescent era. In any case, the only possibility to avoid self-destruction is a deep and strong societal mutation, based in some sort of Kantian ethics. The implementation of these ethical guidelines would prohibit placing potentially destructive knowledge at the disposal of any ethically underdeveloped society. This knowledge could be a threat to the survival of the recipient civilization.

Only beacon, low-information signals should be sent, in an intermittent and target mode, to those stars that have planets suitable for life.

From these assumptions, we can derive the following observational predictions:

1. No omnidirectional electromagnetic transmissions with high-information content will be observed.

2. Only beacon, low-information signals should be sent, in an intermittent and target mode, to those stars that have planets suitable for life. For detecting terrestrial-type planets, extraterrestrials can use advanced space interferometry techniques (Beichman et al., 1999). We should expect this type of signals from all advanced technological civilizations at distances over $[35 + (t_f\text{-}2000)/2]$ light-years, where t_f is the observing date in years and $t_f \geq 2000$.

3. An alternative transmission strategy could be the addition of some extraterrestrial artistic creations to the beacon signals. Extraterrestrial art contemplation would help us to expand our perceptive horizons.

4. Those nearby advanced societies that have already received our initial radio transmissions, with the technical capability to detect and decode our weakest signals, will have some idea about our technological and moral level of development. These civilizations may be transmitting to us high-information messages or those chapters from their *Encyclopedia Galactica* that our civilization is in a position to understand—but only those stars at distances $R_t < [35 + [(t_f\text{-}2000)/2] + \tau]$ light-years, where R_t is the distance at the observing date t_f and τ is the time that the extraterrestrial society needs to analyze and evaluate our technological and ethical stage.

5. We may also be able to detect some radiation leakage from nearby civilizations, but this will probably be with very low-information content. The same thing would happen with any serendipitous detection of evidences of technological extraterrestrial activities (Dyson, 1959; Lemarchand, 1994 and 1997).

[The full paper is available in Section V of this volume, pages 153–164.]

Section V

Powerful Insights: In-Depth Papers by Participants and Others

Participants in A Seminar on the Cultural Impact of Extraterrestrial Contact contributed to the value of the event through preconference writing of statements on individual agenda topics and by sharing in discussion sessions the results of their considerable study and reflection on the subject. Further, several of the participants, along with two additional scientists, were invited to submit scholarly papers for this report to shed further light on particular aspects of this large issue. These papers include:

The Role of the Social Sciences in SETI

Albert A. Harrison
John Billingham
Steven J. Dick
Ben Finney
Michael A. G. Michaud
Donald E. Tarter
Allen Tough
Douglas A. Vakoch

OVERVIEW

Since its inception, the scientific search for extraterrestrial intelligence (SETI) has been recognized as an interdisciplinary effort. It has attracted people not only from the physical and biological sciences, but also from the behavioral and social sciences. There are many areas where anthropologists, economists, futurists, historians, philosophers, psychologists, political scientists, and sociologists can assist with SETI. Salient interdisciplinary topics include public beliefs in extraterrestrial intelligence and support for SETI; the conduct of the search; signal detection, decryption, and interpretation; news dissemination and rumor control; and both short- and long-term impact of detection on societies, institutions, and individuals.

Factors that militate against greater participation of social scientists include unfamiliarity with SETI, disciplinary biases that tend to focus research on a limited range of research topics, and the lack of a suitable infrastructure such as an extensive literature base, dedicated conferences and journals, and adequate funding. This essay suggests various ways to publicize SETI and various techniques for strengthening the infrastructure, such as increasing funding, sponsoring conferences, publishing in disciplinary-based refereed journals, developing new publication outlets, and building a high-profile peer group. Furthermore, we can involve social scientists as consultants, train graduate students whose interests encompass SETI, encourage piggyback projects that serve both mainstream disciplinary and SETI interests, and provide both role models and social support for newcomers.

SETI

Successive discoveries that the Earth circles the Sun, that the Sun is but one of many billions of stars in our galaxy, and that there are billions of galaxies, coupled with a growing understanding of the origin and evolution of life, have led to widespread abandonment of the once-prevalent view of humankind as central and unique in the universe (Dick, 1996; Shklovskii and Sagan, 1966; Shostak, 1998). Over the past four centuries, physical scientists have established that the laws of physics and chemistry are universal in the sense that they apply at all times in all places. Over the past century, biological scientists have followed a similar path and it now appears that the laws of biology also hold for all places and all times (Dick, 1996). If the laws of physics and biology are universal, and if there are many solar systems with habitable planets, then we would expect life, including intelligent life, to evolve again and again. Recent discoveries of planets in other solar systems and of reliable self-organizing physical processes that may initiate life add to the plausibility of the "many inhabited worlds" hypothesis.

Whereas we have long since refuted the view that humankind occupies a central place in the physical universe, we have yet to disprove the hypothesis that humankind is the only intelligent (or technologically advanced) form of life. SETI, the scientific search for extraterrestrial intelligence, involves observational procedures that can disprove human uniqueness by uncovering evidence of equal or superior intelligence.

There are five particularly promising strategies for finding extraterrestrial intelligence, according to Tough (1999b). The most common strategy has been the microwave search, that is, the use of radio tele-

scopes to identify patterns of electromagnetic radiation that are of extraterrestrial and intelligent origin. In 1998, several optical SETI (OSETI) projects were added in order to search for pulsed laser messages or other optical signals from many light-years away. A second strategy is to search for astroengineering projects, such as Dyson spheres. Another strategy, which has gained plausibility as we ourselves have developed small and efficient technology, is to search for robot probes within our solar system. These probes could still be monitoring us, or they could have lost their capability to function millions of years ago. If these probes are intelligent enough to monitor our telecommunications, we might establish contact by issuing an invitation or by demonstrating our readiness.

What all SETI searches share, and what distinguishes SETI from other attempts to find extraterrestrial intelligence, is a steadfast insistence on remaining within the assumptions and methods of science. The bedrock is SETI's insistence on (a) skepticism, verification, peer review, and the scientific method, (b) strict safeguards against hoaxes, self-delusion, and erroneous data, and (c) protocols to avoid premature and immodest claims.

Beliefs in extraterrestrial intelligence have waxed and waned over the centuries, but seem to have attained new heights in recent decades (Dick, 1996). Many factors have strengthened this belief within popular culture (Dick, 1996; McCurdy, 1997). People attend to the source, as well as the content, of ideas, and one of the distinguishing features of SETI is the strong scientific qualifications and prestigious institutions of many of its adherents. Over the years these have included scholars affiliated with major academic institutions such as the University of Alabama, the University of California (Berkeley, Davis, and Santa Cruz), Cornell University, Harvard University, and the Universities of Hawaii, Paris, and Toronto. SETI researchers have also included affiliates of the United States Naval Observatory, Jet Propulsion Laboratories, the National Aeronautics and Space Administration, and the RAND Corporation.

SOCIAL SCIENCE INVOLVEMENT IN SETI

For approximately 20 years, beginning with Project Cyclops in 1971, NASA–Ames Research Center was the site of workshops in support of SETI. A role for social science was set forth in Philip Morrison, John Billingham, and John Wolfe's *The Search for Extraterrestrial Intelligence* (1977). Mary M. Connors' unpublished papers, "The Role of the Social Scientist in the Search for Extraterrestrial Intelligence" (1976) and "The Consequences of Detecting Extraterrestrial Intelligence for Telecommunications Policy" (1977), illustrated some of the ways that social sciences could contribute to the effort. The "Interdisciplinary Aspects of SETI" panels at the annual congresses of the International Astronautical Federation provide a venue for ongoing discussions of social science issues, and additional opportunities have been provided by the conferences that led to the *Third Decennial US–USSR Conference on SETI* (Shostak, 1993); the *1993 Bioastronomy Symposium* (Shostak, 1995); and the 1992 NASA workshop that generated *Social Implications of the Detection of an Extraterrestrial Civilization: A Report on the Workshops on the Cultural Aspects of SETI* (Billingham et al., 1999).

In his discussion of SETI, Harrison (1997) points out that our experiences as humans have conditioned our expectations about intelligent life in the universe and have channeled the search process. If "contact" occurs—we will use this term loosely to refer to the acquisition of incontrovertible evidence of one or more technologically advanced civilizations elsewhere—social scientists may help us decode and interpret information and even help us understand extraterrestrial civilizations. If interactive communication is possible, social scientists may help inform the decision whether or not to send a communication, and, if the decision is affirmative, help frame a reply. Contact, we expect, could have a broad and profound impact on individuals, societies, and humanity as a whole. Social scientists could be useful for forecasting and advising how to manage this impact.

Many of these issues have already been discussed within SETI, typically by astronomers, physicists, and astrobiologists. However, the social sciences are distinct fields with their own literature bases, methods, and traditions. It is time for social scientists, with their broad knowledge of the relevant background literature and their in-depth understanding of social science method and practice, to provide greater leadership in these discussions. Given that there are probably fewer than 100 scientists worldwide and from all fields who are immersed in SETI, it is not necessary to recruit large numbers of social scientists. Instead, we need to increase modestly the number of social scientists to ensure ongoing representation, expand the range of disciplines that are

involved, seek greater international involvement, and recruit scholars who are still in the early stages of their careers. We also need to recruit some senior social scientists whose involvement will send a strong and important message to other members of their disciplines.

OPPORTUNITIES

Potential opportunities for social science contributions to SETI range from understanding the nature of extraterrestrial organisms and cultures, which could radically affect the conduct of the search, to forecasting the human response to confirmation of extraterrestrial life. In this report, we present ten areas where SETI can benefit from social science: (1) attitudes and public support; (2) conduct and expansion of the search; (3) composing a model reply from Earth; (4) decryption and interpretation; (5) news dissemination and rumor control; (6) other preparations and readiness for contact; (7) short-term impact and (8) long-term impact on societies, institutions, and people. Under some conditions, social scientists may be helpful for (9) the analysis of extraterrestrial organisms and civilizations; and (10) the initiation and conduct of relations with extraterrestrial civilizations.

Public Attitudes and Support

Social scientists can identify and help us understand people's attitudes towards extraterrestrial intelligence and towards SETI itself. A comprehensive research program would include social scientists who are interested in popular culture, public opinion polling and survey research, attitude formation and change, persuasive communications, and the media. This research could have an action component intended to help people understand SETI as a scientific enterprise, help reduce the confusion of SETI and UFOlogy, and allay fears based on naive misconceptions about such things as the ease of interstellar travel.

Conduct and Expansion of the Search

Detection (along with rigorous confirmation) is the core task of the SETI enterprise. It is therefore extremely important for social scientists to contribute to search strategies to the best of their ability. Each SETI search strategy rests upon certain assumptions about the deeply unknown phenomenon that it is trying to detect. We know so little about the technology, goals, values, and distribution of extraterrestrial intelligence. In order to search intelligently, the SETI community must devote plenty of thought to whom and what it is trying to detect. Social scientists can contribute to a fresh examination of the current assumptions underlying the choice of search strategies (Tough, 1999b). The search procedures rest upon our understanding of the physical universe, and our assumptions about "the other" and their likely level of technological development. Radio SETI, for instance, is based on the assumption that they, like us, will use radio for communicating.

Disciplined thinking by futurists about the long-term future of human technology and goals can help us anticipate the technology and goals of extraterrestrials, since their civilization is likely thousands of years more advanced than ours. Thoughtful exploration of possible alien psychology and sociology (discussed below) can also help us get a better sense of the phenomenon we are trying to detect. In addition, social scientists may help the SETI field understand the cultural, intellectual, and emotional factors that shape the search, and may help move us beyond unnecessarily limiting mind-sets about search strategies. Thus, an important potential role for social scientists is to help the scientists who conduct the search to expand their efforts into new and potentially fruitful areas. Indeed, one major search strategy is itself primarily a social science strategy even though it relies on the elaborate technical infrastructure provided by the World Wide Web (Tough, 1999a).

Composing a Model Reply from Earth

Social scientists can play a key role in developing a model reply message for use someday when some official international body decides to send a reply from Earth. In the urgency and confusion that may follow confirmed contact, the United Nations or the appropriate global scientific organization should welcome a draft reply. They may not use it word-for-word, of course, because the content of the incoming message may influence what we decide to send. But having a draft in place, especially if the process of drafting it has solicited suggestions from around the world, could have a very strong influence on the actual message that is eventually sent. And if the idea of humans actively sending messages to the stars ever gains widespread support, as one way to encourage a message from afar, a model message could be very useful if it reflected widespread consultation.

Decryption and Interpretation

Whereas it is easier to grapple with the possibility of an information-poor detection—that is, the mere identification of something as of extraterrestrial and intelligent origin—we should be prepared for the possibility of an information-rich detection. Unless the "message" is devised in such a way as to be easily deciphered by neophytes in interstellar affairs, it could be very difficult (if not impossible) for us to understand. Thus far, most of the efforts directed at understanding interstellar communications have been undertaken by mathematicians and physical scientists. Here we should welcome the efforts of people trained in such fields as animal communication, archaeology, cryptoanalysis, cultural anthropology, education, linguistics, psychology, and all other fields that impinge upon language and communication. Such scholars can add breadth of perspective by drawing on their knowledge of diverse species, cultures, and languages in their efforts to decrypt and interpret messages. Among the most directly comparable past efforts are attempts to decipher long-dead languages, but even here we have had the advantage of artifacts and our knowledge of human life forms and cultures.

News Dissemination and Rumor Control

Social scientists can help keep politicians, administrators, and other decision-makers accurately informed on the progress of the search and help facilitate the orderly dissemination of news to the public. Here we can benefit from historical precedent and our understanding of the media and mass communications, organizational functioning, social and psychological influences on attitude formation and change, rumor and rumor control, and many related topics.

Other Preparations and Readiness for Contact

In addition to the areas already discussed, there may be other ways in which the social sciences can contribute to humanity's readiness for contact. Interest in this topic is rapidly becoming much stronger. In 1999 alone, a three-day seminar on contact planning was held in Denver; the final session of the two-day Foundation For the Future seminar in Hawaii was devoted to "What next?"; and a one-hour SETI panel discussion at the International Astronautical Congress in Amsterdam explored the major challenges during the 28 days after confirmed contact. In addition, in November 1999, NASA-Ames Research Center sponsored a symposium on "The Societal Implications of Astrobiology," the philosophical, religious, political, sociological, and psychological implications of the discovery of extraterrestrial life. The Denver meeting was noteworthy for its disciplined futures thinking (eight scenarios) and its use of simulation and role-playing. As social scientists direct their minds and their skills to the question of how to prepare for contact, they will no doubt come up with additional needs and solutions. Acting on some of these solutions soon could pay off in reduced confusion and conflict after contact.

Short-Term Impact

Social scientists can help us forecast, understand, and guide human reaction to contact. As Mary Connors was the first to point out, very different issues are likely to come to the fore right after detection and then later on (Connors, 1976). Short-term impact begins as soon as news is released. It is measured in minutes, hours, and days. Short-term impact includes initial reactions to the news, first impressions of the extraterrestrials, attitude perseverance and change, rumor, and collective behavior, including possible panic. Here, expertise on demographic and cultural differences, human information processing, social influence processes, and collective behavior will help.

Long-Term Impact

Long-term impact can range from a rethinking of our own place in the universe based upon the sheer confirmation of the "other inhabited worlds" hypothesis to profound changes in human culture and institutions. It is possible to rate the potential impact in terms of the amount of information that is available and in terms of the potential for interactive communication.

At *Force 1*, impact will involve the assimilation of knowledge that we are not alone in the universe. This, by itself, will affect our philosophy, our science worldview, our religion, and our culture.

At *Force 2*, we may gain scientific, technical, or other information from the extraterrestrial culture that will affect our own science and technology, with far-reaching implications for our economy, our political institutions, and our international affairs.

At *Force 3*, we will communicate and interact with the extraterrestrial culture, trading information, and perhaps even developing a long-term dialogue (Michaud, 1979, 1990, 1998).

Assessing and guiding the long-term impact will require expertise from essentially all fields. Obvious areas of concern include social change, cultural diffusion, technology diffusion, international relations, metalaw, sociology of knowledge, sociology of law, sociology of occupations, social welfare, the history of science and technology, the psychology of intergroup relations, and so on. There will be no shortage of expert involvement *after* contact, and the main difficulty will be separating meritorious ideas from the noise. What we can do now is establish a group of social scientists who will have given advance thought to these matters and who are in a position to help other scientists—and the public—think productively about contact and its aftermath. In particular, this group might develop a conceptual framework and a research agenda that form a solid base for recommended actions.

Analysis of Extraterrestrial Organisms and Civilizations

The riskiest or most dubious opportunities for social scientists are in the analysis of extraterrestrial organisms and societies. Opinion is divided on the value of undertaking this effort. On the one hand, detection may involve a civilization that is so different from ours and so remote in time or space that any attempts at understanding are a waste of time. This claim may be accurate, or a mere convenience that allows the search to continue apace without serious consideration of the aftermath. On the other hand, even as there are universal laws in the physical and biological sciences, there may be universal laws in anthropology, political science, psychology, and sociology, that is, basic functional relationships that apply at all times in all cultures (Harrison, 1997). If so, then it is possible that "they" will be recognizable to us, and advance preparation may help.

One of the challenges that people will face after receipt of a signal is in understanding an alien worldview. We might gain insights into how we could better understand extraterrestrial perspectives by drawing parallels with ways that diverse groups of humans can overcome differences in conceptualizations of reality. One analogue of this is found in comparative psychotherapy research, specifically in attempts to understand how psychotherapists with different theoretical orientations interpret the same clinical phenomena. It has been found that the implicit assumptions that psychotherapists have about human nature and the process of human change can directly affect how these therapists understand their patients (e.g., Vakoch & Goldfried, *in press*). Unless these differences are made explicit, they can be obstacles to communication between therapists with different backgrounds. Research such as this may yield insights into the basic processes of understanding alternative worldviews.

Relations with Extraterrestrial Civilizations

Social science research and disciplined thought could provide an excellent foundation for preparing for the initiation and conduct of relations with extraterrestrial civilizations. Someday that will be a very important topic. Why not begin studying and preparing now? Insights could come from recent and fresh research into negotiations, diplomatic relations, love and altruism, human relations, and other fields. Work by Michael Michaud (1972-1998) and Ernst Fasan (1990) illustrate some of the opportunities here.

CURRENT INVOLVEMENT OF SOCIAL SCIENTISTS IN SETI

Thus far, social scientists have had only modest involvement in SETI, and there is very uneven coverage in different areas. At present, efforts appear to be dominated by Americans who are either retired or at a relatively late stage in their professional careers, suggesting that in the absence of prompt, concerted effort, soon social scientists will have less, rather than greater impact on SETI. Social scientists have tended to focus on individual reactions, neglecting serious treatment of organizations, societies, and interstate political systems. Even representatives from anthropology and sociology have shown a strong psychological bias, meaning that many subfields of anthropology and sociology have yet to be tapped. We find no clear involvement on the part of economists and only modest involvement on the part of historians, who have tended to focus on the intellectual and social histories of the search. There is even more modest involvement on the part of political scientists.

Anthropology

Anthropology, "the study of man," with its emphasis on evolution and culture, is eminently well suited to contribute to the SETI effort. One of the earliest books on the cultural aspects of SETI, Maruyama and Harkins' *Cultures beyond Earth: The Role of*

Anthropology in Outer Space (1975) provides useful insights into early social science thinking on the topic. Written during the Apollo Applications Programs, this volume was based on the assumption that contact would occur when astronauts encountered extraterrestrials in the course of exploring the solar system. Today, the chances of such an encounter seem remote relative to more distal forms of contact, such as through microwave observation, but we should be open to many possibilities. Still relevant is Finney and Jones' anthology *Interstellar Migration and the Human Experience* (1984). Although only a limited number of chapters are focused specifically on SETI, the other chapters in this volume are pertinent in that they give us some models for advanced spacefaring civilizations.

Economics

Economics studies the creation, distribution, and use of wealth. There are two major focal points: microeconomics, which studies economic activity on the part of individuals, small groups, and organizations, and macroeconomics which studies economic activity at the level of the state or beyond. Economics research strategies include mathematical models, empirical studies of economic behavior, and historical precedents. Quantitative procedures predominate. Given the demonstrated volatility of the stock market, word of contact could affect economic activity. It could, for example, affect confidence in investments or investment institutions and stimulate or retard certain kinds of investments (for example, stimulate investments in search equipment and search-related activities and in mass-marketed items related to the search or to the detected culture).

Presumably, any information of a scientific or technical nature that is received from an extraterrestrial culture could have profound effects on terrestrial technology, with the potential of causing major disruptions in large sectors of the economy (for example, utilities, information processing, and health care), perhaps rendering some occupations obsolete while opening up new opportunities in other areas. Social scientists from economics and many other disciplines could also address efforts by institutions and interest groups to control, manage, and even suppress information from ETI because it might affect their economic interests.

Futures Studies

The SETI enterprise is trying to detect a technology that is likely thousands of years more advanced than our technology. In order to make good choices regarding just what to search for, it is valuable to look ahead to our own future technology. This gives us a glimpse of what advanced alien technology might be like. Although the field of futures studies often focuses on the next five or ten years instead of the next 10,000, it nonetheless can offer some useful insights for SETI strategies. Disciplined science-based thinking about the potential future of space travel, computing and artificial intelligence, robotics, and nanotechnology can also provide useful insights into the likely capacities of extraterrestrial technology. One effort to relate such thinking to SETI strategies is provided by Tough (1999b).

History

History has a long-recognized role in SETI. First, intellectual history is useful for putting the search in perspective, both within the framework of science and within the framework of popular culture. Historians have produced several works on the extraterrestrial life debate back to antiquity, but particularly pertinent here is Steven Dick's more recent effort, *The Biological Universe* (1996), which stressed developments during the 20th century. Historians can help us identify precedents that can serve as analogues for contact under varying scenarios. The age of discovery and the age of empire may be of use, for during these eras Chinese, Dutch, English, Portuguese, Spanish, and others sailed forth to encounter new worlds in Africa and the Americas. To the extent that we are more likely to encounter extraterrestrial ideas rather than organisms, the diffusion of ideas across the face of the Earth may provide the best analogues. Here, an analysis of the Dead Sea scrolls, including people's reactions to confirmed and disconfirmed prophecies, would be relevant. History, like political science, can help us analyze how the introduction of a powerful and technologically advanced "third party" affects the relationship among nations.

Philosophy of Science

Philosophy of science can play a central role as we attempt to expand our own science to encompass extraterrestrial life forms and intelligences. Additionally, given that search procedures frequently push our observational powers and our technology

to the limit (Dick, 1996), philosophy of science can help us understand criteria for evidence. That is, given an information-poor detection scenario, what constitutes "incontrovertible" evidence of extraterrestrial intelligence? Finally, philosophers of science can help us understand the perhaps rapid and profound changes in our own science and technology that may result from interacting with extraterrestrial intelligences.

Political Science

Political science is of high relevance but low visibility within SETI. Political scientists who, like economists, draw on mathematical models, empirical observation, and historical analysis, could aid our understanding of public support for the search and ways to organize the search at the national and international levels. Additionally, if the search is successful, we may expect political repercussions that political scientists could both predict and help shape. Under some scenarios, a positive search outcome could alter the balance of power, and conceivably, extraterrestrial societies could become "players," of sorts, in human political affairs. Political science can also analyze how governments might react to a confirmed detection, including motivations for secrecy. This could be particularly relevant if the first detection were made accidentally by a government installation designed for other purposes. SETI enthusiasts from many fields have raised questions of security, international coordination, and the like, but these questions have received only minimal attention (Michaud, 1972-1998).

Psychology

Psychology *is* a broad-based discipline. The leading professional organization, the American Psychological Association, has 159,000 members and affiliates. Despite its historical focus on "the individual," psychology has many different subfields ranging from comparative and physiological psychology (which overlap with biology) to social and organizational psychology (which overlap with sociology).

Simply because of the sheer number of psychologists we would expect significant representation in SETI. The first major work by a psychologist on SETI was John Baird's *Inner Limits of Outer Space* (1987). Baird, an experimental psychologist with a strong emphasis on cognitive psychology, presents a useful discussion of the role of human information processing in the search for extraterrestrial intelligence and the problems of interspecies communication. This work urges caution on the topic of extraterrestrial intelligence and stresses the limitations of SETI. A slightly later book that is heavily psychological was published by management consultant Frank White. His work, *The SETI Factor* (1990), is based largely on interviews and dwells on potential human reactions. Of particular interest are his semi-formal propositions regarding preparing humankind for contact. A more recent work with a strong psychological flavor is Harrison's *After Contact: The Human Response to Extraterrestrial Life* (1997). Harrison, a social psychologist whose graduate education involved both psychology and sociology, addresses the psychology of the search, the nature of extraterrestrials, and predicted human reactions to various search outcomes.

Although at least three psychologists have been involved in recent International Astronautical Federation Congresses, there is very little representation given the large number of psychologists in this world. In recent years, as UFO claims expanded to encompass alien abductions, a growing number of psychologists have turned their attention to abduction reports. Almost without exception these investigators have adopted a critical stance and have found evidence supporting mundane interpretations of unusual experiences. Whereas their research is useful if it dispels misconceptions, it is of little direct benefit to SETI.

Sociology

Sociology focuses on abstract social relations and large social entities. With the exception of sociological social psychologists, sociologists tend to discount the role of the individual and direct attention to the impact of expectations and other situational forces on behavior. So far, it is social psychologists who have tended to represent sociology in SETI. Sociologist David Swift's *SETI Pioneers* (1990), represents a major contribution from sociology to SETI. In this partly psychobiographic work, Swift examines the various forces that led scientists to SETI and also their ideas about extraterrestrial intelligence. Other participants include William Bainbridge (1983), who has done work on people's attitudes towards extraterrestrial intelligence, and Donald E. Tarter (1992), who has written extensively on reply policy among many other topics.

FACTORS LIMITING INVOLVEMENT

Many forces limit involvement of social scientists in SETI. Some social scientists have not heard of SETI, or confuse it with UFOlogy. Disciplinary biases that favor a limited subset of topics work against SETI. Social scientists who choose to work in SETI will not find a strong infrastructure or an established peer group, and may risk ridicule or professional censure. There is little funding to support social science involvement and few quality publication outlets.

Disciplinary Biases

Although many sciences are defined in a very broad way, our sense is that within each field maybe 5 percent of the topics occupy 95 percent of the researchers. This reflects history, politics, and cultural influences as well as intellectual significance. For example, despite its self-proclaimed interest in a broad range of phenomena, the field of social psychology was dominated by cognitive dissonance theory in the 1950s and 1960s, social problems in the 1960s and 1970s, and attribution theory ever since. Other areas that had long been considered fundamental, such as group dynamics, have received a fraction of the attention that they had received until about 1960. Gender-related issues seem to predominate in sociology and may be gaining ascendance in some areas of anthropology. Whether or not similar examples can be developed in each and every social science, the point is that professional organizations, funding agencies, and journal editors dictate fashion and thereby draw disproportionately large numbers towards mainstream areas, leaving relatively few people to work on "avant garde" (or, if you prefer, "fringe") topics. This tendency towards mainstreaming is self-amplifying, in that it has a heavy influence on choices for dissertation topics and on hiring and tenure practices.

By some measures SETI appears to have gained mainstream status in the physical sciences—witness coverage of SETI in astronomy texts—but is unknown or misunderstood in the social sciences. Indeed, it may be that SETI is less well known in the social sciences than among the public because social scientists' interests divert them from the interests that prevail in popular culture.

Social science has modeled itself on the physical sciences. Perhaps nowhere is the influence of logical positivism as strong as in the field of psychology. In the early decades of the 20th century, psychology had both an experimental tradition (based on research continuous with biology) and a psychoanalytic tradition (based on an emphasis on early childhood experiences and inferred mental constructs). By the 1920s the "school" of behaviorism became dominant. Behaviorism focused on the antecedents of behavior and on behavior itself, making no assumptions about possible mental events that mediated between the antecedent stimulus and the consequent response. By focusing on observables and eschewing "ghosts and social glue," psychology hoped to become respectable through emulating physics. Early requirements for membership in the American Psychological Association included three research publications to ensure high professional qualifications. The founder of behaviorism, John B. Watson, is reputed to have said, "If you can't see it, it doesn't exist, and if it doesn't move, you can't study it." The situation has eased today with strong interest in "cognition" (mental states and information processing) and the (numerical) domination of the field by clinical psychologists. However, the "spirit" of behaviorism still influences the field and the hypothetical nature of extraterrestrial intelligence may make it difficult to enlist psychologists.

For some psychologists, there is a thin line between hypothetical beings and imaginary beings. In mental health work, imaginary beings are associated with weak intellect or mental illness. Because of this, there is a debilitating ridicule factor and a good chance that one's work will be dismissed as "parascience." One of us, who published an article in a respected journal, was dismayed to discover that the abstracting service classified this article as parapsychology, thereby lumping it with clairvoyance, telekinesis, past life regressions, and the like.

Limited Funding

For the most part, social science research is not very expensive, at least, in comparison to research in the physical and biological sciences. This is fortunate because governmental funding for the social sciences has decreased dramatically over the past few decades. This poses two problems. First, even though some work on the "cultural aspects of SETI" can be done on the proverbial shoestring, funding is useful for basic equipment, research assistants, travel for inspecting archives, attending conventions, and so forth. The lack of travel funds is a particular problem, since the major SETI meetings take place at international locations and have registration fees geared to the salaries of aerospace executives and

engineers. Social scientists who might be interested in SETI find their energies drawn to more conventional areas where they can get funds to cover research expenses, course releases, and summer salaries. The lack of funding in the social sciences has drawn many social scientists away from research and to summer teaching, consulting, and other income-generating activities.

Weak Literature Base

Science includes assumptions, methods, and a set of data that are accessible through that field's literature base. With two or three exceptions, books that address the cultural aspects of SETI appear as popular science literature or in the physical science literature, not within the social science literature. For example, many bookstores classify Harrison's (1997) *After Contact* as astronomy, astrophysics and space science, or as UFOlogy. Similarly, we find very few relevant articles in the social science databases. For example, although *Psychological Abstracts* publishes tens of thousands of abstracts each year, there are very few abstracts related to extraterrestrial intelligence (as of April 2000, 48 books and articles) and fewer yet when we subtract from the total those that address UFO abductions. When we search for SETI in the mammoth *PsychInfo* database, we find not one article under SETI. Thus, social scientists who might want to get involved in SETI have had to go beyond their fields to learn about the search and its cultural implications. There is a chicken-egg problem here: The lack of a literature base means that few social scientists are drawn to the area; the lack of involvement prevents development of the literature base.

Limited Publication Outlets

Leading scholarly journals seem to have a conservative bias. Usually they are edited by senior members of the field who have an understandable fondness for the topics and procedures that allowed them to achieve fame. Even if the conservative editorial establishment does not consider articles on SETI to be "at the fringe," manuscripts on this topic are likely to fall outside of these editors' past experiences. There is no established literature base to set a baseline for evaluating new articles, and it may be difficult if not impossible to find qualified peer reviewers within the discipline. Some of us have had difficulties publishing social scientific research in discipline-based journals. At the worst, social science editors define SETI as a "fringe area" of dubious intellectual merit and of no interest to a scientific audience.

Minimal Peer Support

The primary reference group for academics consists of the peers who share their specific research interests. This community of scholars is not necessarily found on one's home campus, but at other campuses and research institutions, both nationally and internationally. Through attendance at meetings, mail, telephone, and now email, this community provides members with encouragement, feedback, and emotional support. For many academics, it is the accolades of this peer group—not the praise of campus administrators or of the public—that serves as the most powerful motivator. For all intents and purposes, there is no established peer group to support social scientists' interests in SETI. This means that researchers in this area have to operate without peer support, or else develop a peer group on some other basis (for example, a shared interest in unusual topics).

INCREASING SOCIAL SCIENCE INVOLVEMENT

Social science is crucial for the SETI endeavor and there are many points at which scholars from anthropology, economics, history, political science, and sociology can make positive contributions. Indeed, if we can increase involvement, the social scientists that we involve will identify many new analogues and fruitful topics. SETI as an empirical endeavor is rapidly approaching its 40th birthday. Almost all of the evidence that has been accrued in recent years boosts many of the estimates that enter into the Drake Equation. This, coupled with massive advances in search technology, augurs well for a positive outcome. We are way beyond that point where the cultural aspects of SETI can be treated as a side issue, and we are rapidly moving beyond that point where we can advance based on the ideas of popular writers or of well-intended physical or biological scientists who, by treating sociocultural issues, operate beyond their area of training.

Powerful forces tend to complicate the task of involving social scientists in SETI. As already noted, many social scientists have not heard of SETI or confuse it with nonscientific interests. Social scientists, whose tools currently lack the precision of those used in the physical sciences, and who sometimes smart following invidious comparisons with the "hard" scientists, may be leery of people with strong technical backgrounds.

Such factors as the lack of funding and limited publication outlets discourage all of us, but may

make SETI particularly unattractive to academics who have yet to earn tenure or who are interested in rapid advancement. The ability to attract funds and publish in refereed journals are two of the most important indicators of scholarly achievement and are essential for advancement in many research universities. This is particularly discouraging for junior faculty members who could make long-term contributions to the SETI effort. These dissuaders feed upon and amplify one another, and make it both difficult, and potentially unrewarding, for social scientists to get involved in SETI. Steps must be taken to remedy this situation.

High-Profile Leadership

We need a visible, full-time leader to serve as a role model, to rally social scientists, and to facilitate good social scientific research in behalf of SETI. For decades such leadership was provided by John Billingham, a physician by training who became very attuned to the interdisciplinary aspects of SETI. At first, Dr. Billingham provided leadership for biological and social sciences at NASA-Ames, and, following the loss of government funding for SETI, at the SETI Institute.

There are many reasons for establishing a high-profile position at the SETI Institute, the SETI Australia Centre, or comparable location. First, SETI is a complex endeavor, which requires a broad understanding of SETI as well as a firm foundation within one's own social science discipline. A scholar who is located at a SETI research institute will have a much better understanding of SETI than one who is trying to do similar work in an isolated academic setting. Second, too many social scientists have had to do SETI-related research "on the side" while working on other, more conventional projects. The opportunity to focus on SETI itself will accelerate this person's research progress. Third, a full-time position with a stable SETI organization will help legitimize the role of social science within the SETI community and increase acceptance of SETI in the social science community.

This person's work will have a salutary effect on the work of other social scientists who may be drawn to SETI. Through lectures and writings, he or she will engage the interests of other social scientists. He or she can mentor newcomers, help them locate relevant books and articles, and develop professional networks. He or she will serve the larger interdisciplinary community, for example, by organizing conferences and workshops, providing editorial services, and identifying funding sources and other opportunities.

At the same time, a resident social scientist will offer certain benefits to the host institution. Even as the social scientist serves as a spokesperson who informs the social science community about SETI, he or she will keep the physical scientists at the institute informed about pertinent developments in fields outside their disciplines. If and when contact occurs, the resident social scientist will help the institute make the transition from pre-contact to post-contact activities. Adding social science to the institute's repertoire represents a form of diversification, which may help the host institute survive if contact is made by a competing organization or in a manner that departs from current expectations.

A few months after this section was written for discussion at the Melbourne meeting, the SETI Institute displayed outstanding vision and leadership by creating a new position to promote research into cultural issues. The Institute appointed Dr. Douglas Vakoch as resident Social Scientist in February 1999. This is an excellent start toward the goals discussed in the previous three paragraphs, and may stimulate similar appointments of social scientists around the world.

Looking to the future, our model should be nothing less than a permanently endowed position. We should seek funding from organizations and individuals who are not interested in providing additional support for the technical aspects of the search, but who have interest in the cultural aspects. Separate funding sources are essential to prevent in-house competition for funds between the physical scientists and the social scientists. The reason we should seek a permanent endowment is to ensure that the position survives during periods of low financial support for the technical side of SETI. If the social scientist's position were funded from a central source, the position would be too tempting a target if budget cuts became necessary. It is therefore incumbent upon social scientists to take the lead role in developing an endowment for this position. Although we should not lose sight of the greater goal, temporary funding would permit a quick start, and the position's first incumbent could help raise permanent funding.

Publicizing SETI

We need to inform social scientists about the rationale behind SETI, the search procedures, and the

potential role for social scientists. One strategy would be to reach different disciplines, or clusters of disciplines, through their disciplinary or interdisciplinary academic journals. Because of the biases discussed earlier, our manuscripts must be clear, compelling, scholarly, and targeted toward specialized audiences. When people are uncertain about the content of a message, they look to the qualifications of the source. Thus, it would be helpful to have the materials drafted by recognized scholars or people associated with highly regarded institutions. We might consider having large numbers of coauthors, including astronomers with prestigious affiliations. This would signal the respectability of SETI in the physical sciences and reassure readers that SETI has the support of a scientific community.

Another step is to identify select groups of scholars within a discipline and organize paper sessions or symposia at a regional, national, or international meeting. This will be very difficult because, at present, no individual discipline has a strong nucleus of social scientists who are already interested. In our attempts to organize such a meeting we will have to establish SETI's reputability and relevance for the discipline.

Funding

Although funding is limited, we need to ensure that social science receives a "share of the pie." To qualify for this, social scientists will have to work with other SETI scientists to "enlarge the pie." This will require casting SETI-related social science in ways that are attractive to governmental agencies and finding all new sources of funds. To these ends, we must work with philanthropic organizations and individual philanthropists, and our success may depend upon creative new partnerships.

Some universities still provide funds to offset travel costs, for example, airfare for one international trip per year. The rub is that such funds may be limited to those who will present "original research," which in the sciences may mean new empirical data, thus limiting funding opportunities to only a subset of the many topics that need to be addressed for SETI. Additionally, such funds may be administered by committees whose members have disciplinary or other biases against SETI. Because there are no obvious existing funding mechanisms for social scientific research in SETI, social scientists are often not willing to search out possible funding sources, but instead take the safer route of seeking funding for more conventional lines of research.

The endowed position could allow a secure base from which the incumbent social scientist could seek more long-term external funding for his/her own research, as well as facilitate contacts between funding agencies and other social scientists. One of the functions of an endowed position would be analogous to the provision of startup funding to new academics. In research-oriented academic departments in the social sciences, it is recognized that the institution must make an initial investment in its new faculty members in order to increase the likelihood of long-term productivity and eventual outside funding. Thus, it is possible that an endowed position might eventually pay for itself in increased external funding.

It is particularly important to defray the costs of attending International Astronautical Congresses, the triennial International Astronautical Union Bioastronomy Conferences, and other meetings where SETI social science is welcome. Participation in these meetings serves several goals. First, the price of admission is an original paper, which encourages new research on SETI. Second, fellow panelists can offer useful suggestions and feedback. Third, over two or three meetings, the neophyte becomes a part of the research community, adding new friendships to the justifications for continued involvement. Defraying travel costs is particularly important for junior faculty whose salaries are low.

Dedicated Conferences

In the early 1990s, scholars who were interested in the cultural aspects of SETI planned a major weeklong conference, *The 1995 International Conference on SETI and Society*, to be held at the Majestic Congress Center in Chamonix, Mount Blanc, France. This conference, subtitled "Cultural Aspects of the Search for Extraterrestrial Intelligence and the Discovery of Signals from Other Civilizations in the Galaxy" was to be of unprecedented size, scope, and duration, a true watershed for increasing the role of social science in SETI. The Chamonix Conference was to address a full array of issues regarding the cultural aspects of SETI, ranging from philosophical underpinnings through the immediate and long-term effects of contact.

Unfortunately, due to the loss of NASA funding for SETI, the Chamonix Conference did not materialize. Thus, since the mid-1990s, social scientists have largely had to content themselves with subsidiary roles at more general SETI gatherings. (Unique exceptions were the 1992 workshops reported by

Billingham and others [1999], the 1999 Hawaii seminar that provided the foundation for the present volume, and NASA's Societal Implications of Astrobiology Symposium.) Dedicated conferences can be high-profile events that attract the attention of both social science and SETI communities. They can allow us to build a "critical mass" of qualified social scientists who can spend an extended period of time discussing cultural aspects in depth. They also allow us to publish conference proceedings that will at once provide an archival record of our efforts and stimulate further work. Conferences have proven useful for winning the support for SETI of distinguished physical and biological scientists and should prove useful for winning the support of distinguished social scientists also.

There are many conference models ranging from small, transient work groups that meet for a few days to discuss a limited number of issues to large, comprehensive, multistage events that encourage sustained thought and culminate in the publication of comprehensive proceedings.

This latter model holds great promise for involving leading social scientists in SETI. For such a series of conferences, the first stage is to identify outstanding social scientists and then use travel funds, honoraria, and other incentives to make their involvement in a planning conference attractive to them. The second stage is to implement the resulting plans with a series of larger conferences that are held at six- to eight-month intervals and in the aggregate allow for in-depth coverage of a wide range of topics. Each of these conferences builds on the other, and there are "homework" assignments between meetings. The conference organizers assign staff to handle logistics, provide clerical and research support, and make sure that the meetings are successful. The organizers also assume responsibility for final preparation of the proceedings or other documents. This expensive and time-consuming effort would be justified by (1) gaining the interest of top leaders within different social science disciplines; (2) developing superior publications that can then be widely distributed; and (3) the wave of support that will come from other social scientists when they discover that some of their discipline's leaders have an interest in SETI.

Developing a Scholarly Literature Base

Those of us who are already involved in SETI must "bite the bullet" and develop papers that will be publishable within our disciplines. It is no longer good enough to limit ourselves to journals that attract audiences from the physical sciences or that are intended for "space buffs" who are already supporters of SETI. If we have become somewhat lax because we have been targeting audiences from outside of our disciplines, we will have to tighten our standards. Presumably, the best place to start is with the least controversial aspects of SETI.

Some professional societies publish journals that pertain to the field as a whole and are circulated to the entire membership of the association. Examples include the American Psychological Association's *American Psychologist* and the American Psychological Society's *Psychological Science*. A very high-quality article, with multiple authors of demonstrated reputability, may be accepted by this kind of journal. An article submitted to the *American Psychologist* about ten years ago was returned to the authors without having undergone peer review on the basis that "Psychology and the Search for Extraterrestrial Intelligence" would not interest many readers. Changes in SETI and popular culture may make it worth trying this again.

As an interim step, we should try to increase our publishing in reputable sources that already do recognize SETI as a scholarly activity. One possibility would be an expansion of publication in *Acta Astronautica*, which currently devotes a special issue to SETI every four or five years. The current practice, which precludes relatively rapid publication of articles, could be alleviated by more frequent publication of special SETI issues. Another promising outlet is the *Journal of the British Interplanetary Society*. A social scientist in an endowed position could serve as a focal point to encourage such publishing, for example, by acting as guest editor of special issues of journals. Increasing publication of SETI-related social science articles in such sources would help build a literature base for subsequent articles submitted to discipline-based journals in the social sciences. We emphasize that developing a better literature base in journals that are devoted to space exploration, although valuable, is not a substitute for increased publication in social science journals.

Other opportunities for developing the literature base include newsletters and anthologies. Newsletters often feature nonrefereed articles and contain scant detail. Furthermore, while they may inform and enthuse researchers who are already in a field, they are not necessarily suitable for attracting new contributors. Anthologies such as conference pro-

ceedings or books of readings serve a useful purpose because they do become a part of the archives. However, collections of specialized papers may not be very widely distributed and hence suffer some of the problems of newsletters. In addition, proceedings editors sometimes fail to deliver on their promises, or at least fail to do so in a timely manner, and such bad experiences can discourage potential contributors. For example, a NASA-sponsored study of humans in space conducted in San Diego in 1984 did not appear in print for over a decade. A study of the manned Mars mission eventually published by the American Astronautical Society was first drafted in 1988 but not printed until 1996. Many publishers are wary of heavily multiple-authored books such as conference proceedings. These tend not to sell well; hence, publishers are reluctant to produce them.

There are strategies that can reduce the cost of conference proceedings and hence make them more attractive to publishers. One of us has had experience with a volume that had approximately 50 contributors. Each agreed to waive royalties. Also, the proceedings were from a conference that had NASA-NSF funding, and some of the remaining funds were used to purchase and distribute copies to contributors in lieu of royalties. None of this is to be confused with "vanity" publishing. The manuscript went through the same editorial review and production process as any other manuscript. The subsidy restructured the economics of the project and made it possible to print and distribute a professional, hard-covered book instead of a paperback based on camera-ready copy. These two concessions made publication attractive to an otherwise unenthusiastic publisher.

Increasing Visibility as a Peer Group

Social scientists who are already in SETI must form a conspicuous interdisciplinary peer group for anthropologists, economists, historians, psychologists, political scientists, sociologists, and indeed humanists who might contribute to SETI. We need prominent, enthusiastic role models who are willing to actively recruit and serve as mentors. We are in a transitional period when people are learning about SETI and it is a good time to "stand up and be counted."

Some of us have received support from groups of space advocates. These have provided us with the opportunity to try out new ideas and to receive preliminary feedback. Some of us have presented papers at such meetings that have subsequently been revised for presentation at the International Astronautical Congresses or entered into the literature. Because these space advocacy groups tend to be very heterogeneous and enthusiasm sometimes outruns critical thinking, they may be more useful for getting people started than supporting sustained professional contributions.

If it is to be effective, the social science peer group must be well accepted within the broader SETI community. It will not attract new adherents if there is a strong view among astronomers and astrobiologists that social science is a "weak sibling" or somewhat tangential to SETI. We cannot expect to find new recruits if we ourselves are not accepted, or, as in some space advocacy groups, continually overpowered by people who are totally preoccupied with technology.

Piggyback Projects

Another strategy is to *develop piggyback projects*, that is, encourage projects that develop somewhat standard disciplinary themes but at the same time yield valuable insights for SETI. For example, people's beliefs about extraterrestrial intelligence can serve as an arena for testing theories of attitude formation and change, or people's beliefs about government coverup may give us some insights as to the steps that governments might take to improve credibility.

The basic model here is SERENDIP (Search for Extraterrestrial Emissions from Nearby Developed Intelligent Populations), a microwave search that serves the interests of both basic astronomy and SETI. The way that this is done is searching for microwave evidence at the same time that the radio telescope is collecting data of interest to "mainstream" astronomy. As an example from the social sciences, in a study comparing American and Chinese attitudes about ETI (Vakoch and Lee, 1997), the Chinese collaborator administered the questionnaires for the study in the same testing session at which she gathered data for her experiments in cognitive psychology. This required little extra effort for her, because she had already recruited participants for her own research unrelated to SETI. Questions about SETI can examine broader social scientific issues, as when a study of attitudes towards ETI helps build our understanding of basic processes of attitude formation and change.

Other Strategies for Encouraging Involvement

There are many strategies in addition to those set forth above. One additional strategy is to *involve volunteer consultants*. Those of us who are already engaged may be able to identify people who are willing to donate one or two hours of their time to steer us in promising directions or to critique our work. This will broaden our perspectives and also provide additional quality checks without making heavy demands on marginally interested colleagues.

Another opportunity is to *train covert Ph.D.s*. There are some highly qualified students who are interested in space exploration, including both human expansion into space and SETI. A few of these can receive graduate training at the International Space University and then move forward to an uncertain future. As for the rest, because of disciplinary biases, lack of funding for space-related research, the low priority accorded social scientists for the funding that is available, and so forth, there are very few job opportunities, even for the best graduates. One of us will not accept a graduate student unless it is possible for that person to develop dual competence, for example, strength in environmental psychology, as it is generally perceived, as well as interests in life in isolation and confinement. The dissertations of such students can follow the *Piggyback* strategy identified in the preceding section.

Another way to get people involved is to *include coauthors*. That is, invite colleagues and students to help develop a paper that you are working on in behalf of SETI. This will engage their interest, show them that SETI is a responsible endeavor, and (if you choose the right person) make your work easier. It is helpful if the end product is at least a convention paper and preferably publishable. This strategy can be particularly fruitful with students and with junior colleagues.

Most social scientists currently involved in SETI are North American. This is problematic, because reactions to contact may differ from culture to culture, and our goal is to understand world reaction. This lack of diversity, recognized by the IAA SETI Committee, could in part be overcome by encouraging social scientists with interests in SETI to collaborate with colleagues from other cultures. An endowed social scientist at a place like the SETI Institute or the SETI Australia Centre could play a central role in facilitating such collaborations, by virtue of his or her contacts with a range of colleagues both in the social sciences and in the broader SETI community.

Finally, *we can develop professional networks*. Psychology is an immense field and although the other social sciences have nowhere near so many professionals, they are still large. Of these hundreds of thousands of social scientists there must be some who are already interested in SETI but have yet to be identified. Active networking can help us find and cultivate such individuals. We have seen the impact that email groups like the ALLSETI list can have on maintaining periodic contact between members of the SETI community. An endowed social scientist could serve as a "facilitator" or "hub" of such a communication network.

The Quality of Social Science Insights and Ideas

This essay has outlined a wide variety of steps that can help the social sciences increase their visibility, status, and contribution within the SETI field. In all of this, however, it is important to remember that the core factor is the quality of social science insights and ideas. The impact of social scientists will be profound if they contribute fresh ideas about the nature of ETI and how to detect it, bold insights into the variety of human reactions if the search succeeds, and farsighted scenarios of humanity's eventual relations with extraterrestrial intelligence. The quality of their thought, the ingenuity of their research designs, and the depth of their findings will, in the long run, be particularly significant factors in their contribution to the SETI field.

REFERENCES

Bainbridge, William S. (1983). "Attitudes toward Interstellar Communication: An Empirical Study." *Journal of the British Interplanetary Society, 36*, 298-304.

Baird, John, (1987). *The Inner Limits of Outer Space*, Hanover, New Hampshire, The University Press of New England.

Billingham, John; Heynes, Roger; Milne, David; Doyle, Steven; Klein, Michael; Heilbron, John; Ashkenazi, Michael; Michaud, Michael; Lutz, Julie; and Shostak, Seth, Editors (1999). *Social Implications of the Detection of an Extraterrestrial Civilization: A Report of the Workshops on the Cultural Aspects of SETI*, Mountain View, California: SETI Institute Press.

Connors, Mary M. (1976). "The Role of the Social Scientist in the Search For Extraterrestrial Intelligence," unpublished manuscript, Moffett Field, CA: NASA–Ames Research Center.

Connors, Mary M. (1977). "The Consequences of Detecting Extraterrestrial Intelligence for Communication Policy," unpublished manuscript, Moffett Field, CA: NASA–Ames Research Center.

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

Fasan, Ernst (1990). "Discovery of ETI: Terrestrial and Extraterrestrial Legal Implications." *Acta Astronautica, 21*, 131.

Finney, Ben R. and **Jones, Eric M**. (1984). *Interstellar Migration and the Human Experience,* Berkeley, CA: University of California Press.

Harrison, Albert A. (1997). *After Contact: The Human Response to Extraterrestrial Life*, New York: Plenum.

McCurdy, Howard (1997). *Space and the American Imagination*, Washington, DC: Smithsonian Institution Press.

Maruyama, M. and **Harkins, A.** (1975). *Cultures Beyond Earth: The Role of Anthropology in Outer Space,* New York: Vintage Books.

Michaud, Michael A. G. (1979). "Extraterrestrial Politics," *Cosmic Search, 1(3)*, 11-14.

Michaud, Michael A. G. (1990). "A Unique Moment in Human History," in Ben Bova and Byron Preiss, Eds. *First Contact: The Search for Extraterrestrial Intelligence,* New York, NAL Books, 243-261.

Michaud, Michael A. G. (1998). "Policy Issues in Communicating with ETI," *Space Policy*, *14*, 173-178.

Morrison, Philip; Billingham, John; and **Wolfe, John**, Eds. (1977). *The Search for Extraterrestrial Intelligence*, NASA Special Publication SP-419, Washington, DC: National Aeronautics and Space Administration.

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

Shostak, G. Seth, Ed. (1993). *Third Decennial US-USSR Conference on SETI*, San Francisco, Astronomical Society of the Pacific, San Francisco.

Shostak, G. Seth, Ed. (1995). *Progress in the Search for Extraterrestrial Intelligence: The 1993 Bioastronomy Conference*, San Francisco, Astronomical Society of the Pacific.

Shostak, G. Seth, Ed. (1998). *Sharing the Universe: Perspectives on Extraterrestrial Intelligence*. Berkeley, CA: Berkeley Hills Press.

Swift, David (1990). *SETI Pioneers*. Tucson: University of Arizona Press.

Tarter, Donald E. (1992). "Interpreting and Reporting on a SETI Discovery," *Space Policy*, May, 137.

Tarter, Donald E. (1995). "Reply Policy and Signal Type: Assumptions Drawn from Minimal Source Information." Paper presented at the 46th International Astronautical Congress, Oslo, Norway, October.

Tough, Allen (1999a). About Allen Tough and the Invitation to ETI. See http://members.aol.com/WelcomeETI/4.html.

Tough, Allen (1999b). "The Array of Search Strategies." Paper presented at the International Astronautical Congress, Amsterdam, October. A revised version is included in this volume. Also at http://members.aol.com/AllenTough/strategies.html.

Vakoch, Douglas A. (in press). "Constructing Messages to Extraterrestrials: An Exosemiotic Approach." *Acta Astronautica*.

Vakoch, Douglas A. and **Goldfried, Marvin R.** (in press). "Psychodynamic and Cognitive-Behavioral Perceptions of Interpersonal Therapeutic Issues." *Psychotherapy Research*.

Vakoch, Douglas A. and **Lee, Yuh-shiow** (1997). "Reactions to Receipt of a Message from Extraterrestrials: A Cross-Cultural Empirical Study." Paper presented at the 48th International Astronautical Congress, Torino, Italy.

White, Frank (1990). *The SETI Factor*, New York: Walker and Company.

This essay is a revised and updated version of a report that was discussed in Melbourne at the October 1998 meeting of the SETI Committee of the International Academy of Astronautics, and again in Amsterdam at the October 1999 meeting of its Subcommittee on Issues of Policy Concerning Communications with Extraterrestrial Intelligence. Albert Harrison was the lead author for the original report in 1998. Toward the end of 1999, Allen Tough produced this slightly revised and updated version, which incorporates additional suggestions from several of the original authors.

The Cosmic Environment for the Growth of Complexity

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ABSTRACT

The unifying scenario of cosmic evolution is outlined by following the natural changes among radiation, matter and life in standard, big-bang cosmology. Using aspects of non-equilibrium thermodynamics, especially energy flow considerations, we argue that it is the contrasting temporal behavior of various energy densities that have given rise to the environments needed for the emergence of galaxies, stars, planets, and life forms. We furthermore argue that a necessary (though perhaps not sufficient) condition—a veritable prime mover—for the emergence of such ordered structures of growing complexity is the expansion of the Universe itself. Neither demonstrably new science nor appeals to non-science are needed to explain the impressive hierarchy of generative change, from atoms to galaxies, from cells to society.

Keywords: Cosmology; Evolution; Thermodynamics; Energetics; Free energy rate density.

1. Introduction

Cosmic evolution is the study of change through time—the totality of the many varied changes that have occurred throughout all time and across all space. More specifically, cosmic evolution comprises the generative and developmental changes in the assembly and composition of radiation, matter, and life throughout the Universe. These are the changes that have produced our Galaxy, our Sun, our Earth, and ourselves (Chaisson, 1979).

Figure 1 shows the arrow of time, which provides an archetypical illustration of cosmic evolution. Regardless of its shape or orientation, such an arrow represents an intellectual road map of the *sequence* of events that have changed systems from simplicity to complexity, from inorganic to organic, from chaos to order. That sequence, as determined from a substantial body of post-Renaissance observations, is galaxies first, then stars, planets, and eventually life forms. In particular, we can identify seven major construction phases in the history of the Universe: particulate, galactic, stellar, planetary, chemical, biological, and cultural evolution. These are the specialized phases—separated by discontinuities on localized scales—that are responsible for the disciplinary and fragmented fields of reductionistic science.

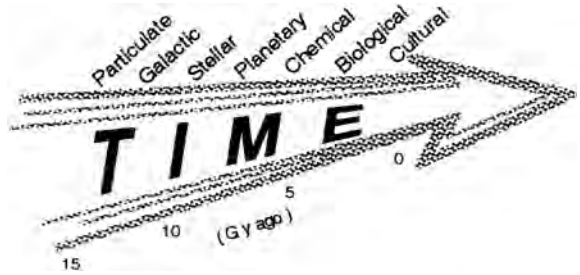

Figure 1. An arrow of time can be used to highlight salient features of cosmic history, from the beginning of the Universe to the present. Sketched diagonally along the top of this arrow are the major evolutionary phases that have acted, in turn, to yield increasing amounts of order, form, and structure among all material things. Despite its drawn implication of "time marching on," the arrow implies nothing strictly deterministic; rather, much as for its most celebrated component—neo-Darwinism—the twin elements of chance and necessity, of randomness and determinism, embed all aspects of the cosmic evolutionary scenario.

As such, the modern subject of biological evolution—neo-Darwinism—is just one, albeit important, subset of a much broader evolutionary scheme encompassing much more than mere life on Earth. In short, what Darwinism does for plants and animals, cosmic evolution aspires to do for all things. And if Darwinism created a revolution in under-

standing by helping to free us from the anthropocentric belief that humans basically differ from other life forms on our planet, then cosmic evolution is destined to extend that intellectual revolution by releasing us from regarding matter on Earth and in our bodies any differently from that in the stars and galaxies beyond.

Of central importance, we can now trace a thread of understanding—a loose continuity of sorts—linking the evolution of primal energy into elementary particles, the evolution of those particles into atoms, in turn of those atoms into galaxies and stars, the evolution of stars into heavy elements, the evolution of those elements into the molecular building blocks of life, of those molecules into life itself, of advanced life forms into intelligence, and of intelligent life into the cultured and technological civilization that we now share. These are the historical phases—much the same as those noted above, but now reidentified from a broader, integrated perspective—that are responsible for the interdisciplinary world-view of the present paper. The claim here is that, despite the compartmentalization of modern science, evolution knows no disciplinary boundaries.

2. Matter

Although modern cosmology—the study of Nature on the grandest scale—stipulates that matter only later emerged from the radiation of the early Universe, it is pedagogically useful to quantify first the role of matter and thereafter the primacy of radiation. In this way, the potentially greatest change in the history of the Universe—the transformation from radiation to matter—can be clearly and mathematically justified.

Imagine an arbitrary shell of mass, m, and radius, r, expanding isotropically with the Universe at a velocity, v, from some central point. The sphere within the shell is not necessarily meant to represent the entire Universe, as much as an exceedingly large, isotropic gas cloud—in fact, larger than the extent of a typical galaxy supercluster (≅50 Megaparsecs across) which comprises the topmost rung in the known hierarchy of matter assemblages in the Universe. Invoking the principle of energy conservation, we quickly arrive at the Friedmann-Lemaitre equation that describes a family of models for the Universe in bulk,

$$H^2 - {}^8\!/_3 \, \pi \, G \, \rho_m = - \, k \, R^{-2},$$

where H is Hubble's constant (a measure of galaxy recession in an expanding Universe), G is the universal gravitational constant, ρ_m is the matter density, and k is a time-dependent curvature constant. R is a scale factor which relates the radius, r, at any time, t, in cosmic history to the current radius, r_o, at the present epoch—namely, $r = Rr_o$. Solutions to the above equation specify three general models for the Universe:

- The Universe can be "open" (i.e., k negative) and thus recede forevermore to infinity (and beyond).
- The Universe can be "closed" (i.e., k positive) wherein its contents eventually stop, thereafter contracting to a point much like that from which it began.
- The Universe is precisely balanced between the open and closed models; in fact such a model Universe would eternally expand toward infinity and never contract.

Consider the simplest case, when $k = 0$ in the above equation, also known as the Einstein-deSitter solution. Here, we find the critical density for closure,

$$\rho_{m,c} = 3H^2/8 \, \pi \, G,$$

which, when evaluated for G and for H (≅*65 km/sec/Mpc*), equals 10^{-29} gm/cm^3. This is approximately 6 atoms in each cubic meter of space, or about a million times more rarefied than the matter in the "empty space" between Earth and the Moon. Whether the actual current density is smaller or larger than this value, making the Universe open or closed, respectively, is not currently known, given the uncertainty concerning "dark matter" within and around galaxies.

To follow the evolution of matter throughout cosmic history, we appeal to the conservation of material particles in the huge sphere noted above, $\rho_m = \rho_{m,o} \, R^{-3}$, substitute into the special ($k = 0$) case of the Friedmann-Lemaitre equation, and manipulate,

$$\int dt = ({}^8\!/_3 \, \pi \, G \, \rho_{m,c})^{-0.5} \int R^{0.5} \, dR.$$

The result is that $t = {}^2\!/_3 \, H^{-1}$, which accounts for the deceleration of the Universe, and also suggests that the Universe (for the special $k = 0$ case) is about 12 billion years old. (Neither H nor t is known to better than 30 percent accuracy.) This equation additionally stipulates how the average matter density thins with time,

$\rho_m \cong 10^6\ t^{-2}$,

where ρ_m is expressed in gm/cm^3 and t in seconds.

Figure 2 plots this evolution of matter, in bulk, throughout all of universal history.

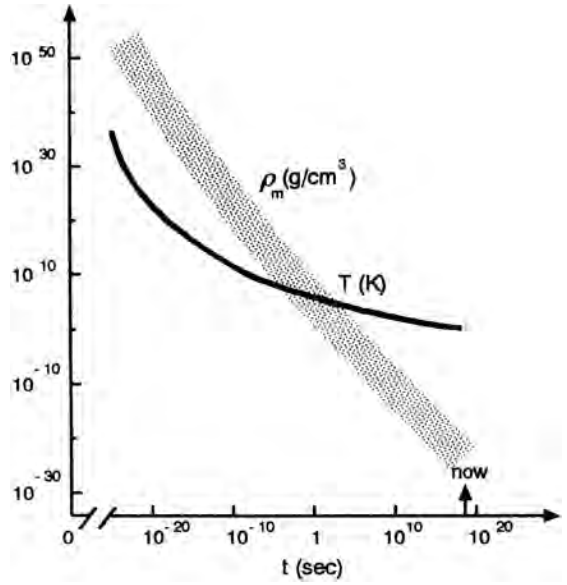

Figure 2. A log-log plot of ρ_m, the density of matter on average, and of T, the temperature of radiation on average, over the course of all time, to date. These plots refer to nothing in particular, just everything in general. The width of the line drawn for ρ_m represents the considerable range of uncertainty in the value of ρ_m observed today; by contrast, T is very accurately measured today.

3. Radiation

The same analysis regarding matter can be applied to radiation in order to map the change of temperature with time. Again, for the simplest $k = 0$ case,

$H^2 = 8\ \pi\ G\ \rho_{r,c}\ /3R^4$,

where ρ_r is the equivalent mass density of *radiation*. Here the R^4 term derives from the fact that radiation scales not only as the volume ($\propto R^3$) but also by one additional factor of R because radiation (unlike matter) is also affected linearly by the Doppler effect. And noting that $\rho_r c^2 = aT^4$, where a is the universal radiation constant for any black-body emitter and T is the temperature of radiation, we find the temporal dependence of average temperature throughout all time (in seconds),

$T \cong 10^{10}\ t^{-0.5}$.

The universal radiation, having begun in a fiery explosion (called the "big bang"), has now cooled to 2.7K, the average value of the cosmic microwave background measured today by radio telescopes on the ground and satellites in orbit. Figure 2 also plots this run of T versus t.

For the first hundred centuries of the Universe, radiation had reigned supreme over matter. All space was flooded with photons, especially light, X rays, and γ rays, ensuring a non-structured, undifferentiated, (virtually) informationless, and highly uniform blob of plasma; we say that matter and radiation were intimately coupled to each other—thermalized and equilibrated. As the universal expansion paralleled the march of time, however, the energy housed in radiation decreased faster than the energy equivalently contained in matter.

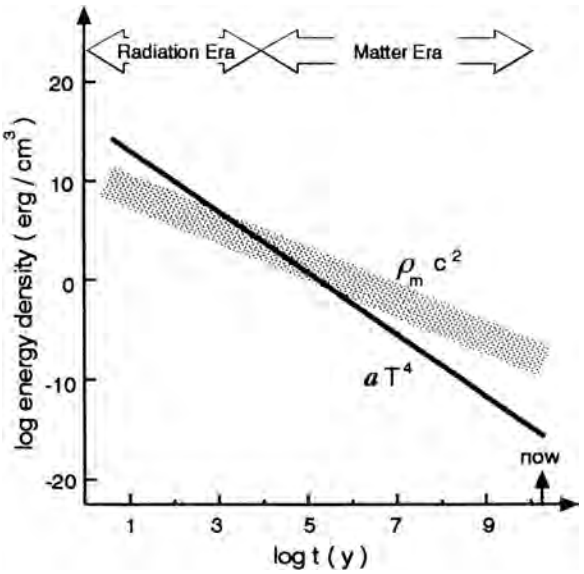

Figure 3. The temporal behavior of both matter energy density and radiation energy density. The two curves intersect at $t \cong 10{,}000$ years, at which time the Radiation Era changed into the Matter Era.

To see this, compare the energy densities of radiation and matter, and especially how these two quantities have evolved in time. First convert the matter density derived earlier to an equivalent *energy* density by invoking the Einsteinian mass (m)–energy (E) relation, $E = mc^2$—that is, by multiplying the above equation for ρ_m by c^2. Now, some 12 billion years after the big bang, $\rho_{m,o}\ c^2 \cong 10^{-9}$ erg/cm^3, whereas $aT_o^4 \cong 4x10^{-13}$ erg/cm^3; thus, in the current epoch, $\rho_{m,o}\ c^2 > aT_o^4$ by several orders of magnitude, proving that matter is now in firm control (gravitationally) of cosmic changes, despite the Universe still being flooded today with (2.7-K) radiation. But, given that $\rho_m c^2$ scales as R^{-3} and aT^4 scales as R^{-4}, we conclude that there must have been a time in the

past when $\rho_m c^2 = aT^4$, and an even earlier time when $\rho_m c^2 < aT^4$. Manipulation of the above equations shows that these two energy densities crossed over at $t \cong 10{,}000$ years, well less than a million years after the big bang. Figure 3 is a graphical presentation of the contents of this paragraph (Field and Chaisson, 1985).

This crossover represents a preeminent change in all of cosmic history. The event, $\rho_m c^2 = aT^4$, separates the Radiation Era from the Matter Era, and designates that time (~10,000 years) at which the Universe gradually began to become transparent. Thermal equilibrium was destroyed and symmetry broken, causing the radiative fireball and the matter gas to decouple; it was as though a fog had lifted. Photons, previously scattered innumerable times by subatomic material particles (especially free electrons) of the expanding, hot, opaque plasma in the Radiation Era, were no longer so affected once the electrons became bound into atoms in the Matter Era. This crucial and dramatic change was over by about 100,000 years, when the last throes of the early plasma state had finally transformed into neutral matter. The microwave (2.7-K) radiation reaching Earth today is a relic of this signal phase transition, having streamed unimpeded (except for being greatly red-shifted) across space and time for most of the age of the Universe, granting us a "view" of this grandest of all evolutionary events that occurred long, long ago.

4. Life

Of all the known clumps of matter in the Universe, life forms, especially those enjoying membership in advanced technological civilizations, arguably comprise the most fascinating complexities of all. What is more, technologically competent life differs fundamentally from lower forms of life and from other types of matter scattered throughout the Universe. This is hardly an anthropocentric statement; after more than ten billion years of cosmic evolution, the dominant species on planet Earth—we, the human being—has learned to tinker not only with matter and energy but also with evolution. Whereas previously the gene (strands of DNA) and the environment (whether stellar, planetary, biological, or cultural) governed evolution, twentieth-century Earthlings are rather suddenly gaining control of aspects of both these agents of change. We are now tampering with matter, diminishing the resources of our planet while constructing the trappings of utility and comfort. And we now stand at the verge of manipulating life itself, potentially altering the genetic makeup of human beings. The physicist unleashes the forces of Nature; the biologist experiments with the structure of genes; the psychologist influences behavior with drugs. We are, quite literally, forcing a change in the way things change.

The emergence of technologically intelligent life, on Earth and perhaps elsewhere, heralds a whole new era: a Life Era. Why? Because technology, despite all its pitfalls, enables life to begin to control matter, much as matter evolved to control radiation more than ten billion years ago. Accordingly, matter is now losing its total dominance, at least at those isolated residences of technological society—such as on planet Earth. Literally, life is now taking matter into its own hands—a clear case of mind over matter, without any Cartesian separation asserted or implied. Such a consummate reductionist viewpoint, materialistic yet not entirely deterministic, also embraces holism as well, for here we postulate a continuous spectrum of complexity all the way up and down the line, from amorphous and uncomplicated protogalaxies to socially stratified cultures of high order (Chaisson, 1989).

A central question before us is this: How did the neural network within human beings grow to the complexity needed to fashion societies, weapons, cathedrals, philosophies, and the like? To appreciate the essence of life's development, especially of life's evolving dominance, we resume our study of the cosmic environment, broadly considered. And here we return to some of the thermodynamic issues raised earlier.

5. Growth of Complexity

When matter and radiation were still equilibrated in the Radiation Era, only a single temperature is needed to describe the thermal history of the Universe; the absence of any thermal gradients dictated (virtually) zero information content, or zero macroscopic order, in the early Universe. But once the Matter Era began, matter became atomic, the gas-energy equilibrium was destroyed, and a single temperature was insufficient to specify the bulk evolution of the cosmos. As things turn out, since the random motions of the hydrogen and helium atoms failed to keep pace with the rate of general expansion of the atoms away from one another (Layzer, 1976), the matter cooled faster, $T_m \cong 6 \times 10^{16}\, t^{-1}$, than the radiation, $T_r \cong 10^{10}\, t^{-0.5}$.

Such a thermal gradient is the patent signature of a heat engine, and it is this ever-widening gradient that enabled matter, in the main, to "build things." At least theoretically, the environmental conditions became naturally established to permit a rise in "negentropy" of statistical mechanics (Schroedinger, 1944) or in "information content" of the information sciences (Shannon and Weaver, 1949)—both factors qualititatively synonymous with the term "complexity" (Lewin, 1992). Such non-equilibrium states are suitable, indeed apparently necessary, for the emergence of order; thus we reason that *cosmic expansion itself is the prime mover for the gradual construction of a hierarchy of structures throughout the Universe.*

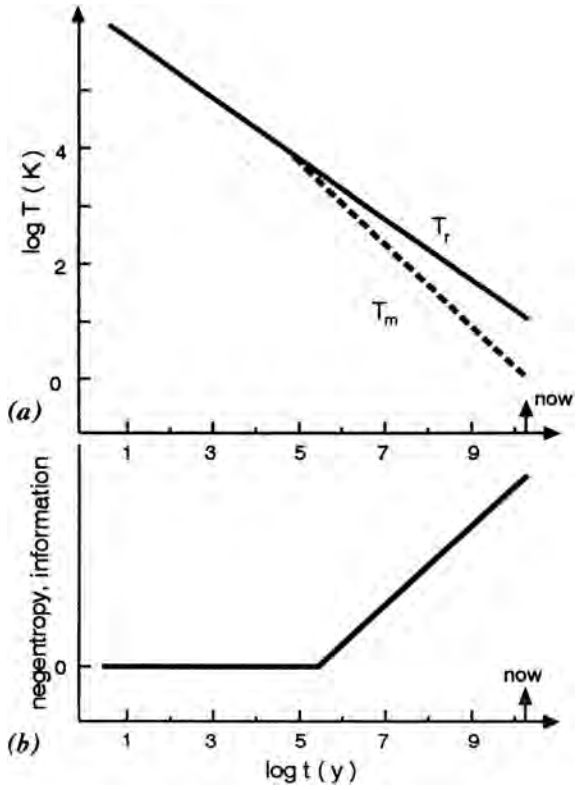

Figure 4. (**a**) The temperature of matter and radiation went their separate ways once these quantities became fully decoupled at $t \cong$ *100,000* years. Since that time, the Universe has been in a non-equilibrium state—a kind of cosmic heat engine. (**b**) The potential for rising negentropy or information content—unquantified here but conceptual synonyms for "complexity"—is broadly proportional to the growing thermal gradient in the Universe.

The key question is this: Have the many and varied real structures known to exist in the Universe displayed this sort of progressive increase in order during the course of time? The answer is yes, and more. Yet how shall we quantify that order—without resorting to tricky empirical values of negentropy whose measurements are virtually impossible, or slippery interpretations of information content whose meaning and connotation are unclear (Marijuan, 1996; Matsuno, 1996)? In the spirit of not having to invent any new science, we return to the non-equilibrium thermodynamics of open systems (Prigogine, 1980). Here, we are not concerned with the absolute value of a structure's total free energy (available for work) as much as with its free energy density; it is the organized energy *density* that best characterizes the degree of order or complexity in any system, just as it was radiation energy density and matter energy density that were important earlier in the Universe. In fact, what is most important is the rate at which free energy transits a complex system of given size. In Table 1 below (Chaisson, 2000), we list our calculated values of $\Im$, the free energy rate densities for six representative structures (and their specific cases computed in parentheses). We also list the ages (in years) of such structures, dating back to their origins in the observational record. Figure 5 plots these results. Clearly, $\Im$ has increased steadily as more intricately ordered structures have emerged throughout cosmic history, and dramatically so in relatively recent times.

Table 1: Some Estimated Free Energy Rate Densities

Structure	*Age (10^9 years)*	*$\Im$ (erg/sec/cm^3)*
Stars (Sun)	10	4
Planets (Earth's climasphere)	5	80
Plants (biosphere)	3	1,000
Animals (hominid body)	0.01	17,000
Brains (human cranial)	0.001	150,000
Society (modern culture)	0	750,000

For each structure, the entropy increase of the surrounding environment can be mathematically shown to exceed the entropy decrease of the system per se, guaranteeing good agreement with the second law of thermodynamics. We thus arrive at a clean reconciliation of the evident destructiveness of thermodynamics with the observed constructiveness of cosmic evolution. The sources and sinks of such energy flows, indeed through complex, yet disparate, entities such as stars, planets and life forms, all relate back to the time of thermal decoupling in the early

Universe, when the conditions naturally emerged for the onset of order and organization.

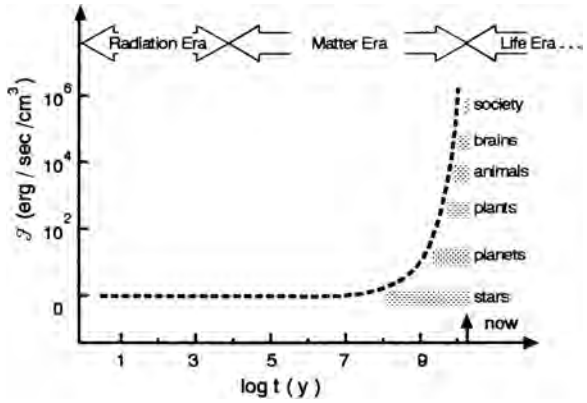

Figure 5. The rise in free energy rate density, $\mathfrak{I}$, plotted as horizontal histograms for those times at which various open structures have existed in Nature, has been dramatic in the last few billion years. The dashed line approximates the rise in negentropy, information, or complexity sketched in the previous figure, but it is energy flow, as graphed here, that best characterizes the order, form, and structure in the Universe. The three principal eras, discussed in this paper, are bracketed across the top.

6. Conclusion

Cosmic evolution accords well with observations that demonstrate an entire hierarchy of structures to have emerged, in turn, during the history of the Universe: energy, particles, atoms, galaxies, stars, planets, life, intelligence, and culture. As a general trend, we recognize an overall increase in complexity with the inexorable march of time—a distinctly temporalized Cosmic Change of Being, without any notion of progress, purpose or design implied. With cosmic evolution as an intellectual basis, we can begin to understand the environmental conditions needed for material assemblages to have become progressively more ordered, organized, and complex, especially in the relatively recent past. This rise in order, form, and structure violates no laws of physics, and certainly not those of modern thermodynamics. Nor is the idea of ubiquitous change novel to our contemporary world-views. What is new and exciting is the way that frontier, non-equilibrium science now helps us to unify a holistic cosmology wherein life plays an integral role.

Acknowledgements

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References

Chaisson, E.J., 1979, Cosmic Evolution: A Synthesis of Matter and Life, Zygon, 14, 23-39.

Chaisson, E.J., 1989, The Life Era, (W.W. Norton, New York).

Chaisson, E.J., 2000, Cosmic Evolution: The Rise of Complexity in Nature, (Harvard University Press, Cambridge).

Field, G.B. and **Chaisson, E.J.,** 1985, The Invisible Universe, (Birkhauser, Boston).

Layzer, D., 1976, The Arrow of Time, Astrophysical J., 206, 559-569.

Lewin, R., 1992, Complexity (Macmillan, New York).

Marijuan, P.C., 1996, From computers and quantum physics to cells, nervous systems and societies, BioSystems, 38, 87-96.

Matsuno, K., 1996, Internalist stance and the physics of information, BioSystems, 38, 111-118.

Prigogine, I., 1980, From Being to Becoming, (W.H. Freeman, San Francisco).

Schroedinger, E., 1944, What is Life? (Cambridge Univ. Press, Cambridge).

Shannon, C.E. and **Weaver, W.,** 1949, The Mathematical Theory of Communication (Univ. of Illinois Press, Champaign-Urbana).

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Cosmic Humanity

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ABSTRACT

Over the next thousand years the domain of humanity will increasingly spread to the stars, a process that will alter our future in profound ways. At least three factors will drive this expansion: 1) increased understanding of cosmic evolution, changing our perception of ourselves and our place in the universe; 2) contact with extraterrestrial intelligence, bringing knowledge, wisdom, and problems of culture contact now unforeseen; and 3) interstellar travel, transporting humanity's emissaries to at least the nearest stars. The consequences of these events are not predictable in detail, but may be studied by examining the lessons of cosmic evolution; by using history to analyze the reception of new worldviews and intellectual culture contacts on Earth; and by anticipating the likelihood of success in interstellar travel and its effects. The prospect of Interstellar Humanity during the next millennium is likely to have an effect on all branches of terrestrial endeavor, whether religion, philosophy, science, or the arts. The stage of human drama will be vastly expanded.

Introduction

Fifty years ago the British philosopher and science fiction writer Olaf Stapledon wrote his essay "Interplanetary Man." At the brink of the Space Age, Stapledon, best known for his *Last and First Men* (1930) and *Star Maker* (1937) epics, believed that humanity would spread throughout the solar system over the next few centuries, barring the destruction of civilization made possible by the new atomic age. He realized that expansion of the human domain would be very different depending on whether or not the planets were inhabited; he concluded, in line with scientific thinking of his time, that this was very unlikely.

Humanity would therefore be left to colonize the planets of our system, most likely unencumbered by problems of extraterrestrial contact; the question that exercised Stapledon was humanity's use of the planets. Exploitation of physical resources, power over a larger physical domain, and the satisfaction of curiosity would all be part of it, but Stapledon believed the solar system was destined for more than mere extension of life as it existed on Earth. Man should use other worlds not for the sole purpose of increasing luxury or power, but "should avail himself of their resources in such ways as to advance the expression of the spirit in the life of mankind. He should use them so as to afford to every human being the greatest possible opportunity for developing and expressing his distinctively human capacity as an instrument of the spirit, as a centre of sensitive and intelligent awareness of the objective universe, as a centre of love of all lovely things, and of creative action for the spirit."[1]

But Stapledon had more in mind than simply a wider scope for *Homo sapiens*. An avid reader since his undergraduate days of genetic pioneers Gregor Mendel, Francis Galton, and August Weismann, he believed that through eugenics specially adapted human or quasi-human races should be developed. "Thus the goal for the solar system would seem to be that it should become an interplanetary community of very diverse worlds each inhabited by its appropriate race of intelligent beings, its characteristic 'humanity,' and each contributing to the common experience its characteristic view of the universe. Through the pooling of this wealth of experience,

1. "Interplanetary Man," in *An Olaf Stapledon Reader*, ed. **Robert Crossley** (Syracuse, N. Y., 1997), 218-241: 237-238.

through this 'commonwealth of worlds,' new levels of mental and spiritual development should become possible, levels at present quite inconceivable to man."[2] By "Interplanetary Humanity" Stapledon thus hoped for more than the mere spread of humanity through the solar system; he hoped for a species physically, mentally, and spiritually improved over terrestrial humanity, privileged with new insights. Such genetic improvement was a key concept of his later fiction.

Such was the main message of Stapledon's best-known essay. In a postscript, however, he noted that intelligence in other planetary systems was also possible, no matter how unlikely it was in our own system. Unaware of the developments in radio astronomy, begun with Karl Jansky in 1933 and being developed in 1948 by Grote Reber and a very few others, Stapledon conjectured that "communication with intelligent races in even the remotest planetary systems may be effected by a highly developed technique of telepathy." Though he was (as far as we know!) wrong about the technique, Stapledon was very much in the spirit of today's tradition when he wrote, "If, by one means or another, man does succeed in communicating with intelligent races in remote worlds, then the right aim will be to enter into mutual understanding and appreciation with them, for mutual enrichment and the further expression of the spirit. One can imagine some sort of cosmical community of worlds."

With the benefit of 50 more years in understanding of our universe, we can see that not only will at least parts of Stapledon's vision of interplanetary humanity likely be realized over the next centuries, but that over the next millennium *Homo sapiens* will almost certainly become *interstellar* humanity. This will occur in three stages, each one filled with more potential—and more danger—than its predecessor. At Level One we will have an increased awareness of our place in the universe by an increased understanding of cosmic evolution. This increased awareness is simply a matter of the advance of many branches of science, and is well underway at the end of the 20th century. At Level Two we will have contact with extraterrestrial intelligence, most likely in the form of remote radio contact rather than physical contact. We are now on the brink of determining whether such intelligence is rare or abundant in the universe; we have only begun to think about the consequences. At Level Three, humanity will travel to the stars, physically spreading into the universe a genome constructed over 3.8 billion years of evolution on Earth, and perhaps by that time also altered along Stapledonian lines.

In all stages of interstellar humanity, the questions of cosmic purpose and human destiny will be paramount. Our place in the scheme of cosmic evolution, the outcome of contact with extraterrestrials, and our ability to travel to the stars all bear strongly on the issue of our place in the universe and the ultimate fate of our species. Increased cosmic awareness, the exchange of information with extraterrestrials, and even the realization that intelligence is scarce as we physically expand into the galaxy will alter our religions, our philosophies, and the image of ourselves. Whether or not the "blind watchmaker" universe has an underlying purpose in cosmic evolution, whether our destiny is intertwined with alien sentient minds, and the nature of our long-term future are questions likely to be answered in the next millennium. All other questions pale in comparison.

Cosmic Evolution

At the end of the 20th century, more and more members of our species are increasingly aware of the new universe. At the beginning of the 20th century, respected scientists could still believe that our Sun was located at the center of our galaxy, and that this galaxy—with a diameter of some 3600 light years—comprised the entire universe. Today we know that the universe extends some 12 to 15 billion light-years, is populated with bizarre objects like pulsars, quasars, and black holes, and is an Einsteinian space-time continuum that has no center. The Hubble Space Telescope, peering into the very depths of this universe, finds billions of galaxies similar and dissimilar to our own. The Earth seems an insignificant speck in the vastness of space.

At the same time this new universe of immense space is not static, but evolving, and presumably has been evolving for as long as 15 billion years. Following in the wake of the Darwinian revolution, the idea of cosmic evolution was already glimpsed at the beginning of the 20th century, though the immensity of the time scale was not yet known. Percival Lowell's *The Evolution of Worlds* (1909) applied physical evolution to the solar system, while George Elery Hale's *The Study of Stellar Evolution* (1907) applied it to the stars. By 1929 Edwin Hubble gave an evolutionary dimension to the universe as a whole, by providing

2. *Ibid*., 238.

data on the recession rate of galaxies that showed the universe was expanding. Today the Big Bang cosmology is believed to provide the reason for that expansion, and the density of the universe appears to be such that the expansion will continue forever.[3]

But cosmic evolution applies to more than the physical universe. Harvard biochemist Lawrence J. Henderson not only grasped the essential idea of cosmic biological evolution in *The Fitness of the Environment* (1913), but also claimed a superior role for it: *The properties of matter and the course of cosmic evolution are now seen to be intimately related to the structure of the living being and to its activities; they become, therefore, far more important in biology than has been previously suspected. For the whole evolutionary process, both cosmic and organic, is one, and the biologist may now rightly regard the universe in its very essence as biocentric*. Volumes such as Harlow Shapley's *Of Stars and Men* (1958), Eric Chaisson's *Cosmic Dawn* (1981), and Carl Sagan's *Cosmos* (1980) spread the idea that human destiny may be understood only in the context of cosmic evolution.[4]

Today, cosmic biological evolution is the central assumption of NASA's Origins program, the touchstone for both astronomers and biologists, and the starting point for numerous science fiction writers. The worldview of cosmic evolutionists from Henderson to the present is epitomized by Nobel biochemist Christian de Duve, who in *Vital Dust: Life as a Cosmic Imperative* (1995) concluded that "the universe is not the inert cosmos of the physicist, with a little life added for good measure. The universe *is* life, with the necessary infrastructure around it; it consists foremost of trillions of biospheres generated and sustained by the rest of the universe."[5]

This "biological universe," as I have termed it elsewhere, is very different from a merely physical universe filled with lifeless planets, stars, and galaxies.[6] As the new universe and cosmic evolution pervade the consciousness of *Homo sapiens*, they hold different meanings for different groups. Cosmic consciousness is expressed in many forms, some of them unpalatable to most scientists: belief in UFOs and extraterrestrial abduction, space-oriented religious cults (such as Heaven's Gate) whose members sacrifice their lives to join the supposed aliens, and ever more elaborate (and often hostile) scenarios of science fiction. While this diversity should warn us that human reactions to the new universe will not be monolithic, it should not prevent us from recognizing undeniable underlying principles.

First, for all groups, the increased awareness of the new universe should dash any remaining hopes for an anthropocentric universe. Even though the idea that the universe was made for man survives in the form of the elegantly misnamed "anthropic principle," in fact that principle is (in Henderson's terms) a "biocentric principle" that points to the abundance of life in the universe in many forms, rather than in the form of man. If life, mind, and intelligence are the common outcomes of cosmic evolution, rather than simply planets, stars, and galaxies, then our religions, philosophies, and other human endeavors as currently formulated are too parochial. They will need to be significantly altered, expanded, or discarded in the coming millennium.

Secondly, quite apart from its nonanthropocentric consequences, cosmic evolution provides humanity a cosmic context in time. Our own planet is 4.5 billion years old; as we look into space we can now see solar systems only half a billion years old. Because of the finite speed of light, the more distant we look, the further back we are looking into our past, stretching back perhaps 15 billion years. But we are also looking into our future. Several generations of stars have already been born, lived, and died, and by peering into space we see their fate, and our fate. We know that in 1.1 billion years our Sun will become too hot for life on Earth, that in 7 billion years it will become a full-fledged *red giant* engulfing the Earth, and that a few hundred million years later it will settle down to the dead end of stellar evolution known as a *white dwarf*. Though we are not accustomed to thinking in such time scales, cosmic evolution defines the stage of the human drama and allows us to see the life of our species in perspective.

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3. **Percival Lowell**, *The Evolution of Worlds* (New York, 1909); **G. E. Hale**, *The Study of Stellar Evolution* (Chicago, 1907); 2; **Hubble**, *The Realm of the Nebulae* (New Haven, 1936). The latest ideas on the ultimate fate of an eternally expanding universe are found in **Fred C. Adams** and **Gregory Laughlin**, "The Future of the Universe," *Sky and Telescope*, 96 (August 1998), 32-39.

4. **L. J. Henderson**, *The Fitness of the Environment* (Cambridge, Mass., 1913), reprinted with an introduction by **George Wald** (Gloucester, Mass., 1979), p. 312; **Harlow Shapley**, *Of Stars and Men* (Boston, 1958); **Eric Chaisson**, *Cosmic Dawn* (Boston, 1981), **Carl Sagan**, *Cosmos* (New York, 1980).

5. **Christian de Duve**, *Vital Dust: Life as a Cosmic Imperative* (1995), 292-293.

6. **Steven J. Dick**, *The Biological Universe* (Cambridge, 1996), *Life on Other Worlds* (Cambridge, 1998).

Finally, cosmic evolution teaches us that we are all "star stuff," in Sagan's colorful terminology. All elements except hydrogen and helium, including the biogenic elements and those found inside our bodies, were forged deep within the stars. Over the next millennium, as new-generation space-based and ground-based telescopes carry out the "archaeology of the heavens," they will uncover our past and our future. Even as they confirm the immensity of the universe and its blindingly hostile nature compared to our fragile biosphere, our human star stuff makes humanity a part of the cosmos in the same way that Copernicus made the Earth part of the cosmos 500 years ago. With this knowledge we may begin to feel at home in the universe rather than estranged from it. We will increasingly understand it, to some extent control it, and perhaps have to share it, depending on whether or not life is abundant. In this context, much depends on the prevalence, nature, and motives of extraterrestrial intelligence.

Extraterrestrial Intelligence

Nothing could usher in a sustained interstellar humanity more forcefully or more quickly than contact with extraterrestrial intelligence. While the first half of the 20th century still held hope for interplanetary intelligence, even Stapledon realized—and we are now virtually certain—that if extraterrestrial intelligence exists, it will be found only among the planets of other stars. (Unless such intelligence or its artifacts find their way to our solar system.) The discoveries of possible Martian fossils, of Europan oceans, of the ancient origin of terrestrial life under adverse conditions, and of extremophile organisms on Earth today, all point to life as a probable common emergent property of the physical universe. At the same time the discovery of numerous planetary systems populated by gas giants, presumably accompanied by terrestrial planets, provides abundant potential life sites. Although the frequency of the evolution of intelligence is still problematic, electromagnetic SETI (Search for Extraterrestrial Intelligence) programs, if they are to succeed at all, will certainly succeed in the next thousand years. Alternative modes of contact are logically possible: Bracewell probes or Tough microprobes, a breakthrough in UFO studies, and the discovery of alien artifacts in the course of space exploration are possibilities that cannot be ruled out.[7]

The consequences of the discovery of extraterrestrial intelligence in the next millennium depend strongly on the contact scenario. But we need not surrender because of this uncertainty; at least three approaches are possible in studying such contact. The first is the imagination, as exemplified in alien science fiction literature, which lays out the possibilities. The effect of the physical presence of extraterrestrials on Earth in the mode of Arthur C. Clarke's *Childhood's End* (1953) is very different from the discovery of an alien artifact, as played out in Clarke's *Rendezvous with Rama* (1973) and its sequels. Both are again very different from scenarios of radio contact, as examined in James Gunn's *The Listeners* (1972) and Carl Sagan's *Contact* (1985). And all these scenarios are far removed from the vision of Fred Hoyle's *Black Cloud* (1957), where the intelligence is nonhumanoid, or Stanislaw Lem's *Solaris* (1961), where the alien intelligence remains mysterious and incomprehensible. Science fiction literature (some more elegantly than others) provides a rich source of thoughtful commentary on the consequences of extraterrestrial contact. Though there is an overemphasis on alien invaders in the mode of H. G. Wells's *War of the Worlds* (1898), we do not in fact know which of the logical possibilities we will find in reality. In its more sublime creations, witnessed in Mary Doria Russell's *The Sparrow* (1996), science fiction sheds light on religion and morality. The imaginations of science fiction writers demonstrate the possibilities; science must discover the realities.

A second approach is grounded in the data of human experience and history. We may demonstrate this by taking the case of radio contact. Contrary to popular wisdom, radio contact with extraterrestrials—the object of SETI programs—will not be analogous to the physical contact of cultures on Earth. As has often been pointed out, physical culture contacts on Earth have most often been disastrous: witness Cortes and the Aztecs, or Pizarro and the Incas, or any number of other culture contacts. Rather, radio contact is analogous to intellectual culture contacts on Earth. Particularly apt is the analogy to the transmission of Greek knowledge to the Latin West via the Arabs in the 12th and 13th centuries. The result was the Renaissance. Moreover, because contact among extraterrestrial civilizations is fundamentally delayed by the finite speed of light in direct proportion to the

7. On Bracewell probes, see **Ronald Bracewell**, *The Galactic Club* (San Francisco, 1975), 69-83. On Tough microprobes see **Allen Tough**, "Small Smart Interstellar Probes," *Journal of the British Interplanetary Society*, 51 (May 1998), 167-174.

intervening distance, like the Greek and European civilizations, communications must take place across time. It is even possible the extraterrestrial civilization will be extinct by the time its signal reaches Earth, as the Greek civilization had reached its peak long before its knowledge was transmitted to the Latin West.[8]

If the decoding of an extraterrestrial message results in a vast amount of knowledge, these analogies might break down. But a case can be made that deciphering a message could be a slow process, perhaps continuing over generations, and thus more analogous to the translation of Greek knowledge. While both positive and negative analogies may be usefully applied, the nature of the message is the all-important unknown factor. Because of the age of the universe, however, extraterrestrial civilizations are likely to be much older than we are, perhaps, it has been conjectured, holding the knowledge of the universe in an *Encyclopedia Galactica*. By making contact we may become part of a Galactic Club—Stapledon's cosmical community of worlds.

In a more general sense, we may use the trajectory of worldviews as an analogy for extraterrestrial contact. The belief in "the biological universe"—one in which cosmic evolution commonly ends in life and intelligence—is a kind of worldview similar in status to the Copernican worldview or the Darwinian worldview. Like them, the biological universe as worldview strongly affects humanity's place in the universe. Like them, it is testable locally via spacecraft and globally via SETI programs. And like them, it will go through certain stages of interpretation and explorations of implications. The rich literature in the history of science examining these revolutions may therefore be used cautiously to examine the implications of the biological universe.[9]

The third mode of examining the effect of extraterrestrial intelligence is social science. Albert Harrison's recent book, *After Contact: The Human Response to Extraterrestrial Life* (1997), has led the way in showing how fields such as psychology, sociology, and anthropology can be used as an aid to thinking about implications of contact. In particular he advocates a kind of systems approach, called Living Systems Theory, in which what we know about organisms, societies, and supranational systems on Earth can be used to discuss the outer space analogues of extraterrestrials, extraterrestrial civilizations, and the Galactic Club. This is a promising approach to the study of implications, though Harrison applies it only to aliens and civilizations, not to low life-forms and Martian nanofossils. The latter entails a shift in worldview quite distinct from communicative extraterrestrials, a difference that Living Systems Theory may also illuminate.[10]

The exchange of ideas likely in the radio contact scenario is not the only possibility. Other contact scenarios—physical contact, or contact by probes or microprobes with varying capabilities—have their own analogues in history. No historical analogues will be perfect, but they provide a starting point and lay out options, and the very discussion of why they are not perfect will be illuminating.

Science fiction, terrestrial analogues in human history, and Living Systems Theory are three fundamentally different ways to gauge the impact of extraterrestrial contact. All, it is true, make use of our terrestrial experience. But it is difficult to transcend that experience until contact is actually made. In any case, a systematic study using these three approaches promises to shed considerable light on our future over the next millennium. While the nature of the knowledge gained from extraterrestrial contact remains a wildcard, these approaches can nevertheless give us an outline of possible impacts. Whatever the impact, we may predict that the exchange of information will shed light on the great problems of philosophy; if communication can be achieved, for example, the problem of objective knowledge will be raised to a new level of sophistication as the communicating intelligences share their knowledge. It is hard to imagine any event in the next millennium that could have greater consequences for human life and the future of our planet.

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8. **Steven J. Dick**, "Consequences of Success in SETI: Lessons from the History of Science," and **Ivan Almar**, "The Consequences of a Discovery: Different Scenarios," in *Progress in the Search for Extraterrestrial Life*, ed. **G. Seth Shostak** (San Francisco, 1995), pp. 521-532 and 499-505.

9. **Steven J. Dick**, "Consequences of Success," (note 8); *The Biological Universe*, Cambridge, 1996; "From the Physical World to the Biological Universe," in *Bioastronomy: The Search for Extraterrestrial Life*, eds. **J. Heidmann** and **M. J. Klein** (Berlin, 1991), 356-363.

10. **Albert Harrison**, *After Contact: The Human Response to Extraterrestrial Life* (1997). For other considerations of contact see Paul Davies, *Are We Alone? Philosophical Implications of Discovery of Extraterrestrial Intelligence* (New York, 1995).

Interstellar Travel

Although some believe that interstellar travel is physically impossible because of distance and power requirements, history is not on the side of the pessimists. It is likely that their pessimism falls into the category of what Arthur C. Clarke has termed "failure of imagination," and that ways will be found to cross the ocean of space no less than the ingenuity of our predecessors carried them across the oceans of Earth. Indeed, the first full engineering study for an interstellar starship was published under the auspices of the British Interplanetary Society in 1978, 30 years after Stapledon's lecture. That vehicle was designed to travel to Barnard's star, at six light-years one of the closest stars to our Sun. A feel for even nearby interstellar distances may be glimpsed by realizing that at a cruising speed 12 percent the speed of light, such a starship would take 50 years. The propulsion system was based on nuclear fusion and required mining the helium-rich atmosphere of Jupiter to propel the 450-ton payload. Even then this was a flyby mission; no fuel would remain for deceleration from 12 percent the speed of light.[11]

Clearly interstellar travel will challenge humanity, and many practical problems await solution. When we consider where human transportation technology was a thousand years ago, it is probable that over the next millennium propulsion systems such as the matter-antimatter drive, star sails, or those based on concepts as yet unglimpsed will lead humanity to the stars. Indeed, given the distances and times involved, one technology is likely to leapfrog another, and early-generation starships literally surpassed on their way to the stars.

Whatever the case, interstellar travel will be the capstone to interstellar humanity. Daunting as the task seems, someday the hundreds of billions of stars in our own galaxy will have been explored, and the nearby galaxies will beckon. We may safely predict, however, that the era of intergalactic humanity will not take place in the next millennium. At the speed of light, it would take a half-million light-years to reach the nearest galaxy. Unless, that is, one is transported to distant regions of the universe via wormholes associated with black holes. But this, too, is unlikely in the next millennium. Humanity is likely to be preoccupied over the next millennium with roving our own galaxy, with its 100,000 light-year diameter. Even at the end of the next millennium, humanity will still have limits.[12]

We may well wonder, if extraterrestrials are abundant and interstellar travel is common, why interstellar starships are not evident in the vicinity of Earth. This paradox, first posed by Enrico Fermi 50 years ago, asserts that given the long time scale of the universe, if extraterrestrials are abundant, they should have colonized the galaxy within a few million years and arrived on Earth long ago. Since we do not see them (barring arguments for the extraterrestrial hypothesis of UFOs), skeptics of the biological universe assert they do not exist. This argument has led SETI proponents to assert that interstellar travel is not economical, not the most efficient mode of interstellar contact, or not an interest of most civilizations. However, only one civilization is required to give force to the paradox. Conversely, only one need be discovered by SETI programs or interstellar travel to find the solution to the Fermi Paradox.

Quite aside from any merits of the Fermi Paradox, human interstellar travel over the next millennium will likely proceed. History shows that exploration is an essential part of the human imperative, and while for economic and other reasons robot probes may precede human exploration, even the brief history of interplanetary exploration indicates that human exploration will follow. The Pioneer 10 and 11 and Voyager 1 and 2 spacecraft, vestiges of interplanetary humanity, are our species' first emissaries to the stars, complete with messages for any extraterrestrials who chance to intercept them. At .005 percent the speed of light, the Voyagers will take 80,000 years to reach the distance of the nearest star, Alpha Centauri.

We should recognize that it is possible—though we believe not probable, in light of what we now know about cosmic evolution—that *Homo sapiens* is the only intelligent species in the galaxy. There is precedent for this too in science fiction; perhaps its most famous story, Isaac Asimov's *Foundation* series, is carried out in a galaxy devoid of extraterrestrials but colonized by man. One can hardly say that it is a less interesting universe; the preservation of knowledge is its centerpiece, and the *Encyclopedia Galactica* its

11. *Project Daedalus—The Final Report on the BIS Starship Study*, ed. **A. R. Martin**, *Journal of the British Interplanetary Society*, Supplement (1978).

12. On interstellar travel see **I. A. Crawford**, "Interstellar Travel: A Review for Astronomers," 31, *Quarterly Journal of the Royal Astronomical Society* (1990), 377-400. On the wormhole concept and its history see **Paul Halpern**, *Cosmic Wormholes: The Search for Interstellar Shortcuts* (New York, 1992).

anchor. The *Encyclopedia Galactica* is also a frequent theme of universes populated with extraterrestrials, now containing all the knowledge of the Galactic Club. In either case, the era of interstellar humanity will not be "the end of history" or "the end of science" in the rather parochial view of Earthbound humanity posited at the end of the second millennium.[13]

With interstellar travel the human genome will physically be transported into space. Moreover, it is likely that the long distances required in interstellar travel will drive human intervention in that genome, so that humans, or their successor species, will be engineered to withstand the rigors of the trip. Even if traditional ideas like suspended animation prove practical, genetic considerations are likely to play an important role in maximizing efficiency and success. What effect an extraterrestrial genome might have on us it is too soon to say, but natural selection on distant planets may have developed more efficient models of intelligence than ours; at the pace of genetic intervention today, it is likely that over the next millennium our species will wish to make use of alien genetics, quite aside from its own. The principles of human ethics and morality will continue to be tested.

Finally, even as interstellar travel proceeds, Asimov and others remind us that new sciences will arise and old ones will sprout new directions as yet unseen. "Psychohistory"—the statistical treatment of historical trends to predict future outcomes—plays a major role in the *Foundation* novels. The social sciences may come into their own in the next millennium, and brain sciences almost certainly will. Moreover, technologies such as robotic intelligence and nanotechnology will be developed. These new sciences and technologies will feed into the future in ways now intrinsically unforeseeable. But they will change only the details, not the fact, of interstellar humanity.

What are the consequences of interstellar travel? A glimpse of the struggles that interstellar travelers will face may be seen in Finney and Jones's *Interstellar Migration and the Human Experience*.[14] Again, it is based on analogy, with European exploration, Polynesian expansion across the Pacific, and the stillborn attempts of other societies at colonization. For those who succeed, we may predict only in the most general terms that interstellar humanity will be highly dependent on technology, still struggling with the same problems of human nature that we face today, but will operate in a vastly expanded domain that incorporates a full knowledge of cosmic evolution and may involve interstellar politics in which the principals are extraterrestrial civilizations. Unlike radio contact, physical contact with extraterrestrial intelligence forces us to consider the negative analogies of physical culture contact on Earth. If we can survive such contact, the deepest questions of the species, pondered since our earliest human ancestors looked skyward and wondered about the stars, will be answered. Stapledon's fondest wish may be realized in interstellar humanity rather than interplanetary man.

Cosmic Destiny

In the era of interstellar humanity, the fundamental questions of the species are likely to remain the same as today. Foremost among them are the questions of cosmic purpose and human destiny, issues that were raised in the 20th century in the context of the new biology and the new astronomy, which find their intersection in the discipline variously termed *bioastronomy*, *exobiology*, and *astrobiology*—the study of the biological universe.

Almost at the same time Stapledon wrote his essay on "Interplanetary Man?" the French scientist LeComte du Nouy wrote a widely hailed volume entitled *Human Destiny* (1947). There he concluded that the simple protein molecule would have taken 243 orders of magnitude more time than the age of the Earth to form by chance, that life itself could therefore not have arisen by chance, and that "these consequences inevitably lead to the idea of God." The same theme pervaded the influential book *Chance and Necessity* (1971) of the French biologist Jacques Monod when he wrote, after long thought on the consequences of his own discoveries, "The universe was not pregnant with life, nor the biosphere with man. Our number came up in the Monte Carlo game."[15]

It was this kind of universe that led to pessimistic ideas of cosmic purpose and human destiny. Nobel

13. **Francis Fukuyama**, *The End of History and the Last Man* (New York, 1992); **John Horgan**, *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age* (Reading, Mass., 1996).

14. *Interstellar Migration and the Human Experience,* ed. **Ben R. Finney** and **Eric M. Jones** (Berkeley, 1985).

15.**LeComte du Nouy**, *Human Destiny* (New York, 1947); **Jacques Monod**, *Chance and Necessity* (New York, 1971), 144-146.

physicist Steven Weinberg, for example, wrote, "It is almost irresistible for humans to believe that we have some special relation to the universe, that human life is not just a more-or-less farcical outcome of a chain of accidents reaching back to the first three minutes, but that we were somehow built in from the beginning…. It is very hard to believe that all this is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakable unfamiliar early condition, and faces a future extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it also seems pointless."[16]

But this conclusion did not take into account the biological universe, nor did it consider unexpected developments in the fields of chaos and complexity. In particular, Stuart Kauffman and others have pioneered the idea of self-organization; in his book *At Home in the Universe* Kauffman has detailed how life could have originated by the natural tendency of matter to self-organize. Under this scenario, Nobel biochemist Christian de Duve could write, "I view this universe not as a cosmic joke, but as a meaningful entity—made in such a way to generate life and mind, bound to give birth to living beings able to discern truth, apprehend beauty, feel love, yearn after goodness, define evil, experience mystery."[17] This is the view championed by many cosmic evolution pioneers, including Carl Sagan. The whole scenario of cosmic biological evolution, not taken into account by du Nouy, Monod, or Weinberg, potentially places human life in a new context in terms of purpose and destiny. It is just such questions that coincide with the Stapledonian wish to use new worlds to advance the human spirit; those are the questions of ultimate importance to interstellar humanity.

Human destiny very much depends on the course of cosmic evolution. With Stapledon, we may conclude that it will be very different if the galaxy is inhabited, or if it is not. If it is, then we may join the Galactic Club, have access (and perhaps even add) to the *Encyclopedia Galactica*. If it is not inhabited, then it is our destiny to fill the galaxy with life; the *Encyclopedia Galactica* will be the history of the human race, or its genetic or robotic descendants. In the latter case, interstellar migration and colonization are our future; interstellar travel, rather than extraterrestrial intelligence, will predominate interstellar humanity. In that case, the Fermi Paradox will have proven its force, though the search for life will likely go on as an important part of the exploration imperative.

Conclusion

Cosmic evolution, extraterrestrial intelligence, and interstellar travel will shape interstellar humanity in the next millennium. Those who take part directly in these ventures will certainly be affected, but so also will much of humanity. Consciousness of cosmic evolution is increasing and will continue to increase because of a fundamental human desire to answer the question that more than 130 years ago T. H. Huxley called "the question of questions for mankind—the problem which underlies all others and is more deeply interesting than any other," humanity's place in nature.[18] Huxley was speaking in the context of Darwinian theory of evolution by natural selection; that question has now been extended to cosmic evolution, and therefore the problem of our place in the universe.

The search for extraterrestrial life is an essential part of that problem. Whereas Kepler, Galileo, Newton, and their modern-day successors demonstrated the role of physical law in the universe, the question at stake in the extraterrestrial life debate is whether an analogous "biological law" reigns throughout the universe, whether Darwinian natural selection is a universal phenomenon rather than simply a terrestrial one, whether there are other biologies, histories, religions, and philosophies beyond the Earth. In short, at stake is whether *Homo sapiens* inhabits a physical, or a biological, universe. The two yield fundamentally different worldviews. During the next millennium, probably earlier rather than later, we will likely discover which is true. The rest of the millennium will be spent in exploring the implications of this profound truth.

Looking back from the year 3000—some 40 generations hence—most of the historical and political issues that concern us now will have been forgotten. World War II will seem as distant as the Battle of Hastings does to us now. The geopolitical landscape will have transformed into an astropolitical landscape. Our science will seem quaint and embryonic.

16. **Steven Weinberg**, *The First Three Minutes* (New York, 1977), 154.

17. **Christian de Duve**, *Vital Dust* (New York, 1995), xviii; **Stuart Kauffman**, *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity* (New York and Oxford, 1995).

18. **T. H. Huxley**, *Man's Place in Nature* (1863; Ann Arbor, Mich., 1971 ed.), 71.

But the desire to know better our place in the universe, to push the frontiers, to explore beyond one more barrier, will remain.

A final cautionary note is in order. The question mark in Stapledon's title referred not only to the accuracy of his prediction, but also to the survival of civilization in the new atomic age. Even in our age, we must still allow for the possibility that the hopes for interplanetary and interstellar man will be dashed by the follies of adolescent humanity, and that a thousand years from now some extraterrestrial archaeological expedition will be picking through the remains of terrestrial man, whose follies exceeded its promise and cut short its brief history. As with the atomic age, the age of genetic engineering and other scientific advances yet unseen will each bring danger as well as opportunity. Even though the destruction of *Homo sapiens* might constitute only a blip in the scheme of cosmic evolution (depending on the prevalence of intelligence elsewhere), as individuals each of us must do what he or she can to see that this future does not prevail.

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How Old Is ET?

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ABSTRACT

This paper considers the factors that determine the probable age of a civilisation that might be detected in a SETI search. Simple stellar evolution considerations suggest an age of a few Gyr [gigayears or billion years]. Supernovae and gamma-ray bursters could in principle shorten the lifetime of a civilisation, but the fact that life on Earth has survived for at least four Gyr places a severe constraint on such factors. If a civilisation is detected as a result of a SETI search, it is likely to be of order one Gyr more advanced than we are.

1. Introduction

When we conduct searches for extraterrestrial intelligence, we often make implicit assumptions about the age of the civilisation that we are trying to find. For example, our strategy for searching for a life-form of a similar age to us is likely to be different from that for a civilisation billions of years more advanced than we are. Similarly, in the event of a confirmed detection, the way in which we plan our response will also depend on how advanced that civilisation may be. In this paper, I estimate the likely age of the civilisation that we are most likely to detect, should we be successful in our searches.

The two key factors that determine how old a detected civilisation is likely to be are (a) the length of time since intelligent life first appeared in our galaxy and (b) the median lifetime of a civilisation. The second of these is more problematic, since the development of a civilisation can be cut short by a wide range of events, including disease, war, global mismanagement, asteroids, supernovae, and gamma-ray bursters. We should also acknowledge the possible existence of other hazards, of which we are not yet aware. For example, the devastating effect of gamma-ray bursters has been appreciated only in the last two to three years, and there are probably other phenomena yet to be discovered. Events such as disease, war, and global mismanagement are almost impossible to quantify, and so in this paper I concentrate on those events that we *can* quantify: asteroids, supernovae, and gamma-ray bursters. In the first section of this paper, I consider what the maximum lifetime of a planetary-bound civilisation might be.

Throughout this paper, I make a very conservative assumption that an extraterrestrial civilisation (ET) resembles us in most significant respects (other than age and evolution). In other words, ET lives on a planet orbiting a solar-type star and has taken as long after the formation of its star to evolve to "civilisation" as we have, which is ~5 Gyr (gigayears or billion years). I therefore estimate the longevity of ET by looking at the hazards that confront the Earth.

2. The Natural Lifetime of a Civilisation

I assume that stars like our Sun have been forming since the formation of the galaxy some ten Gyr ago. Observed changes in metallicity since then are not sufficient to alter this simple assumption significantly. Our Sun is now about five Gyr old and has an expected total lifetime of ten Gyr.

For the first five Gyr of the life of the galaxy, there would not have been enough time for a civilisation to develop, and so ET did not exist. Between five and ten Gyr, assuming a constant rate of star formation, the number of civilisations would increase linearly until the present day. At around the present time, some of those first solar-type stars will be dying at the same rate as others are forming; so, assuming their civilisations die at the same rate as they do, the number of civilisations is then level from now on.

The median age of a civilisation is therefore the median age of those civilisations that started between five and 0 Gyr ago, which is 1.7 Gyr. Therefore, in the absence of other factors, any civilisation that we detect via SETI is likely to be 1.7 Gyr more advanced than we are.

3. The Effect of Supernovae

A supernova results from the explosion of a high-mass star after its hydrogen and helium fuels are used up, at the end of its lifetime. A supernova exploding within 50 light-years of the Earth would have a catastrophic effect. The 1040 J of energy produced in the first few days would bathe the Earth in a total amount of ionisation some 300 times greater than the annual amount of ionisation from cosmic rays. Surprisingly, little of this radiation would reach Earth. Instead, most of it would ionise atmospheric nitrogen, which reacts with oxygen to form nitrous oxide, which in turn reacts with ozone.[3] The effect would be to reduce the amount of ozone in the Earth's atmosphere by about 95%, resulting in a level of UV on the Earth's surface some four orders of magnitude greater than normal, which would continue for a period of two years. This would certainly result in almost 100% mortality of small organisms and most plants. The effect on mammals is not clear; some might survive. However, this two-year period would be followed by a longer (80 years) period of bombardment by the cosmic rays from the supernova, which have similar, although slightly reduced, effects. It is difficult to see how anything other than an advanced civilisation could survive such an extended holocaust.

A supernova such as this goes off in our galaxy roughly every five years, and we expect one within 50 light-years of the Earth roughly once every five million years. We expect one even closer (within ten light-years) every 200 million years. All life would be expected to be destroyed at this interval. Clearly this has not happened, since we are still here, and I will return to possible reasons in a later section.

4. The Effect of Gamma-Ray Bursters

Gamma-ray bursters (GRB) are a recently discovered phenomenon, in which some 1045 J of energy is released in a few seconds. The ones that have been observed on Earth appear to be distributed uniformly across the observable universe. Their power is such that we are able to detect GRB right up to the edge of the observable universe. The mechanism is still not known, but is likely to involve the merging of two neutron stars, possibly resulting in the formation of a black hole.

A GRB is some five orders of magnitude more energetic than a supernova, and could occur even at the galactic centre, 25,000 light-years away from us, and have a similar effect as a supernova within 50 light-years. However, in this case there is an even more deadly effect, in that, should a GRB go off in the galactic centre, the immediate blast of ionising radiation would be followed by an intense blast of cosmic rays lasting perhaps a few weeks.[4] These cosmic rays would initiate a shower of relativistic muons in the Earth's atmosphere, causing a radiation level on the surface of the Earth some 100 times greater than the lethal dose for a human being. The muons are so energetic that they would even penetrate nuclear air-raid shelters to a depth of perhaps hundreds of metres.[2]

We expect such a GRB roughly once every 200 million years, and it would almost certainly result in the extinction of all life on Earth other than that deep in the ocean. Again, clearly this has not happened, since we are here.

5. Mass Extinctions on Earth

The geological and biological record shows a series of mass extinctions of life on Earth. The most famous is that at the Cretaceous-Tertiary (KT) boundary, which was almost certainly caused by an asteroid hitting the Earth about 65 million years ago. The KT mass extinction wiped out the dinosaurs and paved the way for the emergence of mammals as the dominant species on Earth.

Less well known are a series of similar, and in some cases even more extreme, mass extinctions every few tens of millions of years, and many smaller extinctions, the last of which was only 11,000 years ago. The cause of most of these is unknown. It is likely that a range of causes, including asteroids, distant supernovae, and climatic changes, is responsible for them.

All these mass extinctions are on a much smaller scale than the catastrophic events we expect from a nearby supernova or a gamma-ray burst in the galactic centre. In each of these cases, a number of species (sometimes as many as 50 percent) were extinguished, but a sufficient range of diversity remained for the biota to recover in a relatively short time.

6. Why Are We Here?

I have identified two causes that should wipe out essentially all life on Earth roughly every 200 million years, and yet we are here. Two possible explanations are: (1) The calculation of either the time scales or the severity of the effects is erroneous, or (2) we have been very lucky!

In the first case, simply multiplying the time scale by a factor of a few is insufficient. We have been evolving for at least four Gyr, and so the interval between catastrophes must be at least four Gyr for us to survive so far. Presumably the precise interval will vary randomly around this figure, so any surviving civilisation can look forward to a lifetime of between zero and a few Gyr. In this case, if we detect ET, then ET will have a median age of perhaps one or two Gyr, which is similar to the 1.7 Gyr derived from simple stellar evolution arguments. Thus, in this case, the supernovae and GRBs have not significantly changed the median age of ET.

In the second case, we have already survived for some 20 times the mean interval between catastrophes, which is very lucky indeed. Whilst it is not possible to quantify this without more detailed knowledge of the frequency distribution of supernovae and GRBs, it is likely that the probability is so low that we are alone in the galaxy. Apart from providing a solution to the Fermi paradox,[1] this implies that the median lifetime of ET is meaningless, as we will never detect ET!

7. Conclusion

Conventional models imply that supernovae and gamma-ray bursters will extinguish life on planets at intervals of about 200 million years. Since this has not happened on Earth, either these conventional models are wrong, or else life on Earth is probably unique in the galaxy. The first case predicts a median age of ET as being of the order of one billion years. The second case predicts that we will never detect ET. Thus, if we *do* detect ET, the median age is of order one billion years. Note that in this case the probability of ET's being less than one million years older than we are is less than one part in a thousand.

Therefore, any successful SETI detection will have detected a civilisation almost certainly at least a million years older than ours, and more probably of order a billion years older.

References

1. Annis, J., 1999, JBIS, 52, 19.

2. Leonard, P.J.T., and **Bonnell, J.T.,** 1998, Sky & Telescope, 95, 28.

3. Rudermann, M.A., 1974, Science, 184, 1079.

4. Thorsett, S.E., ApJ, 444, L53.

Networking with Our Galactic Neighbors

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ABSTRACT

If we are able to find one extraterrestrial civilization, we should be able to find many. By the year 3000 either we will have abandoned the search for extraterrestrial intelligence, or we will have made progress networking with other civilizations in our galaxy. One alternative is that we will first detect a civilization that, like our own, has not yet confirmed the existence of other distant civilizations. This success will accelerate our search efforts and put us in touch, one by one, with many more extraterrestrial societies. Under this alternative we would be founding members of the Galactic Club, that is the largest network of communicating civilizations within our galaxy. Another alternative is that our initial contact will be with a civilization that is already affiliated with the Galactic Club, with the result that we ourselves are offered membership. Whether we help build the first network of civilizations or are inducted into a pre-existing network could have profound implications for humanity in the year 3000.

Introduction

Growing evidence that principles of physics, chemistry, and biology hold for all times and all places has increased acceptance of the "many worlds" hypothesis.[1,2] A combination of observation, experimentation, and inference suggests that there are many hospitable sites for life in the universe, that the processes that give rise to life are common rather than infrequent, and that there are convergent paths to the evolution of intelligence.[3-5] Even as the improvement of optical telescopes enabled the search for life on neighboring planets during the last decades of the 19th century, the evolution of radio telescopes and information processing technology has encouraged us to seek evidence of life outside of our solar system in the 20th century.[1-5] If the rationale underlying the microwave search is correct, there is a reasonable (50-50) chance of detecting ETI in the next two decades.[6]

A belief that although intelligent life is abundant it is still only sparsely distributed, a conviction that interstellar travel is difficult if not impossible, and devotion to a search strategy intended to detect telltale electromagnetic activity have all led radio astronomers to expect a "minimum detection scenario."[7] According to this orthodoxy, apart from heralding the presence of another civilization in the universe, the first intercept is not likely to be very informative. Either there will be little or nothing to decipher (as in the case of intercepting a navigation beacon), or, because of their advanced nature, we will not be able to understand any information that is superimposed on the carrier wave. If this proves true, then for many years following first contact, all we may know is that we are not alone in our galaxy. This state of relative ignorance could continue for decades, but is unlikely to continue for centuries or millennia.

SETI 3000

Certainly our thinking about contact is influenced by our own life expectancies. But how might our thinking change if we could watch events unfold over the next 50 generations? Undertaking this thought experiment today, we might become more optimistic about the chances of detection. As the years pass we should see vast improvements in our search technology. In slightly over half of the span of one human life we have progressed from monitoring single radio frequencies to monitoring billions of channels at once.[4,5] As we enter year 2000 we anticipate technol-

ogies that will allow us to search for extraterrestrial lasers, identify patterns of energy use that are suggestive of advanced civilizations, image extra-solar planets, and explore other solar systems by means of tiny, inexpensive robot probes.

We could continue for many years without definitive results and still maintain vigorous search efforts. Despite the efficiency of microwave observation, the sky is very large and it will take time to explore it thoroughly. Beyond this, the idea of extraterrestrial companions is heavily if not indelibly ingrained in Earth's cultures and religions and in the popular imagination. Strong beliefs of any type (including those favorable or unfavorable to extraterrestrial life) are notoriously difficult to change. People simply ignore or discount evidence that is inconsistent with their views while embracing evidence that they can interpret as consonant. For a while, the search will be revitalized as we revise our thinking about ET and as new communication and search strategies come on line. Over the long run, however, scientists who are able to maintain a sense of objectivity will lose interest as generations of their predecessors fail to find conclusive evidence. For those of us alive today and perhaps our children and grandchildren, the search will continue, periodically refreshed by new theories, technologies, and hopes. Yet long before 3000, either we will conclude that we were misled by centuries of illusory progress in physics and biology, or we will determine that "we are not alone" in our galaxy.

Contact, if it occurs at all, is likely to occur within the early years of the new millennium. If contact occurs in the near future, then a thousand years from now we will have shifted attention from initial reactions to contact to its long-term effects on people, institutions, and societies. In a thousand years, the minimum detection scenario—if it unfolded at all—would be a chapter in history. The years that SETI scientists anticipate devoting to deciphering and interpreting ET's first message will be long past. If we have found one civilization, we will have found many. Either by a long and circuitous path, or by events that could occur almost overnight, we may become part of a vast interstellar network of civilizations.

The Galactic Club

James Grier Miller's Living Systems Theory applies common principles to analyze biosocial entities at seven hierarchical systems levels.[8] In ascending order these are the cell, organ, individual, group, organization, community, society, and supranational system. Each of these system levels is successively higher in the sense that it encompasses systems at all lower levels (for example, an individual is composed of cells and organs) and is characterized by distinctive emergent properties (for example, consciousness or personality). On Earth, communities and societies evolved slowly over time, and supranational systems have appeared only recently. Supranational systems consist of networked societies that agree to accept decisions from an echelon that is higher than that of any individual member state—for example, individual nations submitting to the decisions of the United Nations or the European Union. Contemporary terrestrial supranational systems tend to be piecemeal and exert only fragmented control over their constituents. The higher echelon may influence only a limited number of activities (for example, mutual defense, international trade, and environmental protection) and participation may require nothing more than abiding by mutually agreed-upon rules. A tight alliance of all of the civilizations in our galaxy would constitute a supranational system, but so would a cluster of neighboring societies that agreed to reserve certain radio frequencies for interstellar communication.

Ronald Bracewell coined the term *Galactic Club* to describe a vast but possibly sparse network of civilizations.[9] A Galactic Club would begin when two technologically advanced societies made contact with one another. More members would be added as each civilization continued to search. In some cases the Club would acquire individual societies, and in other cases it would add clusters of societies that had previously found one another. Some members, perhaps within the same solar system, might be able to visit one another and engage in direct trade, but most members would be bound together by radio or some other efficient communication technology. If, as some theorists surmise, there are many civilizations that are millions of years older than our own,[6] we might expect that there are already one or more incipient Galactic Clubs within the reach of our radiotelescopes. The smallest originating Galactic Club would consist of two members and a mature Galactic Club could have an almost endless membership roster. Quite possibly, interstellar distances would limit size, and even a mature Galactic Club might influence only a part of any given galaxy. A Galactic Club might begin as a loose network of communicating civilizations, develop common

interests and cooperative themes, and eventually evolve into a powerful supranational system. As a supranational system, the Galactic Club would differ from empires and similar arrangements where one member dominates others. As a supranational system, the Galactic Club's decisions would be made at an organizational level higher than that of any individual participating member state.

Drawing from Living Systems Theory[8] and other sources we can make some educated guesses about the characteristics of a Galactic Club.[10,11] First, we might expect a mature Galactic Club to be of immense size. For example, if, in a galaxy the size of the Milky Way, eligible societies were, on the whole, a mere 30 light-years apart, there would be 300 million potential members.[9] Second, we would expect that the Galactic Club would be very stable. Even a major disaster, such as the death of a solar system, would leave most members untouched. Third, we would expect a slow pace of political and social change. Generally, the larger the biological or social entity, the slower its tempo. Because a Galactic Club would be one of the largest social systems imaginable, its processes are likely to be the slowest of all, if for no other reason than because of the time required for interstellar communication. Most likely, authority will be maintained by the control of information, that is, through releasing useful information to members in good standing and withholding information from civilizations that choose not to cooperate. If some members of the Galactic Club have overcome difficulties of interstellar travel, then economic or military sanctions could be available.

The galaxy is old enough that there has been plenty of time for a Galactic Club to form. Why have we seen no evidence of its existence? There are many possibilities here, including failure to conduct a thorough search and inability to recognize (or accept) signs of extraterrestrial intelligence. A Galactic Club does not imply that one civilization (or collection of civilizations) will occupy the entire galaxy, either in person or by means of clunky, self-replicating robots that would have seemed right at home in a 1950s-era science fiction movie. Advanced civilizations may use communications systems that are currently beyond our imagination, or infiltrate the galaxy with nanoprobes, perhaps no larger than a grain of sand, that are not found easily.

We should not be too quick to dismiss sociological explanations of the lack of evidence. As I point out in *After Contact: The Human Response to Extraterrestrial Life*, sociological explanations have been eliminated categorically on the basis that there should be exceptions to any sociological rule.[11] For instance, although there might be an almost overwhelming tendency for maturing civilizations to shift from outward expansion to inner contemplation, there must be at least one civilization interested in colonizing the galaxy. Or, even if 99 percent of the civilizations that arise find it too expensive to migrate to our solar system, at least one civilization should have the resources to do this.

These analyses rest on the shaky assumption that societies are free agents. In fact, societies impose obligations and constraints on one another. Societies run into opposition from other societies, from alliances and coalitions, and from supranational systems. Despite enormous wealth and power, a society might not be free to make itself evident within our solar system, because other societies, alone or in combination, prevent this from happening. For example, among the approximately 180 nations on Earth, at least one would want to take over a small, rich society like Kuwait. In fact, Iraq tried this, but was thwarted by a coalition of other nations. Analogously, it is not necessary for all extraterrestrial societies to voluntarily refrain from entering our solar system. All that is required is a policy on the part of a dominant coalition that exerts control over events in our part of the galactic neighborhood. Could one particularly powerful society subordinate all others? On Earth, societies that have attempted to do this soon run afoul of internal flaws and concerted efforts on the part of alliances and coalitions. Despite some dazzling successes, none has succeeded in imposing its will on our entire planet.

Charter Member or Inductee?

Understandably, current speculation centers on first contact. Where will they be located, and what will they "be like"? How will we react as we learn about their society, and, if our presence becomes known to them, how will they react to us? It is difficult to look beyond first contact, but if and when it does occur it is likely to be only the first contact of many. At some point, Earth itself will become a part of an immense interstellar network. Would our entry into the Galactic Club be a slow and gradual process, or could it occur very rapidly?

If we are charter members, our initial contact will be with another isolated society. Even if we glean very little information about this society, the discovery

will have the salutary effect of accelerating the search. The promise of more information will be the driving force and will spawn an extensive mythology on ETI. No longer will investigators be forced to "pass the hat" to obtain minimal levels of funding, or fight to share valuable telescope time. The first unequivocal proof of extraterrestrial life will trigger an infusion of government and corporate money, lead to the rapid growth of radio telescope farms, and accelerate the development of alternative search strategies. Expanded efforts will lead to other detections. Some of these may be enigmatic, but others will be informative. Depending on distance, technology, longevity, and patience, some discoveries may lead to two-way communication. As a charter member we would gradually accumulate many contacts and would ourselves help found the Galactic Club.

Alternatively, our first detection could be of a society that is already a member of the Galactic Club. From this first contact we may learn about other societies within the Club and Earth itself could be invited to join. These two scenarios—charter membership versus inductee—could have profoundly different consequences for the management of the initial contact and for our adaptation to the post-contact world.

First Contact

As a charter member of the Galactic Club we would first encounter another civilization that, like us, had no prior experience dealing with off-world civilizations. While each society may have given advance thought to finding another society, each would have to look to its own indigenous theories and analogues for guidance—sources of information that may or may not work well when applied to radically different species and cultures. Neither society would be able to draw on past experience with interstellar affairs. It is in the case of contacting another isolate that the problems we fear are likely to appear full blown: poor communication, terrible misunderstandings, or cascading gaffes that threaten to destroy the relationship before it achieves stability.

If we are a potential inductee into a preestablished network, contact could unfold in a very different fashion. An affiliated civilization will have given sustained and in-depth thought to interstellar contact, and it will have evolved theories and developed analogues based on radically different species and cultures. It will be able to draw on the experiences not only of itself but also on the experiences of other members of the Galactic Club, experiences that could number in the thousands or millions. If so, the "other" will be versed in managing interstellar contacts. Constructing communications that are easy to understand, deciphering messages from other species, managing first impressions, developing working relationships, guaranteeing mutual security, exploring the possibilities of trade and commerce—activities that fall within *terra incognita* for us will be routine for them. Under this scenario, many of the problems that preoccupy us today could be bypassed, at least if we choose to participate and are willing to look to another society for leadership.

Encountering a member of the Galactic Club could pose less of a threat to our security than encountering a fellow isolate. Despite frightening images of alien invaders, my guess is that most advanced civilizations are peaceful rather than belligerent.[12] Availability of almost limitless resources coupled with high technology will eliminate some of the traditional causes of war. Despite the struggle and violence reported in our news media, evidence suggests that we ourselves are moving towards a world where the large and powerful societies do not go to war with one another. John Mueller notes that many countries exist side by side without going to war, that traditionally antagonistic nations have become less quarrelsome over the years, and that more and more industrialized countries have formally renounced war.[13] Each generation, says Mueller, an increasing proportion of people reject war as morally repugnant and methodologically ineffective. John Keegan, the British military historian, draws a similar conclusion and suggests that after 5,000 years or so, warfare as we know it is about to disappear.[14] The rise of liberal democracies is another encouraging sign.[15] Internal politics influence foreign affairs in such a way that liberal democracies steer away from war.[16] As the proportion of liberal democracies goes up, the risk of war decreases.[16]

Computer simulations allow political scientists to control variables and explore many different "what if" scenarios. They enable us, for example, to compare the views of the "realists," who believe that it is in the best interests of large and powerful societies to take what they can from their smaller, weaker neighbors, with the views of the "idealists," who counter that in the long run, a society's interests are best served by refraining from aggression and entering into defensive pacts. Results of simulation studies show that states that do not initiate war but do enter

into defensive alliances survive longer than opportunistic, belligerent, self-serving states.[17] These findings, which are based on abstract models of broad applicability, free us from the idiosyncrasies of world history. They suggest that if paranoid, berserk, or selfish societies last long enough to make contact with other civilizations (probably they do not), their foreign policies may put them out of business.

A recent analysis by Freeman Dyson also implies that interstellar warfare should be a rare occurrence.[18] Territoriality, he notes, was useful and harmless in the early days of humankind when populations were small and space was ample. As Earth's population grew, different groups of people began butting-up against one another, and this led to conflict. As we move into space, which still has ample room for everybody, territoriality once again becomes harmless. In a sense, we live in a narrow window of time where we are filling up our planet but before we can tap the immense resources of space. It is during this interlude that we have become engrossed in playing dangerous zero-sum territorial games.

This does not mean that we could never encounter a troublesome or even dangerous extraterrestrial society. This does mean that SETI should be a "low risk" activity. Nonetheless, in comparison to forming an association with a fellow isolate, connecting with the Galactic Club may be less of a security risk. This is because the affiliated society will have already worked through the insecurities that we associate with initial contact and will have already developed stable relationships with radically different societies. If the Galactic Club has evolved into a supranational system it will operate within a preexisting framework of interstellar law and cooperation, a framework that we, too, might find congenial.

Post-Contact Humanity

What might we learn from our newfound acquaintances? If communication is possible, will they be eager to share their scientific and cultural insights? Will they tell us about their social organization, their political forms, and the nuances of their culture?[19] Here we might note that all living systems, biological and social, have reproductive subsystems intended to replicate and perpetuate themselves.[8, 10, 11] One way that this could be accomplished on an interstellar scale is through disseminating information. Even as many nations on Earth have powerful broadcasting stations to export elements of their culture and build support among outsiders, alien civilizations may broadcast information to herald their achievements and perpetuate their views. And it will be these "gregarious" or "talkative" societies, not the reclusive or silent ones, that will be the easiest for us to find. However, before we attempt to drink too deeply from the wellsprings of interstellar wisdom, we should address five potential problems: gate keeping, information overload, culture lag, unanticipated consequences, and threat to human initiative.

Gate keeping refers to regulating the information that is released. For example, the sending society might be quite selective about the information that it transmits. Whereas this may be a benevolent act—for example, gearing their transmissions to their perceptions of our "readiness"—we have to be open to the possibility that they are sending self-serving information that maintains their power or serves covert political ends. Or, our own society could anoint "gate keepers" who decide whether or not information should be released to the public. This, too, could serve varied purposes. Information that challenges the political or religious status quo could be suppressed or given a particular type of "spin" while information that supports establishment views is released instantly. This may have happened as the contents of the Dead Sea Scrolls were slowly revealed to the public.

If rapid communication is possible, the rate of incoming information could far exceed our ability to process it. Confronted with excess information, individuals, organizations, and societies respond in similar ways: first, by "speeding up," and then by shifting to processing strategies that alleviate the pressure but reduce the quality of the processing. Strategies for coping with information overload include accepting delays, selectively processing only some of the information, or becoming more tolerant of error.[8] Thus, under pressure, we may overlook important ideas while acting on ideas that are relatively inconsequential, ignore important warnings and qualifications, rush forward without following due procedures, and neglect insights that under less lavish conditions would rivet our attention. That is, exactly when we should be alert, thorough, and careful, we may be blasé, wasteful, and sloppy.

We might expect the highest potential for overload if we first encounter a member of the Galactic Club, since this type of society would be positioned to forward information from many other societies, not just its own. It could offer us information about

societies that we could not begin to comprehend if we tried to communicate with them directly, but that we could understand given the interpretive services of an intermediary or "third-party" society. However, because a member of the Galactic Club will already be versed in working with beginners, it may do a better job of making the information useful and understandable, and releasing it at a pace we find manageable.

Culture lag refers to the temporal gap between the introduction of a new technology and its proper and comfortable use by people. It can take decades for the evolution of laws, customs, and attitudes that support rather than clash with new technology. The current rapid rate of technological change could increase many times over following a massive infusion of extraterrestrial knowledge. The Galactic Club may have accumulated the wisdom to reduce risks such as this.

All of us have heard stories about people who are granted wishes but, because they were unable to think things through or were inarticulate, ended up worse-off than before their wish was granted. There was, for the example, the English couple, described in the short story "The Monkey's Paw." Their wish for extra money was promptly followed by the arrival of their son's boss with the announcement of their son's accidental death on the job and a small amount of monetary compensation. Likewise, when we make wishes for our society or for humanity as a whole we must be sensitive to the possibility of unanticipated consequences: results, usually undesirable, that were not foreseen before the change was adopted. Who would have imagined (before the fact) that an influx of silver and gold from the New World would spark runaway inflation that would diminish Spain's power?

If we make clumsy attempts to apply alien insights or technology to solve one problem, we could create another problem of equal or greater magnitude. Technologies that dramatically increase individual life span could put the family under new forms of stress, add to our population problems, and devastate retirement plans. Technologies that relieve social and medical ills or ease our labors could put entire categories of human service workers out of business. The introduction of new power sources could eliminate fortunes based on petroleum and coal holdings. Tracing the implications of a new idea is not easy because some consequences may rest upon very intricate chains of events or not appear until the distant future. The more alternatives we are offered, the more difficult it will be to trace their myriad implications.

Then there is the threat to human curiosity and ingenuity. Could the ready availability of new technology transform into passive users those of us who like to discover and invent new technologies? Could we lose our curiosity and our status as "exploring animals"? Indeed, SETI-Australia astronomer Ray Norris suggests that after detection, science, as we know it, may cease to exist.[6] Fortunately, our curiosity appears to be hard-wired. Once humankind has found the answer to one question, it moves on to another. Perhaps, as Norris suggests, if science ceases to exist, we may rephrase our questions in terms of theology. Let us hope that, as has happened so often in the past, greater knowledge will expand, not contract, our intellectual horizons.

Following contact, would humanity lose its distinctiveness? Would our post-contact culture make us almost indistinguishable from extraterrestrial societies? Certainly, as Seth Shostak points out, when more technologically advanced societies meet less technologically advanced societies, it is the less technologically advanced societies that are the most likely to change.[19] For those of us who prize diversity and tradition, a loss of identity is a high price to pay for possible new insights.

Allen Tough paints a more optimistic picture. He notes that terrestrial examples of culture contact have involved physical contact rather than radio contact. If the aim of the dominant culture is expansion, the lesser society may be overwhelmed, but when contact occurs without aggression, the lesser society may prosper. "We might very well adopt portions of the alien culture," states Tough, "without being overwhelmed by it."[20] Perhaps the fate of Japan after Commodore Perry's visit during the mid-1800s should fuel optimism. The Japanese embraced Western technology, but at the same time gave it a Japanese flavor. This is evident when we compare Japanese and American management styles.

Contact with an affiliate of the Galactic Club may pose less of a threat than contact with an isolate. The reason is that we might expect considerable diversity within the Galactic Club itself, simply because the number of member states and their dispersal over many solar systems would work against a high level of uniformity. Clearly, we would forever be changed and once entering the Galactic Club we would adopt many of the ways of the "other." But given the diffi-

culties of social organization over interstellar distances, the Club may be less of a "melting pot" than a "mosaic" with individual member states retaining much of their identities.

Discussion

As we enter the new millennium, large elements of both the scientific and lay communities are sensitive to the possibility of intelligent life elsewhere. Whereas it is sensible to be cautious as to when unmistakable evidence of ETI will be acquired, some searchers expect this discovery to occur in the near future. From the perspective of our descendants a thousand years hence, initial contact will be part of history and their attention will be directed somewhere else. At that time, any difficulties or dislocations that occurred during first contact will be long past. Interacting with other civilizations will be no more unusual than interacting with human space settlements that will be sprinkled throughout, if not beyond, our solar system. One thousand years from now people will be quite different than they are today. Human interaction with ET could account for only some of these differences.

Right now, we are alone in the universe. Our guesses about extraterrestrial intelligence rest upon a blend of theories and analogues that are indigenous to our planet coupled with varying degrees of imagination. My own guess is that as we anticipate first contact we must be more aware of the possibility that we will first meet an affiliate of the Galactic Club rather than a fellow isolate. Right now we struggle with the idea of coming to grips with one other civilization. We may have to come to grips with relating to many societies simultaneously.

Among the galaxies that are well populated with technologically advanced civilizations, we might expect epochs or ages of social networking. The first of these, the Age of Isolation, would be marked by civilizations that live in ignorance of one another. As they develop and apply interstellar communication technology, they would begin to find other isolates. If we are living in this first epoch, then we should expect to discover a civilization that, like ours, has no previous experience with intelligent life elsewhere. During the second epoch, the Age of Contact, most civilizations will have discovered a small handful of neighbors. There would still be some isolates, but by virtue of such factors as proximity and luck, some societies may have formed networks with many others. In a sense, the Age of Contact would be characterized by "subassemblies" for a future Galactic Club. If our search first succeeds during this second epoch, the odds shift in favor of encountering a civilization that has already undergone "first contact," but this civilization would have had only a tiny taste of the diversity of life forms and cultures in the galaxy. During the third epoch, the Age of Intragalactic Networking, most pairs and subassemblies will have joined together to create a network that is larger than the others and that may evolve in the direction of a mutually beneficial supranational system. Even at this late date, we could still make our first contact with an isolate or a small cluster of societies, but the odds shift in favor of our first contact leading to direct induction into a large network of civilizations. Eventually there could be a fourth epoch, the Age of Intergalactic Networking, when civilizations or clubs from different galaxies begin discovering one another.

Perhaps our galaxy has already entered the third epoch. This follows from a simple analysis of the time interval between the interest and ability to undertake a search and the first success. The civilizations that we expect to encounter are very old—according to some calculations, 2.8 billion years older than ours.[6] If these civilizations have the interest and technological means, many will have begun their searches hundreds of thousands, perhaps millions of years ago. By now, there may be many clusters of civilizations and some of these clusters may have reached enormous size. Of course we should be prepared for the difficulties of contacting an inexperienced civilization, but rather than assume that we will be stymied by an unprepared partner we should be open to the possibility that we might first encounter a member of the Galactic Club.

According to my analysis, rapid induction into the Galactic Club offers both greater promise and greater challenges. On the one hand, if it is privy to the accumulated wisdom of many societies, an affiliate should have more ideas to share. Furthermore, due to its experience in interstellar communication, it should be better able to explain them. On the other hand, this relative abundance of information increases the risk that we will be inundated with more information than we can handle, increase the distance between technology and its human users, and make it more difficult to predict all of the consequences of our choices. Yet, at the same time, despite the greater potential of damage from the wholesale availability of new ideas, the Galactic Club may have

evolved safeguards based on past experiences of sharing information with newcomers.

References

1. **Steven Dick** (1996). *The Biological Universe: The Extraterrestrial Life Debate in the Twentieth Century.* (New York: Cambridge University Press).

2. **Michael Crowe** (1994). *Modern Theories of the Universe: From Herschel to Hubble.* (New York: Dover).

3. **Carl Sagan** and **Ioseff Shklovskii** (1966). *Intelligent Life in the Universe.* (San Francisco: Holden-Day).

4. **Frank Drake** and **Dava Sobel** (1992). *Is Anyone Out There?: The Scientific Search for Extraterrestrial Intelligence.* (New York: Delacorte Press).

5. **Seth Shostak** (1998). *Sharing the Universe: Perspectives on Extraterrestrial Life.* (Berkeley, CA: Berkeley Hills Books).

6. **Ray Norris** (1998). "Can Science Survive a SETI Detection?" Paper presented at the International Conference on SETI in the 21st Century, UWS Macarthur, Sydney, Australia.

7. **Stephen G. Doyle** (1996). "Post Detection Global Institutional Arrangements." Paper presented at the 47th International Astronautical Congress, Beijing, China, October.

8. **James Grier Miller** (1978). *Living Systems.* (New York: McGraw-Hill).

9. **Ronald Bracewell** (1975). *The Galactic Club: Intelligent Life in Outer Space.* (San Francisco: San Francisco Books).

10. **Albert A. Harrison** (1993). "Thinking Intelligently About Extraterrestrial Intelligence: An Application of Living Systems Theory," *Behavioral Science*, *33*, 189-217.

11. **Albert A. Harrison** (1997). *After Contact: The Human Response to Extraterrestrial Life.* (New York: Plenum).

12. **Albert A. Harrison** (in press). "The Relative Prevalence of Benevolent and Malevolent Societies: Implications for SETI." *Acta Astronautica.*

13. **John Mueller** (1988). *Retreat from Doomsday: The Obsolesce of Major War.* (New York: Basic Books).

14. **John Keegan** (1994). *A History of Warfare.* (New York: Vintage Books).

15. **Francis Fukuyama** (1992). *The End of History and the Last Man.* (New York: Avon Books).

16. **Bruce Russett** (1993). *Grasping the Democratic Peace.* (Princeton, NJ: Princeton University Press).

17. **Thomas R. Cusack** and **Richard A. Stoll** (1994). "Collective Security and State Survival in the Interstate System," *International Studies Quarterly, 38* 33-59.

18. **Freeman Dyson** (1997). *Imagined Worlds.* (Cambridge, MA: Harvard University Press).

19. **Seth Shostak**, (1998). "The Lifetime of Intelligent Civilizations." Paper presented at CONTACT XV (Santa Clara, CA: March 7).

20. **Allen Tough** (1991). *Crucial Questions About the Future.* (Lanham, MD: University Press of America), p. 100.

How to Achieve Contact: Five Promising Strategies

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Throughout this volume we have seen that the likely benefits of contact with extraterrestrial intelligence are profound and wide-ranging. A simple conceptual framework for examining these benefits even served as the agenda for the Hawaii seminar.

Some benefits can occur even before contact (Tough, 1998a). But the major benefits will occur after genuine contact is confirmed, especially if some sort of dialogue occurs.

This fact underlines the importance of a key question: *How can we achieve contact? How can we achieve a dialogue of some sort with extraterrestrial intelligence?* Until we answer these questions successfully, humankind will not receive the major benefits.

The scientific search for extraterrestrial intelligence (SETI) is expanding its array of search strategies. This is a highly appropriate change. The next section presents seven reasons why widening the array is so appropriate.

Five of these strategies are especially promising. Because a highly advanced civilization can readily send intelligent probes to monitor our society and telecommunications, we should (1) pursue a variety of means for searching the solar system and Earth for physical evidence of an alien object or its effects; (2) invite contact through invitations to ETI, and (3) encourage contact by becoming sufficiently prepared. For evidence from many light-years away, the most promising strategies are (4) a search for astroengineering projects and their by-products and (5) radio and optical SETI. The bulk of this paper is devoted to these five promising strategies.

The SETI field is united by its common aim of detecting irrefutable scientific evidence of genuine extraterrestrial intelligence. The wisest policy for achieving this goal is to encourage and support all five of the most promising strategies. The valuable benefits for humankind will likely be many times greater than the entire cost of all five strategies.

Seven Reasons for Widening the Search

The scientific search for extraterrestrial intelligence has reached an interesting stage. Having relied primarily on a single strategy for 40 years, the field is now actively considering a wider array of promising search strategies.

This is a highly appropriate change for at least seven reasons.

First, the history of scientific discoveries teaches us the value of widening the array of research methods. It is quite common for a breakthrough to result from a new, fresh, unorthodox strategy or research method.

Second, the SETI field is trying to detect something that is totally unknown and presumably deeply alien. We do not even know whether we are searching for biological intelligence based on flesh-and-blood brains, artificial machine intelligence, or some advanced integration of the two. We have no idea of the origins, history, thought patterns, emotions, ethics, core values, purposes, technological capacities, or other major characteristics of extraterrestrial intelligence. It is likely that ETI will turn out to be surprisingly different from what we expect—deeply alien, puzzling, unlike anything we have ever encountered before. It has, after all, likely advanced to a level of knowledge and technology that is thousands or millions of years beyond our current human level. Because we are facing such a profound unknown, an attitude of humility and scientific open-mindedness seems appropriate. The pursuit of a somewhat diverse array of search strategies seems wiser than keeping the methodology too narrow.

Third, we must remember the likelihood that more than one extraterrestrial civilization is available to be detected. It is all too easy to think only about the *first* detection, ignoring the likelihood of multiple

detections over time. The early years of a new millennium provide a good opportunity to look ahead at the likely pattern of detections over the next thousand years. If several civilizations have arisen in our galaxy, as most SETI scientists hypothesize, then we may detect *several* forms of ETI during the next millennium. For example, we may detect an artificial radio signal, an encyclopedic laser message, a large probe parked in the asteroid belt, and a tiny probe near the Earth's surface.

Fourth, widening the assumptions and strategies of the SETI field may reinvigorate the people, conferences, and writing in the field. Fresh ideas and bold conceptualization, some attention to long-term visions, and a wider variety in conference papers can retain the field's intellectual excitement and avoid a feeling of boredom, fatigue, and disappointment.

Fifth, science and technology have changed greatly in the 40 years since the SETI field chose radio telescopes as its key strategy. That was a logical choice 40 years ago. Radio telescopes were just becoming popular among astronomers, two eminent scientists wrote a paper urging their use for SETI, and a distinguished engineer wrote a paper claiming that interstellar propulsion is impossibly slow and expensive. But our scientific and engineering knowledge today is dramatically different from what it was 40 years ago. Today's decisions about appropriate strategies should be based on the science and technology that we can confidently anticipate today, not on their status in 1959. Today's choices have to take into account our recent advances in such fields as computers, artificial intelligence, robotics, surveillance methods, molecular manufacturing (nanotechnology), propulsion, space exploration, lasers, and fiber optics.

Sixth, although the SETI field is 40 years old, it has not yet produced any confirmed evidence of ETI. That fact points up the need to expand the array of search strategies. Fortunately, several fairly new and highly promising strategies are readily available.

Seventh, those of us in the SETI field should not let the reputation of the UFO field frighten us into unduly restricting our own strategies. All of us in the SETI community worry about being confused with the UFO field. We encounter this confusion in our classrooms, at the faculty club, at social gatherings, in television studios, in legislatures, and in donors' offices. But there is no need to let our fear and anger lure us into poor decisions about our own scientific strategies. If our sober assessment concludes that smart probes could have readily reached our solar system, for instance, then we should have the courage to search for them. To reduce confusion, we should frequently point out that our scientific approach differs from the UFO field in three key ways: (a) we are deeply committed to skepticism, verification, peer review, and the scientific method, (b) we build in strict safeguards against hoaxes, self-delusion, and erroneous data, and (c) we adopt protocols to avoid premature and immodest claims.

All in all, a reasonably wide array of search strategies seems likelier to lead to success than reliance on just one or two. The phenomenon we are trying to detect is so unknown, so old, so advanced, that we cannot be sure which of our strategies is most likely to succeed. Faced with this situation, we should proceed vigorously with *all* promising strategies in order to enhance our chances of achieving contact.

Of the many strategies that have been proposed over the years, which are most likely to detect extraterrestrial intelligence? This paper recommends five strategies as highly promising. It would be appropriate for the SETI field to enthusiastically support and vigorously pursue all five strategies.

What Are We Trying to Detect?

SETI is an acronym for the search for extraterrestrial intelligence. But what are the major characteristics of this phenomenon that we are trying to detect?

Although we know almost nothing about the characteristics of extraterrestrial intelligence, we do know that it is likely very old and extraordinarily advanced. Our technology is very young, largely developed in just the past century or two; any alien technology that we detect will likely be thousands or even millions of years beyond our adolescent technology. Because our Sun is a relatively young star, civilizations that have arisen around other stars are likely much older than ours.

The fact that we are trying to detect such an incredibly advanced technology or civilization is a common theme in the SETI literature. For instance, Seth Shostak (1998, page 200) notes that the civilizations we are likely to detect "will be societies with thousands or millions of years of technology under their communicator belts." A public relations brochure from the SETI Institute (1999, page 14) notes that "it is the general belief that any civilizations we detect would probably be far more advanced than our own, possibly hundreds of thousands or more years ahead of us." Jill Tarter (1998) speculates about "tens of millions of years." Ray Norris (1999) defends

one billion years as the most likely age difference. He adds that the chance of ET being less than one million years ahead of us is extremely low: less than one chance in a thousand. Charles Lineweaver (1999) concludes that the age difference may be 5.2 billion years, and may point up how "naive" and "silly" and "parochial" traditional SETI search assumptions are. Martyn Fogg (1987) calculates that a large number of technical civilizations arose in our galaxy about four billion years ago, and some arose much earlier (some of them even before our solar system was formed). Indeed, the results of his computer simulation indicate that our entire galaxy may have been colonized for the past five billion years.

To gain some perspective on what these large numbers mean, it is useful to recall that our civilization is only about 10,000 years old, much less by some definitions. Just 100,000 years ago our ancestors were hunter-gatherers using stone tools and only rudimentary language.

If alien civilizations are 100,000 years ahead of us, then they are quite capable of sending intelligent probes to explore other planetary systems. Each probe could be smarter and more knowledgeable than any human being, yet could possibly be smaller than a basketball or baseball (Tough, 1998b). Even humankind's adolescent technology will likely become capable of launching interstellar probes within 200 years, much sooner if NASA's current plans pan out. So, any civilization 100,000 years beyond us presumably developed an interstellar capacity long ago.

Looking ahead to humanity's ability to manufacture machines molecule by molecule, Robert Freitas (2000) emphasizes just how tiny a probe's computer might be. He notes that a nanostructured storage device the size of a single human liver cell (smaller than a neuron) could store an amount of information equivalent to the entire Library of Congress. He adds that a single nanocomputer CPU the size of a human cell could equal the computational output of the entire human brain but with much less waste heat.

Regarding the energy required for interstellar nanoprobes, Forrest Bishop (1996) points out that this can be phrased in terms of the storage capacity of a car battery. Quite a contrast to those who argue that interstellar travel would require far more than the world's total energy consumption!

Our current scientific literature on the future of artificial intelligence, robotics, and nanotechnology stretches our imagination about just how smart our own machines will become during this century. Their capacity to sense, diagnose, calculate, think, choose, and communicate will likely exceed the visions of most of today's scientists and futurists. Hans Moravec's chapter (1999) on universal robots has sections on their inner lives, consciousness, joy, love, anger, pain, and pleasure. The fourth robot generation, around the year 2040, will have such superior reasoning powers that "they could replace us in every essential task and, in principle, operate our society increasingly well without us. They would run the companies and do the research as well as performing the productive work.... Meek humans would inherit the earth, while rapidly evolving machines expanded into the rest of the universe" (page 125).

Ray Kurzweil (1999, page 257) anticipates that our super-smart machines will also be tiny: "…a computational-based superintelligence of the late twenty-first century here on Earth will be microscopic in size." Indeed, after several years of being scoffed at and denigrated by mainstream scientists, molecular nanotechnology has itself now become mainstream in funding and acceptance.

Extraterrestrial intelligence, however, is not just one century ahead of our technology, but more likely a thousand centuries ahead. Such an intelligence may have created some means of exploration and communication that goes far beyond our current conceptions of super-smart probes. This is particularly likely after machine intelligence takes over its own evolution, designing artificial intelligence that is more and more advanced. Each machine may be so knowledgeable and intelligent (and wise, ethical, and altruistic?) that it far surpasses any human individual or organization. These super-smart machines may somehow be integrated with biological beings, or they may not. But for convenience in this paper I will simply use the word "probe" to cover all of these possibilities for advanced intelligence.

Our galaxy and universe may be filled with diverse forms of intelligence with extraordinary capacities. Incredibly diverse even in their widespread origins, various streams of intelligence may have evolved into new forms far beyond what human scientists envisage. For instance, they may be actively monitoring and studying fledgling civilizations (such as ours), even providing useful information at some appropriate stage. And they may be busily interacting with intelligence near their own level of development

in order to exchange information, discuss societal and galactic goals, help one another to evolve in appropriate directions, build up a galactic storehouse of scientific and philosophical knowledge, and cooperate on other grand science and engineering projects. Their harmonious cooperation and *Encyclopedia Galactica* may have already evolved even beyond the Life Era described by Eric Chaisson (1987) and the biological universe described by Steven Dick (1996).

Intelligence may eventually become so advanced and widespread that it will prove more powerful than the big impersonal forces of the universe. "The laws of physics are not repealed by intelligence, but they effectively evaporate in its presence.... [Even] the fate of the Universe is a decision yet to be made, one which we will intelligently consider when the time is right" (Kurzweil, 1999, page 260).

Such possibilities point up just how inspiring, awesome, and transcendent our SETI enterprise really is. After all, we are trying to tap into a wisdom, understanding, and knowledge held by a deeply alien intelligence that is 100,000 years beyond us. In the SETI field we often get wrapped up in technical details, internal politics, strategic maneuvering, funding, equipment, the "Rare Earth" ideology versus the abundant intelligence ideology, the ultraconservative traditionalists versus the bold, innovative explorers. But SETI is a much deeper quest than this. Ultimately, today's SETI efforts may be a major step toward a scientific and spiritual dialogue with some ancient intelligence about such topics as cosmology, philosophy, theology, music, art, and the purpose of life.

Interstellar Probes

As we reflect on the likely capacities of civilizations much older than ours, it certainly seems possible that some of them have sent intelligent probes to other stars in order to monitor or dialogue with any civilizations that have arisen. Just as we send probes to explore our cosmic neighbourhood, other civilizations will do the same. It would be hard to believe that all 100,000-year-old civilizations lack the motivation and capacity to monitor other planets and societies in some detail, especially since nanotechnology may enable probes to be self-replicating as they spread through the galaxy. Self-replicating probes could spread far and wide by pausing occasionally to manufacture additional probes. Scientists and engineers now discuss the possibility of faster-than-light communications and travel more seriously than in previous years, but for a patient, self-repairing machine, even one-tenth the speed of light is sufficient.

If a few civilizations in our galaxy began sending intelligent probes to monitor various planetary systems thousands of years ago, then an intelligent alien probe could well have reached our solar system by now. Regardless of our emotional reactions to the situation, it is quite possible that at least one extraterrestrial probe is currently monitoring our civilization and our telecommunications. It makes good sense, therefore, to try to detect such an object.

Three strategies seem especially promising for doing so. Each of them will be discussed below in detail. Strategy #1: search the solar system and Earth for physical evidence of an alien object or its effects.

Second and third strategies become possible if a highly intelligent probe is successfully monitoring our telecommunications. Instead of simply detecting it, we can *invite* it to make contact or we can encourage contact by becoming *ready* for it. Strategy #2: issue invitations asking ETI to have a dialogue with humankind. Strategy #3: become sufficiently prepared for contact, thus encouraging ETI to respond. Both of these strategies could lead to a particularly exciting wealth of knowledge from a rapid back-and-forth scientific dialogue with ETI, unhampered by the language difficulties and slow response time of radio or optical SETI. Because they rely on insights into likely ETI behaviour and goals, and because they encourage dialogue, these two strategies are primarily social science strategies, rather than primarily within the methodology of the physical sciences.

If an extraterrestrial probe or some other form of ETI has reached Earth and is still active, three situations are logically possible: (a) It will not interact with us (at least not within the next few decades) no matter what we do. This situation could result because it is simply not interested, because its primary purpose is to observe the natural development of our civilization untainted by contact, or because it will intervene only if some extraordinary catastrophe is imminent for humankind. For this situation, Strategy #1 is best. (b) Its decision about when to interact with us can be influenced by a friendly and thoughtful invitation, either from some informal group of scientists committed to contact with ETI or from some official organization. For this situation, Strategy #2 is best. (c) Extraterrestrial intelligence will interact with us when we become sufficiently pre-

pared, thus ensuring a positive and harmonious experience, or when we reach some other threshold. For this situation, Strategy #3 is best.

In almost any scenario we can imagine, it also makes good sense for us to try to detect advanced astroengineering projects, extraordinary energy use, by-products, or other distant evidence of a highly advanced technology far from the solar system. This is Strategy #4. Unless all advanced civilizations are highly motivated to keep their existence and location secret, there is a good chance that we will succeed in detecting at least one of them.

Some civilizations may choose to broadcast to other civilizations, to their own space settlements, or to their own spacecraft by radio waves or laser pulses. Consequently it makes good sense to try to detect such beacons and messages and signals, whether intended for us or whether inadvertent "leakage." Strategy #5, then, is to use radio and optical telescopes to search for artificial signals from many light-years away. This strategy is well established, highly regarded, well supported in the literature, and relatively well funded.

Now let us move on to discuss each of the five promising strategies in turn.

Search for an Alien Object

Strategy #1: Search the solar system and Earth for physical evidence of an alien object or its effects.

This broad strategy could be pursued in several different ways. Although readers may disagree on which of these are especially promising and which are valueless, it is useful to begin with a survey of the total range of possibilities. For additional discussions of possibilities, see the chapter on alien technology by Gregory Benford (1999) and the section on detecting a probe by Richard Burke-Ward (2000).

A search for physical evidence could focus on the solar system or on Earth. And it could focus on phenomena that are normally studied by mainstream science or on stranger anomalous phenomena. These two distinctions enable us to cluster the various search approaches into four categories.

(a) Within the solar system, search for unassailable evidence of an alien object. This object might be a probe or spacecraft, for instance, or its discarded parts. Such a search might focus on the Moon, the asteroid belt, or the Lagrange equilibrium points (Freitas and Valdes, 1980). Alternatively, the alien object might be a building, a monument, or some other artificial structure. Indeed, an alien intelligence may have deliberately left an artifact for us to discover at some special landmark in the solar system, such as the highest point on Mars or the deepest canyon on Venus, or in some carefully chosen spot that we will explore someday because of our scientific curiosity or our appreciation of beauty. Or equipment might have been stored below the surface of some body (perhaps in natural cracks or passages) to protect it from damage by cosmic radiation and micrometeorites.

Baugher (1985, p. 155) has even suggested that an alien probe might, on one of the geologically dead moons in the solar system, "construct a vault filled with information and artifacts…. The vault could contain a description of the civilization that sent the probe, as well as a set of instructions for the initiation of contact."

Another approach is to search for heat, exhaust gases, or other effluents and by-products that might be emitted by a probe or spacecraft. Looking for infrared anomalies in the asteroid belt is often suggested as one example, or trying to detect communications from the probe back to its home base, or using the KLT mathematical transform (Maccone, 1994) to detect the electromagnetic signature of a rapidly decelerating alien spacecraft. Where one looks and precisely what one looks for will be influenced by one's estimate of the object's location, propulsion system, and communications.

Another possibility is to search for evidence of mining, in case probes have mined the materials necessary to construct additional probes. The idea of self-replicating probes has been widely discussed in the SETI literature over the years.

Yet another possibility is "the return of a biological specimen [such as] a hair or flake of skin from a humanoid" (Shapiro, 1999, page 248). This situation would require a test to rule out the possibility that the so-called aliens actually developed long ago from humans, but sequestered themselves out of sight to avoid conflict or for some other reason. "A tissue sample would reveal whether the 'extraterrestrials' are DNA-based and as related to us as are, say, the Neanderthals, or whether they truly have an alien biochemistry and a separate origin" (Shapiro, 1999, page 248).

These various searches throughout the solar system could be conducted by some combination of astronomers, military intelligence agencies, astronauts, and space probes.

(b) Search the planet Earth for physical evidence of an alien object. It might be in orbit, on land, or in an ocean. It might have arrived recently or millions of years ago. It might be a super-intelligent probe that is actively monitoring us, or simply a discarded part from an ancient probe. Various sciences, and of course various intelligence and security agencies, may already be monitoring much of the Earth, including the oceans and space. Perhaps we should also ask mountain climbers, hikers, explorers, paleontologists, and deep-sea divers to be on the lookout for a small alien probe or other alien artifacts.

(c) Use rigorous scientific methodology to study apparently anomalous phenomena within the solar system. Three sorts of phenomena have been suggested as possibilities: (i) Look for convincing patterns of extraterrestrial intelligence in rapidly moving objects moving across or near the lunar surface, or other lunar transient phenomena. Do they occur more frequently in an area that is being explored by one of our probes, for example, as Arkhipov (1994) suggests? (ii) Look for long-delayed radio echoes in case ETI is signalling its presence by deliberately sending back to us a radio program or other signal that we transmitted much earlier. Reports of LDEs received decades ago have been studied, but contemporary examples would be far more convincing. (iii) Look for traces of artificial objects among the space debris and meteorites that fall to Earth, and even in old layers of sediment from long ago (Arkhipov, 1998a). Perhaps alien probes or spacecraft occasionally fall to Earth when they have an accident or are abandoned. Other alien debris may leak into the interstellar medium and eventually find its way to Earth.

(d) Develop and implement rigorous new research designs to study any anomalous phenomena that could be signs of ETI presence on Earth. One example would be to use foolproof laboratory procedures to test whether any "physical traces" or "implants" ostensibly associated with aliens or unidentified flying objects provide unmistakable evidence of extraterrestrial origin.

Another example would be to set up sophisticated scanning equipment at promising locations in order to discover whether it is possible to record solid data showing the physical presence of alien probes or spacecraft. For instance, one person or another has suggested radar, lidar, magnetometer, spectrum analyzer, seismometer, Geiger counter, optical spectrometer, ion/ozone detector, gravimeter, geophone, all-sky camera, video camera, and infrared camera, along with equipment to measure weather, sound, and electromagnetic changes.

Some of these projects have also tried to *attract* alien craft by using searchlights, flashlights, laser beams, infrared, radio, sounds, Morse code, or focused mental concentration. In a sense these are invitations to ETI, which is our next topic.

Invitations to ETI

Strategy #2: Issue invitations asking ETI to have a dialogue with humankind.

When our society launches intelligent interstellar probes 100 or 200 years from now, what will they look for? Extraterrestrial intelligence (and its culture, society, and knowledge base) will presumably be high on the agenda. Consequently, we will build probes capable of monitoring any alien communications near the target star and then learning alien languages. It is reasonably likely that an alien probe sent to explore Earth will have a similar mission and capacity.

Because the alien intelligence we are trying to detect has technology far beyond ours, it could well be monitoring our telecommunications in some detail. We do not know exactly how it does this, of course, but the idea seems not too farfetched when we consider that our own national security agencies already monitor fax and email messages around the world. Much of this electronic traffic can be intercepted as it travels between the ground and a satellite, or between two microwave relay towers. Just imagine what the National Security Agency's technology will be able to do 100,000 years from now!

Once we realize that ETI is likely monitoring our telecommunications, a totally different strategy for contact comes to mind. Instead of *detecting* ETI, we can shift our focus to *inviting* contact. We can issue a warm welcome to ETI, along with an invitation to establish a dialogue with humankind.

The previous section mentioned some elementary ways of inviting contact: trying to attract alien craft by using searchlights, flashlights, laser beams, infrared, radio, sounds, Morse code, or focused mental concentration. Alternatively, we could issue an invitation to ETI through floodlit billboards in remote areas, through a flurry of email or fax messages, or through international news broadcasts.

An even better place for invitations to ETI is the World Wide Web, since ETI can readily find these

invitations during its routine monitoring. Presumably an intelligence that is 100,000 years beyond ours will have little difficulty learning our languages and surfing the Web as competently as we do. If it uses the major search engines to find web pages on *extraterrestrial intelligence*, *alien intelligence*, *alien probe*, or *invitation to ETI*, for instance, it will find any invitations that exist on the Web. A more extensive rationale for a web-based invitation, along with descriptions of six informal messages to ETI on the Web, is presented by Tough (1999).

Is ETI more likely to respond to an invitation from a bureaucratic, formal organization or from a highly committed informal group? There is no way to know the answer to this question without experimenting. There is a human parallel: some environmentalists and some peace activists prefer to work through informal networks or frontline grassroots groups, others prefer larger and more formal nongovernmental organizations, and still others prefer to work through the United Nations organizations.

Consequently, the most effective strategy is for humankind to issue a variety of invitations to ETI from a range of groups and organizations. Over the next few years, several official international organizations might issue their own invitations to ETI, for instance, as may several other groups. UNESCO, the UN General Assembly or its Committee on the Peaceful Uses of Outer Space, and the SETI Committee of the International Academy of Astronautics are excellent examples of official international organizations whose invitation could carry a lot of weight, while the Planetary Society is an example of a citizen-based group. Unfortunately, none of these organizations has demonstrated any interest in issuing an invitation to ETI.

Fortunately, an informal group of 66 scientists and artists, most of whom are already active in the SETI field or the annual CONTACT conference, have issued a warm welcome to ETI and an invitation to engage in dialogue with humankind (Tough, 2000). Their hope is that their ongoing interest in ETI, their vision of a worldwide scientific and educational dialogue between ETI and humankind, and their thoughtful preparations for contact will elicit a positive response from ETI. Perhaps they can be useful to any extraterrestrial intelligence whose mission is to deeply understand human culture, establish contact, help and educate humanity, or link us to some galactic network.

This project is primarily a social science project that focuses on relationship and dialogue rather than physical detection, and could actually succeed and flourish without ever establishing the physical location of ETI. By contrast, the first, fourth, and fifth strategies rely primarily on the telescopes and space missions of the physical sciences and aim to pinpoint the exact location of ETI. At the same time, it is worth noting that the Invitation to ETI project depends on an extraordinary physical infrastructure (the World Wide Web) that became sufficiently widespread for such a project only around 1995 or 1996. (The project was launched in 1996.) The project itself is small-scale and reasonably inexpensive, but it relies on the technological sophistication of the largest and most expensive computer network in human history.

The Invitation to ETI project has received about 30 responses so far, but most seemed to be delusional, juvenile, or a prank. No respondent continued to communicate for very long after I (as coordinator of the project) gently asked for evidence of authenticity that would convince the group of 66 scientists. If any respondent succeeds in passing our initial screening, then an independent team (skeptics, scientists, magicians, computer hackers) will request and assess further evidence. Details are provided in section 8.3 of Tough (1998b).

Unfortunately, formal international organizations are not likely to issue an invitation to ETI in the near future. All the more reason, then, for a committed group of 66 leaders and researchers in extraterrestrial intelligence to maintain its invitation on the Web. It is a fresh low-cost strategy. Its payoff for humankind could be an extraordinary wealth of information through a lively scientific and educational dialogue with a 100,000-year-old intelligence.

Readiness for Contact

Strategy #3: Become sufficiently prepared for contact, thus encouraging ETI to respond.

If a very smart probe is monitoring our civilization, it may be reluctant to establish overt contact before we are clearly ready for such a disruptive and transformative experience. In order to encourage contact, then, we should do all that we can to prepare for it. Our preparation will also be useful if any of the other strategies succeeds, of course, but here we are looking at preparation as a specific strategy used to encourage contact.

Little work is currently being done to implement this strategy. But two relevant invitational meetings were held in July 1999. First, 23 people met in Denver to examine potential scenarios immediately after contact, in a workshop sponsored by the International Space Sciences Organization (1999). Then an almost completely different group of 16 SETI scientists met just before the Bioastronomy conference in Hawaii to examine potential long-term scenarios, in a workshop sponsored by the Foundation For the Future. This volume includes the major ideas from the Hawaii gathering. At both meetings, of course, an underlying theme was the preparations that should be implemented today.

What sorts of preparation and readiness might a highly competent probe want? Perhaps a specific plan for beneficial contact—a plan to be implemented by one of the groups issuing an invitation, for instance. Perhaps a suitable welcoming and negotiating committee prepared to interact flexibly and rapidly with an alien intelligence; again, this could be one of the groups issuing an invitation. Perhaps a set of thoughtful questions that humans hope ETI will answer, as part of our initial contribution to a dialogue (Tough, forthcoming). Perhaps official United Nations arrangements for a warm and secure welcome from all of humankind. Perhaps achieving some sort of threshold, such as discovering the probe (Strategy #1), attempting to communicate with it in a friendly and appropriate manner (Strategy #2), developing a worldwide web of computers, creating some form of super-intelligence, launching our own interstellar probe, or detecting a different civilization many light-years away (Strategy #4 or #5). The concept of a threshold or test is common in mass media and science fiction, including movies such as *2001* and the recent *Mission to Mars*.

Although not easy, most of these forms of readiness could be accomplished within the next few years. Because their potential benefits far outweigh their costs, they should be vigorously pursued.

Unfortunately, it is possible that ETI may insist on a much more difficult threshold. ETI may hide and remain silent until humankind stops waging wars and despoiling its natural environment. All of us should work on behalf of peace and the environment, of course, even though success is unlikely for several decades. But we can also hope that the threshold required for contact is simply readiness.

Astroengineering

Strategy #4: Try to detect astroengineering projects, extraordinary energy use, byproducts, or other distant evidence of a technological civilization.

Astronomers may be able to detect signs of major engineering projects or space colonization by civilizations whose technology has advanced far beyond ours. Highly advanced technology may well give off some evidence of its existence, and advanced civilizations may feel no need to conceal such evidence because of the vast distances to other civilizations.

A review article by Guillermo Lemarchand (1994) notes that "other civilizations at a more advanced stage of technology may have turned their entire planetary system into an immense Dyson sphere around their sun to capture every photon of solar energy. Even more advanced life forms may control a whole galaxy of star systems or groups of galaxies using technologies almost beyond our current comprehension" (page 12). Our astronomers may be able to detect telltale evidence of such astroengineering projects.

Interested in far-future developments in computers, neuroscience, and engineering, Robert Bradbury (1999) looks ahead to the day when "continued progress in these areas leads to a convergence which results in megascale superintelligent thought machines. These machines, referred to as Matrioshka Brains, consume the entire power output of stars, consume all of the useful construction material of a solar system, have thought capacities limited by the physics of the universe, and are essentially immortal." To detect extraterrestrial intelligence, "we should start with the laws on which our particular universe operates and the limits they impose on us. Projections should be made to determine the rate at which intelligent civilizations, such as ours, approach the limits imposed by these laws. Using these time horizons, laws and limits, we may be better able to construct an image of what alien intelligence may be like and how we ourselves may evolve." Bradbury urges astronomers to move beyond their usual assumption that the universe is dead; if several civilizations have advanced to limits allowed by the physics already known to us, their characteristics may explain some observations that currently perplex astronomers. He lists several common mysterious or anomalous astronomical observations that could be signs of gigantic super-intelligent computers, engineered galaxies, stellar mining, or other super-advanced technology. His examples include missing mass,

gravitational microlensing observations, missing stars in galactic halos, low surface brightness and dwarf galaxies, an excess of far-infrared light detected in the COBE mission, the age discrepancy between the universe and globular clusters, the anisotropic distribution around the galaxy of low temperature objects in the IRAS survey data, the arrangement of observable galaxies as "walls," variations in the cosmic microwave background radiation, and the variation in the brightness of Type Ia supernovas, depending on their age.

Annis (1999) examined 31 spiral galaxies and 106 elliptical galaxies for evidence of Kardashev type III (highly advanced) civilization. None of these galaxies showed signs of modification, but he suggests a further careful search.

Tilgner and Heinrichsen (1998) have described a program for searching for astroengineering products, particularly Dyson spheres.

If a distant civilization used beamed propulsion between stars, we might be able to detect the beam (Clements, 1999).

In a paper on potential new strategies, Alexey Arkhipov (1998b) suggested a search for broadband leakage of natural radio emissions of numerous artificial magnetospheres that protect inhabited orbital constructions from star wind, because the interaction of solar wind with planetary magnetospheres generates powerful emissions at low frequencies.

Distant Artificial Signals

Strategy #5: Use radio and optical telescopes to search for artificial signals from many light-years away.

It is quite possible that some other civilization is broadcasting a beacon or message in our direction by radio or pulsed lasers. Radio and optical telescopes can be used to search for these artificial signals, and also to detect any inadvertent leakage from communications or radar.

This broad strategy can be pursued in three distinct ways, generally called radio SETI, active SETI, and optical SETI. Let's examine each of these three in turn.

The traditional strategy for 40 years, *radio SETI* is still going strong. Its radio telescope icon is still the most common symbol for the entire SETI field, and it receives far more funding than any other strategy. Several major search projects are still in operation, although others have been shut down for various reasons. Richly informative websites are maintained by the SETI League, the Planetary Society, SETI Centre Australia, and the SETI Institute (www.setileague.org; seti.planetary.org; seti.uws.edu.au; www.seti.org).

To search for artificial radio signals, various approaches have been implemented: single beam and multibeam searches; all sky surveys; targeted searches; piggybacking onto the research targets of other astronomers; distributing data for analysis to desktop computers around the world. Radio searches may expand soon with telescope arrays covering one hectare or even one square kilometer. SETI Australia Centre has suggested searching for holographic images, and some people have discussed a search for extraterrestrial art or symphonies.

Most radio searches focus on stars that could have habitable planets. It is also possible to search for radio signals from relay stations, knowledge depositories, artificial intelligence, probes, or other smart machines located far from any planetary system on which life could have readily arisen. Seth Shostak closes his recent book with such a scenario, which "suggests that SETI scientists consider aiming their radio telescopes at some unconventional targets…. When we swing our radio telescopes towards the heavens, we are looking for intelligence, after all, not biology" (Shostak, 1998, page 201).

Some people advocate sending a welcoming message to extraterrestrial intelligence in hopes that it will trigger a radio reply from ETI. This approach is often called *active SETI* or ASETI. If the message is carefully crafted amidst widespread discussion, such an effort could be useful as part of a comprehensive approach to radio SETI. An international committee did discuss this approach in 1998, but little action has ensued.

A few uncoordinated ASETI efforts have arisen in recent years. In 1997, the European Space Agency collected more than 100,000 messages and signatures on the Internet, loaded them onto a CD-ROM, and sent it to the surface of Titan (Saturn's largest moon). One news report noted that the messages ranged from whimsical invitations for aliens to come to dinner to appeals for galactic peace. An unrelated American commercial venture called Encounter 2001 used radio for its active SETI in 1999. The last page of their message, which was broadcast from a Ukrainian antenna, invited anyone who reads it to reply and send information about themselves. And a Brazilian group of amateur astronomers prepared to launch Extracom, an effort that they claim is "the first pri-

vate extraterrestrial communication initiative." Their initial email announcement proclaimed that "it is time to join the great galactic community. It is time to speak freely from Earth to the whole universe" (Marx, 1999).

Optical SETI tries to detect pulsed lasers, infrared messages, or other artificial optical signals from many light-years away. Stuart Kingsley has described and promoted the idea of optical SETI for several years, and maintains a richly informative website at www.coseti.org. Also, *Bioastronomy News* (1999) devoted one issue to optical SETI. It presented the history and rationale, a list of theoretical and observational projects since 1961, and details on three major searches that began in 1998. And Paul Horowitz (2000) surveyed, explained, and even illustrated the optical SETI strategies.

Other Possible Strategies

In addition to the five particularly promising strategies, several other possibilities have been suggested by various scientists.

For example, perhaps a highly advanced technology can use polarized neutrinos, quantum entanglement, gamma rays, tachyons, gravitational waves, or some other particle or technique to communicate across vast distances.

Perhaps some alien intelligence embedded messages in the human genome or genetic code millions of years ago. Or in microbes designed to survive in an extreme environment, such as the deep hot zone of Earth. Or in the DNA of organic material that reaches our atmosphere from space.

Perhaps signs of alien meddling in our society could be detected if we looked far enough beyond the mundane forms of intervention that we might readily expect.

If we let our imaginations roam even further, we could consider looking for people whose minds are controlled by ETI or who are actually artificial life forms manufactured by ETI. For instance, we could study schizophrenics who believe they are ET: maybe some of them are not as deluded as we assume.

Summary and Reflections

Any extraterrestrial intelligence that we detect is likely to be far ahead of us in knowledge and technology—perhaps 100,000 years, a million years, or even a billion. For ETI, sending a very smart probe to monitor us could well be as easy as producing a bottle of champagne is for us. If ETI exists in our galaxy, there is a reasonably good chance that its probe has already reached Earth.

This means that we should vigorously pursue and support these three promising strategies for detecting near-Earth ETI: (1) search the solar system and Earth for physical evidence of an alien object or its effects; (2) issue invitations asking ETI to have a dialogue with humankind; and (3) become sufficiently prepared for contact, thus encouraging ETI to respond.

We should also pursue two promising strategies for detecting signs of intelligence that is many light-years away: (4) search for astroengineering projects, extraordinary energy use, by-products, or other distant evidence of a technological civilization, and (5) use radio and optical telescopes to search for remote artificial signals.

Because each of these five strategies could succeed in certain circumstances in which other strategies fail, humanity would be wise to vigorously pursue all five. The valuable benefits to us and to future generations could far outweigh the entire cost of all five strategies.

These five promising strategies provide a roadmap to the future of SETI—a glimpse of the field's likely diversity within a decade or two. And by the year 3000, all five strategies may turn out to be successful.

The SETI field is united by its common aim of detecting irrefutable scientific evidence of genuine extraterrestrial intelligence. The wisest policy for achieving this noble goal is to encourage and support all five of the most promising strategies, while simultaneously continuing to assess the potential value of other strategies as well.

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Over the years, I have been grateful for my father's interest in my work, for his ideas, and for his enthusiastic support of my intellectual ventures. This paper is lovingly dedicated to Dr. David L. Tough (1907-1999).

References

James Annis, "Placing a limit on star-fed Kardashev type III civilisations." *Journal of the British Interplanetary Society*, **52**, 33-36 (1999).

Alexey V. Arkhipov, "'Invasion Effect' on the Moon," *Selenology* (American Lunar Society), **13** (1), 9-11 (1994).

A. V. Arkhipov, "Earth-Moon system as a collector of alien artefacts," *Journal of the British Interplanetary Society*, **51**, 181-184 (1998a).

A. V. Arkhipov, "New approaches to problem of search for extraterrestrial intelligence," *Radiofizika & Radioastronomia*, **3** (1), 5-11 (1998b).

Joseph F. Baugher, *On civilized stars: The search for intelligent life in outer space*. Englewood Cliffs, New Jersey: Prentice-Hall, 1985.

Gregory Benford, "Alien technology." In Ben Bova and Byron Preiss (editors), *Are we alone in the cosmos: The search for alien contact in the new millennium*. New York: ibooks, 1999.

***Bioastronomy News*,** 11 (1), 1999.

Forrest Bishop, "The Starseed/Launcher." 1996. http://www.speakeasy.org/~forrestb/starseed_launcher.html.

Robert Bradbury, "Matrioshka Brains," 1999. http://www.aeiveos.com/~bradbury/MatrioshkaBrains/MatrioshkaBrains.html (May 2, 2000).

Richard Burke-Ward, "Possible existence of extra-terrestrial technology in the solar system." *Journal of the British Interplanetary Society*, **53**, 2-12 (2000).

Eric Chaisson, *The life era: Cosmic evolution and conscious evolution.* New York: Atlantic, 1987.

Robert Clements, informal communication, September 1999.

Steven J. Dick, *The biological universe: The twentieth-century extraterrestrial life debate and the limits of science*. Cambridge: Cambridge University Press, 1996.

Martyn J. Fogg, "Temporal aspects of the interaction among the first galactic civilizations: The Interdict Hypothesis," *Icarus*, **69**, 370-384 (1987).

Robert A. Freitas Jr., "Nanomedicine FAQ [#19]." http://www.foresight.org/Nanomedicine/NanoMedFAQ.html. April 2000.

Robert A. Freitas Jr. and Francisco Valdes, "A search for natural or artificial objects located at the Earth-Moon libration points." *Icarus*, **42** (June 1980), pages 442-447.

Paul Horowitz, "Flash! Optical SETI joins the search," *The Planetary Report*, **XX** (2) (March-April 2000), pages 8-15.

International Space Sciences Organization, "Contact Planning II abstract/summary" (1999). http://www.isso.org/res/contact.htm. A full report is being prepared for public distribution.

Ray Kurzweil, *The age of spiritual machines: When computers exceed human intelligence*. New York: Viking, 1999.

Guillermo Lemarchand, "Detectability of extraterrestrial technological activities," *SETIQuest*, **1** (1), 3-13 (1994).

Charles H. Lineweaver, "Why did we evolve so late?" In Guillermo Lemarchand and Karen Meech (editors), *Bioastronomy '99—A New Era in Bioastronomy, Proceedings of a Conference held on the Kohala Coast, Hawaii, 2-6 August, 1999,* ASP Conference Series 213 (2000).

Claudio Maccone, "Mathematical algorithm to detect alien spacecraft approaching the Earth." Paper IAA-94-IAA.4.1.656 presented at the 45th congress of the International Astronautical Federation, Jerusalem, 1994.

E. B. Marx ("spokesman for Grupo Independente de Radio Astronomos"), widely disseminated email messages April 1 and April 9, 1999.

Hans Moravec, *Robot: Mere machine to transcendent mind*. New York: Oxford University Press, 1999.

Ray P. Norris, "How old is ET?" Presented at the 50th International Astronautical Congress, Amsterdam, October 1999. Reproduced in this volume. An electronic version is at http://www.atnf.csiro.au/~rnorris/papers/n163.htm.

SETI Institute, *Perspectives*. Mountain View, California: SETI Institute, 1999.

Robert Shapiro, *Planetary dreams: The quest to discover life beyond Earth*. New York: Wiley, 1999.

Seth Shostak, *Sharing the universe: Perspectives on extraterrestrial life.* Berkeley: Berkeley Hills Books, 1998.

Jill Tarter, "SETI and the religions of the universe." Presented at the Templeton symposium on *Many worlds: The new universe and its implications for theology*, Nassau, Bahamas, November 1998.

C. N. Tilgner and **I. Heinrichsen,** "A program to search for Dyson spheres with the Infrared Space Observatory." *Acta Astronautica*, **42**, no. 10-12 (May-June, 1998), pages 607-612.

Allen Tough, "Positive consequences of SETI before detection." *Acta Astronautica*, 42, 745-748, (1998a).

Allen Tough, "Small smart interstellar probes," *Journal of the British Interplanetary Society*, **51**, 167-174 (1998b). An earlier version is at http://members.aol.com/WelcomeETI/8.html.

Allen Tough, "Fresh SETI strategies," *Journal of the British Interplanetary Society*, **52**, 286-289 (1999). An earlier version is at http://members.aol.com/AllenTough/mel.html.

Allen Tough, "Invitation to ETI," a set of linked web pages, revised February 2000. The home page provides an overview at http://members.aol.com/WelcomeETI, the list of members is at http://members.aol.com/WelcomeETI/5.html, extensive background is provided at http://members.aol.com/WelcomeETI/4.html, and the invitation itself is at http://members.aol.com/WelcomeETI/hello.html.

Allen Tough, "What people hope to learn from other civilizations." *Acta Astronautica*, forthcoming. A more complete set of questions for ETI, developed from the same survey of 224 people in 12 countries, is provided at http://members.aol.com/WelcomeETI/hello.html.

The Contact Hypothesis:
On the Impossibility of Sustained and Mutually Beneficial Contact between Aliens, and Two Proofs to the Contrary

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Editor's Note: Will it be easy, difficult, or impossible for humans and an advanced alien intelligence to understand each other? The potential difficulty of such communication was a prevalent theme during the Hawaii seminar.

Fortunately, a dissenting view has been presented by Dr. Reed Riner. He tackled this question carefully back in 1985 in this unpublished paper presented at the third annual CONTACT conference. His conclusion is that sustained and mutually beneficial contact between alien cultures is quite possible.

Professor Jim Funaro, the founder of CONTACT, has graciously permitted us to include this revised version of the paper in the present volume. Current information about CONTACT can be found at http://www.cabrillo.cc.ca.us/contact.

The role-playing at CONTACT usually involves a human team and a flesh-and-blood alien team, but the March 2000 meeting experimented with a fresh paradigm. The alien team consisted of highly advanced artificial intelligence (a super-smart computer embedded in an alien probe that had reached Earth). It had monitored our telecommunications, including the World Wide Web, and learned our languages. The two teams were in different rooms and communicated only by text. My assessment is that the two teams overcame their inevitable communications difficulties quite rapidly, and conducted a simple but successful dialogue during the 50-minute simulation. After experiencing this dialogue as the leader of the human team, I became quite optimistic about our chances of successful communication with an alien intelligence.

—Allen Tough

Introduction

In this discussion I attempt to demonstrate that sustained and mutually beneficial contact between alien intelligences and cultures is possible.[1] First I will appraise the logistics of this third CONTACT conference. Then I will offer four other ethnographic examples in which this kind of contact has happened and argue through examples that because contact between cultural aliens has happened before, it can happen generally. Briefly I will suggest how this ethnographic line of inquiry may be extended. Then I will draw some generalizations from the examples, and argue for the legitimacy and productivity of considering culture as if it is a formal system, which it may well be. In this context I will propose a more formal argument of the contact thesis, and suggest with four examples how this line of inquiry may be extended.

The Continuity of CONTACT

The title and theme for this paper were suggested by Jim Funaro this past year (1984/5) in a series of telephone conversations. For a few grim months and for several kinds of reasons it appeared that we might not have a CONTACT III…or IV or V or VI. But we are here, and that is why I want to begin by celebrating the continuity of our CONTACT.

1. In preparing this paper for publication after 15 years since its original conference presentation, I have pruned and moderated the rhetoric that was intended to amuse as well as to stimulate an audience composed mostly of friends and acquaintances, and I have updated many of the citations. My remedial expansions and clarifications in the body are set off in italics and footnotes. Many of the examples are now dated, and the developments and refinements during the interim merit incorporation, along with the keener insights and criticisms into the argument.

I have retained from the original version the thread of celebration of CONTACT, and I still believe that it will be possible to find common denominators for meaningful communication with extraterrestrial aliens, and languages, media to convey meaning in the event that we meet—or create—sentient aliens.

Sometime in 1981/2 Funaro began work on a project, the success of which seemed highly improbable. He intended to summon, to lure, and otherwise entice, representatives from three mutually alien cultures—some science-fiction writers, some graphic and performing artists, and some anthropologists—out of their traditional territories. He proposed asking them not just to meet each other, but to collaborate, deliberately and enthusiastically, in a mutually beneficial process of sustained contact.

Considered analytically, this enterprise required organizing on at least seven different levels. The participants, coming from different cultural contexts, would have to:

1. Be funded, transported, housed, fed, etc.
2. Be supported with local arrangements, publicity, etc.
3. Get to know and trust one another as individuals.
4. Learn each others' languages and frames of reference, and discover common currencies of reciprocity and exchange.
5. Discover what resources—and needs—each individual and group had to contribute to the enterprise.
6. Invent some processes for interaction, some roles and role-relationships.
7. Invent a vision of beneficial common purpose.

It is always best to start this kind of project by building a small system that works (Weick, 1969:105-108). Seven levels of organization is not a particularly small system; it approaches the complexity of inventing and engineering a whole culture (Jay, 1971; Weick, 1969:6). I'm sure skeptics laughed when Funaro first sat down at the typewriter, and hasten to note that he now uses a MAC to manage this extended exercise in problem-solving behavior.

Some of the parts of this manifold task were easier than others. He had, initially at least, a host of eager minions to whom component parts of the larger task could be delegated. He carefully selected the agents for contact who were already motivated to communicate with one another—writers who thought and wrote anthropologically, and anthropologists and other social scientists who were as interested in alternative and hypothetical cultures as they were in actual ones. Artists to mediate between them. Funaro had a sketch of structure, one that created a true "field" by combining the complementary processes of critical observation, the symposia, and subjective participation, the simulation activity, the first Bateson Project. And he had a generally defined objective, inspired by conversations with Gregory Bateson; their common objective was not quite so general as "to boldly go where no minds had gone before," but more specifically to explore and define the limits of our concept of "the alien" and the possibilities that would follow from contact with the aliens through the process called play.[2] Never, of course, has there been any question that structured information, ideas, art, and knowledge would emerge as the currency of this exchange.

These resources notwithstanding, forging a sustained and mutually beneficial contact among such aliens was unlikely. It is generally thought that any meaningful communication with alien intelligences is impossible. There are serious arguments against it:

- What is the likelihood that any alien intelligences exist?[3]
- What is the likelihood that we will ever encounter them?
- What is the compound probability that they and we will be motivated to communicate with each other?
- What is the likelihood that we will be able to communicate with each other?
- What is the likelihood that any kind of sustained and mutually beneficial relationship could result from such communication?

The answer to these questions is the product of their five likelihoods, and that is a very small number indeed. It would seem to be a probability that borders more nearly on impossibility, or fantasy, than on likelihood.

The fact that we are here, that we can celebrate the continuity of our CONTACT, is one empirical demonstration that sustained and mutually beneficial contact between aliens can be achieved. Our CONTACT provides us with an immediate and concrete, if micro, example of sustained and mutually beneficial contact between aliens. We are participant-observers embedded in a field that is our own continuing cre-

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2. Critical, often peer-refereed, dialogue about the "other" surfaced in anthropology in 1985, well-exemplified by Jacob Pandian's *Anthropology and the Western Tradition* (1985).

3. I wrote in ignorance of the Drake Equation; see http://www.seti-inst.edu .

ation, and a pretty fancy piece of applied anthropology it is, Mr. Funaro.

Ethnographic Examples

But one case, especially under the limited and favored circumstances that support CONTACT, should not be, by itself, generalized to a proof.

The most voluminous argument against alien contact is not one of slim odds for their—the Aliens'—existence and the possibility of our contacting them, of imperialistic CONTACT. I think we can accept the reckonings of contemporary cosmologists that the probability for this is 1 (one). Rather, the reigning argument against sustained and beneficial contact proceeds from the apparent fact that most instances of culture contact in OUR historic experience have resulted in the emasculating subordination of one party by the other or the destruction of one or mutually by both parties. The popular image of alien contact situations is: "They destroy, enslave, colonialize us, perhaps inadvertently, or we would do that unto them, however inadvertently, or we both destroy each other…inevitably because of an inability to communicate."

It is pertinent to note that simultaneous with this, our CONTACT-III (1985) conference members of the European Federation of Intercultural Learning and the World Futures Studies Federation are convened in Rome (26 Sep–1 Oct, 1985; *the CONTACT venue was subsequently reset to the now-traditional 1st weekend in March*) to discuss: "Common Values for Humankind: Is Cultural Diversity Compatible with Peace?" (WFSF Newsletter, 1985:3-5). The gloomy supposition about contacts with cultural aliens is acceptable if one's examples are drawn only from the domain of conventionally recorded history. But that sample is deceptive because it is drawn from a single category—the realm of imperial states; it is that pernicious "sample of one" again.

Conventionally recorded history, our own sample of one, is the product of nation-states and empires, those hierarchically organized sociocultural systems in which "history" has been written by the elite, about the elite and for the elite—that favored 10% of the population at the top of the power pyramid, and consuming 90% of the product. A broader, more legitimate sample should include the cultures from outside of history: the bands, tribes, and chiefdoms who collectively represent well over 98% of the sum total of human experience, whose history is oral, mythological, and archaeological, and whose organization is other than rigidly hierarchical. This broader example provides numerous examples of nondestructive, sustained, and mutually beneficial multicultural contacts. The Pomo trade feasts in central California, the Iroquois and Creek Confederacies around the Great Lakes, the Taos Pueblo trade fairs that preceded white contact, and the pre-contact trade networks that connected the Pacific Coast and the Greater Southwest all illustrate sustained and beneficial contacts. The Bantu-pygmy symbiosis provides an example from outside the Americas (Turnbull, 1963). But three of the most conspicuous examples, examples that illustrate mutually beneficial contact at three successive level of sociocultural integration, are potlatching on the Northwest Coast of North America, the Kula Ring in the Melanesian Pacific, and the symbiotic relationship among the Kohistanis, Pathans, and Gujars in the Pakastani State of Swat. I will describe each briefly.

Potlatching was a system of reciprocal feasting and gift-giving among some 31 or more different chiefdoms representing seven language families and three different linguistic phyla, distributed along the 1500 miles of the Northwest Coast from the panhandle of Alaska down into Oregon (Spencer & Jennings, 1977:116-118). The reciprocity of feasting ameliorated the negative effects of local scarcities and surpluses. The gift-giving had longer-range effects, temporally and geographically, allocating both material and non-material commodities—tools, the products and formulas of the plastic and performed arts, and elements of ideology. These kinds of allocations were effective both within and among the participating cultures. The combination of feasting and gift-giving had the further effect of keeping settlement and land use patterns in a continuing non-depleting relationship with the ecology (Vayda, 1961; Piddock, 1965; Suttles, 1960).

In Melanesia, diametrically across the Pacific from the Northwest Coast of North America, the Kula Ring of inter-island trade facilitated sustained and mutually beneficial culture contacts among 16 island-based cultures—and perhaps as many as a half-dozen more peripheral participants. The Ring spanned an area roughly 200 miles in diameter, and included 16 routes, the longest of which was 130 miles. These were traversed by large expeditions in outrigger canoes connecting the cultures in "trade, magic, ceremonial exchange, overseas travel and pleasure seeking" (Malinowski, 1922; Hoebel, 1972:349, also Hunter and Whitten, 1976: 248—

250). We can infer that this system provided extended benefits comparable to those of potlatching.

The case in the mountainous Pakistani Northwest frontier state of Swat provides a different kind of example. Here 30,000 Dardic-speaking, village-living Kohistanis, organized into loosely connected patrilineages, subsist by irrigated terrace agriculture and transhumant herding. They share the territory with 450,000 Pashto-speaking Pathans who are organized into a complex multi-caste society on an intensive agricultural base—and with an uncertain number of Gujri-speaking Gujars, four patrilineal clan/tribes of nomadic herdsmen. The whole system is characterized by the stable co-residence of the three ethnic/linguistic groups. Each group exploits different but interdigitated ecological niches and is linked to each of the other groups in symbiotic economic relations (Barth, 1956).

Examples of sustained and mutually beneficial culture contact seem to proliferate outside the states, outside those systems that are organized in terms of asymmetrical and exploitive power and economic relationships. This pyramidic organization in the examples known to us is justified and legitimized by dualistic and patristic background assumptions that posit an equally asymmetrical relationship between humans, nature, and some ultimate reality—like Heaven or Utopia. Also note that organized warfare with uniforms, ranks, codified tactics, and strategies, and the motivation to conquest seem to be unique to the state category of sociocultural systems. This strongly suggests that exploitive, destructive relations between cultures is a phenomenon derivative from some kinds of cultural organization and not from others, and previous samples have looked only at the state kind.

We also observe that, while the examples of constructive contact cluster outside the state category, they are not ubiquitous there; this seems to imply that however beneficial and desirable they may be, there is a certain kind of improbability about them. The improbability of these kinds of events supports rather than challenges my argument. The contact process can express a quest for a higher level of organization and for intelligence. Intelligence and organization are expressions of a single process: the systematic removal of randomness, of equivocality, and of ambiguity, and overall the reduction of entropy (Weick, 1969:29; Hofstadter, 1979:629-32). This process is encoded, made manifest in structures and organizations (Bohannan, 1973). From this it follows that the more improbable the structure and organization of an event, the more intelligence lies behind it. The converse is equally true.

The ethnographic examples differ in an important respect from the CONTACT example: they evolved—slowly, arbitrarily, pretty much by trial and error. CONTACT, by contrast, was preconceived and deliberate, planned. Our CONTACT more nearly approximates the suddenness with which extraterrestrial contact is apt to occur—suddenly if not intentionally.

Regardless, it would be instructive and immediately useful, to proceed with an exercise in controlled comparison over the seven levels of organization that we can see in our own CONTACT situation to discover exactly what more specific significant features these—and similar—cases hold in common. I will defer that to another time because I have demonstrated that there is a sufficient number of well-documented cases to support the thesis that mutually beneficial contacts have been devised and sustained among mutually alien human groups—across the broadest differences in ways of thinking that we know.

Generalizations

Now I want to draw some generalizations from the preceding as a way of moving into the formal proof. People who have thought about how intelligence could evolve propose a kind of creature that may be legitimately, if sparsely, described as "creatures who have a carbon-based biology, are bigger than Irish setters and smaller than grizzly bears, have heads centralizing the primary sensory and data processing functions at one end, and excretory sphincters, or their equivalents, at the other" (de Camp, 1939; Clement, 1974). These assumptions are reasonable and sufficiently general to apply in specifying our category of "alien." *Further, this kind of alien will be motivated by a hierarchy of basic needs akin to that described by Maslow (1970, 1971), a system that mediates between whatever "biology" characterizes the alien, and the information system that directs its behavior.*

We may also generally say of these creatures that they are:

1. Surviving, communicating creatures who are intent on extending their abilities to control and predict their physical surroundings.

2. Creatures who have evolved matched sets of sensors—effectors for dealing with their physical situation.
3. Creatures who possess the ability (and the motivation) to tackle hard problems—ones that are interesting, rich, and non-trivial in the mathematical sense of the word; in other words, they can learn.

(Minsky, 1985:128.)

No one knows where the fuzzy grey line between non-intelligent and intelligent behavior lies; in fact, to suggest that a sharp borderline exists is probably erroneous. The essential abilities for intelligence are certainly:

- To respond to situations very flexibly
- To take advantage of fortuitous circumstances
- To make sense out of ambiguous or contradictory messages
- To recognize the relative importance of different elements of a situation
- To find similarities between situations despite differences that may separate them
- To draw distinctions between situations despite similarities that may link them
- To synthesize new concepts by taking old concepts apart and putting them together in new ways
- To come up with ideas that are novel

(Hofstadter, 1979:26.)

Now, having specified and restricted the category of what constitutes a plausible, sentient, and generalized "alien" I must collaterally make more explicit what I will mean by "culture" in the more formal proof.

Culture consists of patterns,
explicit and implicit,
of and for behavior
acquired and transmitted by symbols,
constituting the distinctive achievements
of human groups,
including their embodiment in artifacts;

(and that)
the essential core of culture
consists of traditional
(i.e., historically derived and selected)
ideas and especially their attached values;

(and that)
culture systems may,
on the one hand,
be considered as products of action,
and on the other
as conditioning elements of future action.

(Kroeber and Kluckhohn, 1952:181)

Or, as Kluckhohn said elsewhere, "all those historically created designs for living, explicit and implicit, rational, irrational, and nonrational which existed at any given time as potential guides for action." (Kroeber and Kelly, 1945)

Culture is patterns and ideas—organized information as shared among members of a population. A culture, more precisely a cultural tradition is, therefore, a kind of pool of information elements, encoded as signs and symbols. These elements are invented or borrowed, organized and used, more or less self-consciously, by one or more species. They are the technology that enables intelligence, just as genes and chromosomes are the technology that enables life. The increasing number of chimps, gorillas, and orangutans, three different species of higher primate, acquiring some proficiency in American Sign Language demonstrates that cultural elements can be transmitted across species boundaries.

This description of culture also includes the idea that culture is a system of doubly encoded information. It is encoded once in the mind of the culture bearer and once again in observable, sometimes relatively permanent, utterances, actions, and artifacts (Bohannan, 1973), or as artifacts, phenomofacts, and mentifacts (Kealiinohomoku, 1975:19,21,26), or as genes, memes, and ideons (Brown and Greenhood, 1985). Only when this second coding occurs do parts of the information system become manifest, shared, part of culture, and accessible to study. *Culture is an information-based, intra-, inter-, and extrasomatic, intentional system, the use of which is the strategy of adaptation employed by, potentially, a multitude of species. (Humans are born without culture and have to learn it; if they fail to learn it by puberty they seem to loose the ability to learn culture and do not achieve human developmental potential.)*

Formal Proof of the Contact Thesis

The preceding generalizations about "alien" and "culture" provide us with the minimum requisites for intelligence and with solid ground for examining cultures as systems akin to artificial intelligence. This

more formal proof of the contact hypothesis must now bring these two together. It must show first that there are universals of intelligence that can provide a common ground for communication between alien intelligences. Then it must show or persuade that these universals of intelligence will result in universal patterns of culture that can provide a common ground for sustained and mutually beneficial contact between alien cultures. Finally the formal proof should identify the kinds of patterns these are likely to be.

Part One, a formal argument for the possibility of "Communication with Alien Intelligence," has been presented by one of the founding deans of artificial intelligence research, Marvin Minsky (1985). Let me recapitulate.

From a Principle of Economy, Minsky argues that every intelligence must develop symbol systems[(4)]. These systems would represent things, causes, and goals, and be used to formulate and remember the procedures developed for achieving such goals. He contends that only a symbol system can enable a creature to solve the wide range of new, different kinds of problems with a speed sufficient to be recognized as intelligence. In fact, Minsky seems to equate the development and use of a symbol system with intelligence; we cannot determine from the remainder of his discussion whether he is talking about universals of intelligence or universals of symbol systems. Minsky's position, we infer, is that such a distinction is irrelevant, that no alternative is possible.

Minsky proceeds to offer us three sets of capacities requisite to intelligence. These sets of capabilities address respectively the creation, the representation and transmission, and the content of knowledge. With respect to the creation of knowledge, Minsky argues that seven abilities are requisite to the effective manipulation of symbols in learning quickly how to solve hard problems. This set includes the abilities to:

Break hard problems into simpler ones (sub-goals)

1. Make descriptions based on parts and relations
2. Explain and understand how things change
3. Accumulate experience about similar problems
4. Efficiently allocate scarce resources
5. Organize work before filling in the details (to plan)
6. Provide for the problem-solver's own welfare (to possess self-awareness)

Minsky's second set of requisite capacities concerns, more particularly, the representation and transmission of knowledge. He argues for the inevitability of:

1. Object symbols—representing objects, ideas, processes and events
2. Difference symbols—representing differences between, and change in, objects
3. Cause symbols
4. Clause structures—for simplifying and embedding complicated structures

Minsky then argues for a Principle of Sparseness, which entails universals with respect to the content of intelligence. "Every intelligence," he says, "will eventually encounter certain very special ideas because these particular ideas are very much simpler than other ideas with similar uses." He finds examples of these ideas in arithmetic, causal reasoning, economics, utility, linear approximation, probability, and the simplest program-like processes. *The Periodic Table of chemical elements and the Mainstream distribution of stellar types provide additional examples*. These are ideas, information structures, that have no easily accessible alternatives. They stand out as "islands of efficiency" in the open sea of all possible lines of thought. The implication of this Principle of Sparseness is that systems of intelligence cannot proliferate in an unlimited number of directions and configurations, but rather that all of them must exhibit a common central tendency toward the most efficient structures that connect those "islands of [cognitive] efficiency."

Minsky's conclusions dovetail with an extensive body of anthropological literature that, taken together, demonstrates the essential processual unity of the phenomena we variously observe and label as "pre-articulate semantic deep-structure" (Chafe, 1970); "mind/intelligence"(Bateson, p.c. Apr 1977 in Riner, 1984); "problem-solving/ organizing behav-

4. Symbol—any representation of an element of thought, from written character to elaborate choreography, to which meaning or other significance is attributed by the users, the characteristic that Hockett designates as "arbitrariness of patterning" in his identification of the ten distinctive features of language (1960), whereas sign designates a simpler, more mechanical, physical and invariant connection between the sign and what it signifies, as smoke is a singular and direct product of fire. The naturally occurring languages of humans are symbol systems that incorporate elements of simpler sign systems.

ior," "language" including symbol systems generally, and "culture" (Brown and Greenhood, 1985; Bohannan, 1973; Frelich, 1975; Gardner, 1985; Fox, 1979; Jung, 1916; Kearney, 1984; Miller, 1978; Powers, 1973; and Weick, 1969).

In other words, these differently labeled phenomena are expressions in differing media of a few common processes—a system of a few rules and all their consequences. We can expect principles of organization that apply at one level and in one medium to apply at all consequent levels and in all media—in each case limited and molded by the particular context and medium of expression.

Common processes, it follows, will result in common, at least isomorphic, products and patterns of expression. My thesis in this more formalized argument is that the common processes, these universals of all kinds of symbol systems and small sets of rules, provide the foundation for both communication and sustained and mutually beneficial contacts among aliens. Now it remains to illustrate what some of the kinds of processes and patterns are that we can expect to find as universals in alien—terrestrial and extraterrestrial—cultures. Four come immediately to mind[5]; these are:

1. Small sets of rules
2. Recursive systems and fractals
3. Decision trees and expert systems
4. Popping levels to generate meta-rules

Let me explain each of these processes and point to one or two examples of its cultural manifestations.

Every Principle of Economy will argue that fewer resources are expended in following a smaller set of rules than in following a larger one. This conservation of resources does not, however, limit the productivity of a set of rules. The ten definitions and postulates, including the rule for congruence, are sufficient to establish each of the Euclidean and non-Euclidean geometries, each of which is potentially unlimited in its expansion. Fewer rather than more rules actually increase the flexibility of their application.

A cultural example of this is provided by the case of human kinship systems, elegantly in the case of the aboriginal Australian Arunta's marriage rule that ego shall marry his mother's mother's brother's daughter's daughter—a rule that can be abbreviated: EGO = mo-mo-br-da-da. The context for this rule is created by the simple system of paired, complementary, and asymmetrical distinctions of age, sex, and descent (vs. affiliation), the distinctions that are universal in kinship categories. There are only six effective pairs[6], a very deceptively simple set of rules. In this context the easily learned rule results, in the ideal, in the generational and reciprocal exchange of mates between each pair of most distantly related descent groups in a system of eight groups. It takes eight colors and a three-dimensional, seven-generational event space to portray the proper and expected organization of Arunta society. (Service 1978:20-26).

The extent and complexity of effort that goes into describing this system illustrates another distinctive feature of small sets of rules: their asymmetry. While a small set of rules can generate a very complex system, seldom if ever can a very complex system be described in a small set of rules. The Arunta case does not belie this asymmetry; the rule was in fact elicited not by analysis of observed cases, but by an ethnographer who asked an insider to the cultural system.

John Horton Conway's remarkable cellular automaton simulation "game," LIFE, illustrates some other significant features of small sets of rules (Gardner, 1970a,b,c; 1971a,b,c,d). There are only six rules in this small set:

1. LIFE is played in a tessellated field—usually a regularly tessellated, two-dimensional field like a sheet of graph paper
2. The player fills an arbitrary configuration of cells—and applies the next three rules repetitively:
   a) SURVIVAL—every cell with two or three neighbors survives and is copied into the next generation.
   b) DEATH—every cell with one or no neighbors dies of isolation, and every cell with four or more neighbors dies of overcrowding; their cells are emptied in the next generation.
   c) BIRTH—every empty cell with exactly three neighbors is a birth cell; these are filled in the next generation.

5. These four were current "hot topics" in 1985; in 2000 I would focus on the modeling of systems' dynamics and simulations, including how these incorporate the examples here.

6. The pairs are WIfe-HUsband, MOther-DAughter/SOn, FAther-DAughter/SOn, and SIster-BRother; all extended kin can be specified by concatenations of these six role labels, entailing modifications on the six fundamental relationships they describe.

3. Rules 2b and 2c are applied "simultaneously."

LIFE illustrates the variety of small sets of rules that constitute recursive systems—systems in which one set of rules is applied repeatedly to its own sequentially generated and transformed products. The rules in the game of LIFE are deceptively simple, but the products are curiously complex. Every population entered into this process exhibits a tendency toward, and/or complete conservation of, spatial symmetry. While most configurations disintegrate and disappear within a few generations, some small percentage of them arrive at stable, usually regularly oscillating, end states (ethnographically illustrated by *gumsa* and *gumlao* (Leach, 1954)). A yet smaller number of initial configurations continue in unlimited evolution, and a very small number of these generate offspring who go on to live autonomous lives of their own. This last small number of configurations are unusually *intelligent*, we are forced to say, and no doubt closely related to Minsky's "isolated islands of (cognitive) efficiency."

The products of LIFE, like those of so many recursive processes, are temporally asymmetrical: one cannot predict the configuration of any future generation (except by working it out, which is not prediction); neither can one reconstruct the configuration of the preceding generation, even if you do try to work it out. Each population's future is unpredictable, and its past is unreconstructable…so long as you are working from outside the system.

The products of LIFE present yet another curiosity: many of them appear to be fractals. Fractals are structures or patterns of information that are self-symmetrical. That is, a small piece of a fractal structure mirrors the shape of a larger piece, like holographic images in popular understanding, and the whole structure exists in a fractional or decimal dimensionality somewhere between 1 and 2, 2 and 3, and, we suppose, on beyond that. Fractals are the kinds of structures that one sees in Brown-and-Greenhoodian movement and thermonuclear turbulence, in the distribution of metals in the Earth, and in the bonds and bends of macro-molecules, in the contours of islands and lakes, mountains and valleys, and clouds, in the distribution of species in an ecosystem such as the great Okefenokee Swamp, hears in the music of Bach and again sees, increasingly, in computer-generated art (Mandlebrot, 1977; Peterson, 1984a,b; Raloff, 1982; Science News, 1983, 1980; Thomsen, 1982,1980; Weisenburd, 1985).

The preceding are all examples of fractals expressed in natural material structures where the basic forms of materials—circle, spiral, meander and helix, branching patterns, and polygons (especially the hexagon)—predominate (Nova, 1985). We can expect systems of intelligence and culture to converge on these essentials and to produce fractals derivative of these and, subsequently, many less-probable structures. The music of Bach and computer-generated art provide two examples from known cultural systems. I have found the implicit structures and historical changes of design in Navajo rugs, ritual, sand paintings, and myth consistent in this respect (Riner, 1986). *Surely these principles are ubiquitous in systems built by sentients.*

And why is the ideal structure of Arunta kinship patterning never observed in fact? Because the facts, and the chances, of a material, entropic medium of expression intervene. As Mandlebrodt, the discoverer of fractals says, "[They are] randomness combined with self-interaction to a strong degree" (Peterson, 1984a). Wherever the pattern of an ideal and proper system rubs up against the constraints of smart, entropic, material reality we can expect to find a fractal (Weisenburd, 1985:279; Freilich, 1975:208-209). I wonder how many other fractal patterns may await discovery in dusty ethnographies?

The next formal system phenomenon that we can expect to find expressed in all cultural systems is decision trees[7]. These can result in elaborate expert systems for tasks as diverse as diagnosing illness in a patient, to parsing the structures of a language, classifying a botanical sample, prospecting for petroleum, or modeling the economic behavior of traditional Navajos in the contemporary market (Waldrop, 1985; Thompson and Thompson, 1985; Wood, p.c.). But all decision trees begin in someone's perception of difference, a drawing of a simple, usually binary, distinction within/among its fields of perceptions such as: light–dark, loud–soft, harsh–smooth, etc.…again and again and again in an expanding fractal field of the simple…usually 3-element, jointed branch, Y-kind of structure, aimed at reduction of ambiguity.

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7. This item of rhetoric, the one that drew the biggest laugh in the conference paper, I have preserved. Folklore in the academy says that big ideas come back every generation, every 20 to 25 years. That may be a fundamental insight into the Great Scheme of Things (GST). This one, GST—General Systems Theory—seems to be doing so as I revise.

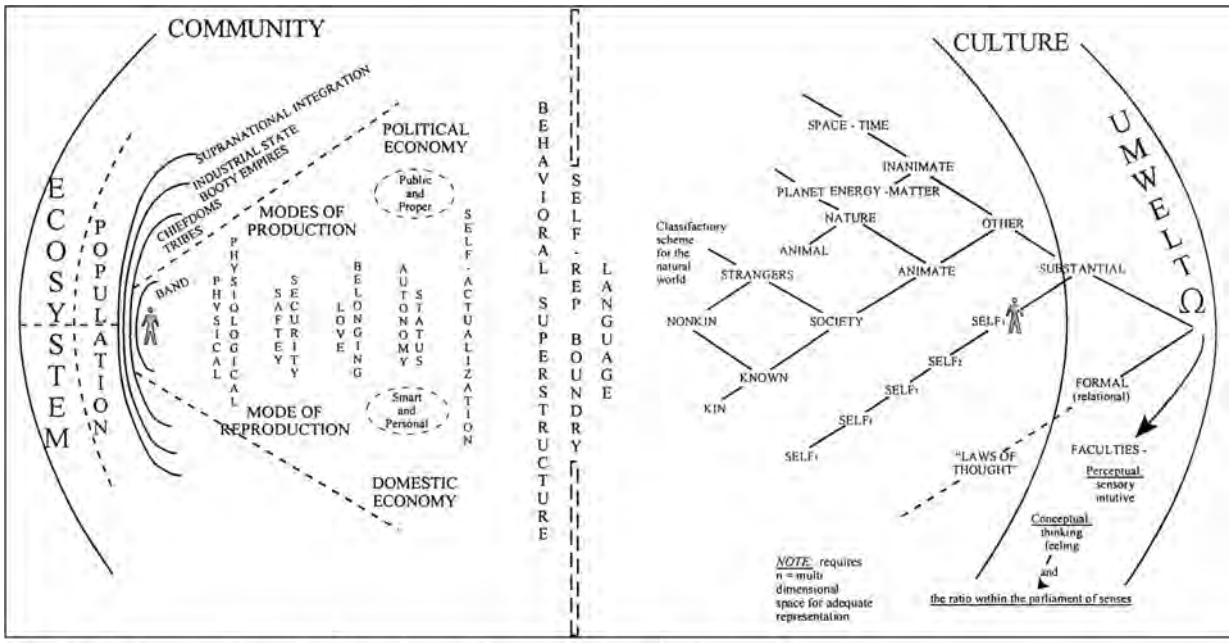

FIGURE 1: The Process of Transactive, Discriminative Mapping Vis-a-Vis the Sociocultural Environment.

As an example of a decision tree well documented in cultures, I offer Figure 1 that depicts the universals of human worldview (Kearney, 1984:65-89). In each instance of branching, I have identified the general nature of the distinction drawn there. For a number of reasons (e.g., making sense of spatio-temporal context, and intangibles such as relationships and causality; Kearney, 1984:89-107) it appears that human distinction-drawing goes off simultaneously in at least four or six more dimensions than the two that I can depict in Figure 1.

Examples of many more specific decision trees, some approaching the multidimensional complexity of semantic networks, characterize a tradition of anthropological research that spans work from the Voegelins' *Hopi Domains* (Voegelin and Voegelin, 1957) through the ethnoscience/ethnosemantic school of Frake, 1962; Werner and Schoepfle, 1987; Spradley, 1980, 1979, *and into the present*.

Finally we come to popping. This is moving one's focus of attention up one level of abstraction to the next in order to write or discover a meta-rule, or down one level in detail to specify procedures. Popping happens all the time in cultural systems, so much so that Marvin Harris has emphasized it in his central and strongest argument for "Why a Perfect Knowledge of All the Rules One Must Know to Act Like a Native Cannot Lead to the Knowledge of How Natives Act" (Harris, 1974). Harris' thesis, however, confounds how any human in any culture can always rationalize; that is, how one can always cite, invent, infer, or abduct a culturally acceptable rule for almost any behavior, no matter how deviant. This point is well made in Mary Douglas' essay "Jokes" (Douglas, 1975).

Popping to a meta-level is not anything more or less than the inverse or complement of embedding. And embedding, Minsky's "clause structures," is another variety of recursion (Hofstadter, 1979: 127-135). If our alien intelligence or culture does not exhibit this particular feature, embedding—and popping, then it probably isn't intelligent.

Let me try for some kind of closure.

Most people argue—shallowly, I believe—that sustained and mutually beneficial contact with aliens is improbable, probably impossible, and "more 'n likely" undesirable anyhow. I have accepted the opinion of cosmologists that the existence and likelihood of an encounter with aliens is probable—and probably equal to 1, equal to certainty.

I have presented ethnographic evidence, the cases of our own persistent CONTACT, also of potlatching, the Kula Ring and tri-ethnic symbiosis among sociocultural systems in Swat, that sustained and mutually beneficial multicultural contacts among communities of *Homo sapiens* have occurred, and that they have bridged some of the greatest differences in ways of thinking that we are able to document among human communities.

I've gone on to argue for a more formal substantiation of the contact hypothesis:

First, that *culture* (and by extension, or inclusion, *language)*, the indigenous problem-solving/organizing behaviors, and formulations of mind/ intelligence, may be legitimately and productively represented and investigated as if culture is a formal system, another specie of artificial intelligence.

Second, that artificial intelligence research provides convincing argument that these kinds of systems do have common properties—universals of process and universals of content.

Third, that these universals are manifest in small sets of rules, including recursive systems generating fractals, decision trees and expert systems, and popping up to new levels to write meta-rules, and down to subordinate levels to write specifications, among their resultant products.

Throughout I have assumed that these kinds of universals, these information-preserving transformations, are the necessary and sufficient foundation upon which sustained and mutually beneficial contact with aliens can be established.

To the extent that I have persuaded readers to this position, then: Viva CONTACT!

References Cited

Barth, Fredrik, 1956, "Ecological Relations of Ethnic Groups in Swat, North Pakistan." American Anthropologist, Vol. 58:1079-89.

Bateson, Gregory, 1977, personal communication, Apr.; see Riner, 1984.

Bohannan, Paul, 1973, "Rethinking Culture: A Project for Current Anthropologists." Current Anthropology, Vol.14 (4):357-372; Oct.

Brown, James Cooke and **William Greenhood,** 1985, "Paternity, Jokes, and Song: A Possible Evolutionary Scenario for the Origin of Mind." Cultural Futures Research, Vol. VIII (2); Winter. Revised edition: Journal of Social and Biological Structures, 14 (3):255-309, 1991.

Chafe, Wallace, 1970, Meaning and the Structure of Language. Chicago, University of Chicago Press.

Clement, Hal, 1974, "The Creation of Imaginary Beings," pp:259-277 in R. Bretnor, ed. Science Fiction, Today and Tomorrow. New York; Harper and Row, Publishers, Inc.

de Camp, L. Sprague, 1939, "Design for Life." Astounding Science Fiction, Vol.22 (3):103-115.

Douglas, Mary, 1975, "Jokes," pp. 90-114 in Mary Douglas, Ed. Implicit Meanings: Essays in Anthropology. London: Routledge and Kegan Paul.

Fox, Robin, 1979, "The Evolution of Mind: An Anthropological Approach." Journal of Anthropological Research, Vol. 35(2):138-156.

Frake, Charles O., 1962, "The Ethnographic Study of Cognitive Systems," pp:72-85 in Anthropology and Human Behavior, eds. T. Gladwin and W. C. Sturtevant. Washington, DC: Anthropological Society of Washington.

Freilich, Morris, 1975, "Myth, Method, and Madness." Current Anthropology, Vol. 16(2):207-226; Jun.

Gardner, Howard, 1985, The Mind's New Science: A history of the cognitive revolution. New York: Basic Books.

Gardner, Howard, 1983, Frames of Mind: The theory of multiple intelligences. New York: Basic Books.

Gardner, Martin, 1970a-d, "Mathematical Games." Scientific American, Vol. 223(10), Oct.; 1970b (11), Nov.; 1970c (12), Dec.; 1971a-d, 1971a Vol. 224 (1), Jan.; 1971b (2), Feb.; 1971c (3), Mar.; 1971d (4), Apr.

Harris, Marvin, 1974, "Why a Perfect Knowledge of All the Rules One Must Know to Act Like a Native Cannot Lead to the Knowledge of How Natives Act." Journal of Anthropological Research, Vol. 30(4):242-251, Winter.

Hockett, Charles F., 1960, "The Origin of Speech." Scientific American, September 1960.

Hoebel, E. Adamson, 1972, Anthropology: The Study of Man. Fourth Ed. New York; McGraw-Hill Book Company.

Hofstadter, Douglas R., 1979, Godel, Escher, Bach: An Eternal Golden Braid. New York; Basic Books, Inc., Publishers.

Hunter, David E. and **Phillip Whitten,** 1976, The Study of Anthropology. New York; Harper & Row, Publishers.

Jay, Anthony, 1971, The Corporation Man: Who he is, what he does, why his ancient tribal impulses dominate the life in the modern corporation. New York: Random House.

Jung, Carl Gustav, 1916, "Septem Sermones ad Mortem (Seven Sermons To The Dead)," in Memories, Dreams andReflections (1981 by C. G. Jung, recorded and edited by Aniela Jaffe). Rev. Ed. Appendix V, pp378-390. New York: Vintage Books.

Keali'inohomoku and **Joann Marie Wheeler,** 1975, Theory and Methods for an Anthropological Study of Dance. Doctoral Dissertation, Department of Anthropology, Indiana University, Bloomington, IN.

Kearney, Michael, 1984, World View. Novato, CA: Chandler & Sharp Publishers, Inc.

Kluckhohn, Clyde and **W. H. Kelly,** 1945, "The Concept of Culture" in Ralph Linton, Ed. The Science of Man in the World of Crisis. New York: Columbia University Press.

Kroeber, Alfred and **Clyde Kluckhohn,** 1952, Culture: A Critical review of concepts and definitions. Papers of the Peabody Museum of Archaeology and Ethnology, Harvard University, 47.

Leach, Edmund, 1954, Political Systems of Highland Burma: A study of Kachin social structure. Boston: Beacon Press.

Malinowski, B., 1922, Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea. London; Routledge & sons, Ltd.; New York: E.P.Dutton & Co.

Mandlebrot, Benoit B., 1977, Fractals: Form, Chance, and Dimension. San Francisco; W. H. Freeman and Company.

Maslow, Abraham H., 1971, The Further Reaches of Human Nature. New York: The Viking Press.

Maslow, Abraham H., 1970 (1954), Motivation and Personality. Second Edition. New York; Harper and Row, Publishers.

Miller, James Grier, 1978, Living Systems. New York; McGram-Hill Book Company.

Minsky, Marvin, 1985, "Communication with Alien Intelligence." BYTE, Vol. 10(4):127-138; Apr.

NOVA PBS, 1985, "The Shape of Things." First broadcast 02/19/85.

Petersen, Ivar, 1984a, "Ants in Labyrinths and other Fractal Excursions." Science News, Vol. 125(3):42-43; 21, Jan 84.

Petersen, Ivar, 1984b, "Super Problems for Supercomputers." Science News, Vol. 126(13):200-203; 29 Sep 84.

Piddock, Stuart, 1965, "The Potlatch System of the Southern Kwakiutl: A New Perspective," Southwestern Journal of Anthropological Research, Vol. 21:244-64.

Powers, William T., 1973, Behavior: The Control of Perception. Chicago; Aldine Publishing Company.

Raloff, Janet, 1982, "Computing for Art's Sake." Science News, Vol. 122(21):328-331; 20 Nov 82.

Riner, Reed D., 1986, "Re-reclassifying the Navajo Chantway Myths." First Annual Navajo Studies Conference, 20-22 Feb, Albuquerque, NM.

Science News, 1983, "Fractals for modeling ecosystems." Science News, Vol. 123(24):389; 11 Jun 83.

Science News, 1980, "Fractal Proteins." Science News, Vol. 180(18):281; 1 Nov 80.

Service, Elman R., 1978, Profiles in Ethnology, Third Edition. New York: Harper & Row, Publishers.

Spencer, Robert F. and **Jesse D. Jennings et al.,** 1977, The Native Americans, Second Ed. New York; Harper & Row, Publishers.

Spradley, 1980, Participant Observation. New York: Holt, Rinehart & Winston.

Spradley, 1979, The Ethnographic Interview. New York: Holt, Rinehart & Winston.

Suttles, Wayne, 1960, "Variation in Habitat and Culture on the Northwest Coast." Proceedings of the 34th International Congress of Americanists (1960); (Horn-Vienna, Austria: Verlag Ferdinand Berger, 1962).

Thompson, Beverly A. and **William A. Thompson,** 1985, "Inside Expert Systems." BYTE, Vol. 10(4):315-330; Apr.

Thomsen, Deitrick E., 1982, "A Place in the Sun for Fractals." Science News, Vol. 121(2):28,30; 9 Jan 82.

Thomsen, Deitrick E., 1980, "Making Music—Fractally." Science News, Vol. 117(2):187.190; 22 Mar 80.

Turnbull, Colin M., 1963, "The Lesssons of the Pygmies." Scientific American, Vol. 28(1); Jan 1963.

Vayda, Andrew P., 1961, "Economic Systems in Ecological Perspective: The Case of the Northwest Coast," in "A Re-examination of Northwest Coast Economic Systems." Transactions of the New York Academy of Sciences, Ser. II, Vol. 23(7):618-624; May.

Voegelin, Charles F. and **Florence M. Voegelin,** 1957, Hopi Domains: A Lexical Approach to the Problem of Selection. International Journal of American Linguistics, Memoir 14, Vol. 23(2), Pt. II.

Waldrop, M. Mitchell, 1985, Complexity: The emerging science at the edge of order and chaos. New York: Simon & Schuster.

Weick, Karl E., 1969, The Social Psychology of Organizing. Reading, MA; Addison-Wesley Publishing Company.

Weisenburd, 1985, "Fractals, Fractures and Faults." Science News, Vol. 127(18):279; 4 May 85.

Werner, Oswald, G. Mark Schoepfle et al., 1987, Systematic Fieldwork. Newbury Park, CA: Sage Publications.

World Futures Studies Federation Newsletter, 1985, (2):3-5, Summer.

SETI, Consilience, and the Unity of Knowledge

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ABSTRACT

E. O. Wilson's recent plea for employing consilience to achieve knowledge unification focuses on linking the biological and social sciences/humanities, yet admits to only minimal progress. If and when SETI succeeds in making contact with extraterrestrial civilizations, a comparative study of these could provide a means for overcoming current barriers to linking the natural and cultural realms, and thereby promote the unity of knowledge. Keywords: consilience, unity of knowledge, SETI, extraterrestrial civilization.

Forty years ago, the physicist-turned-novelist C. P. Snow published *The Two Cultures and the Scientific Revolution*,[1] in which he complained how intellectual life was increasingly being split between two cultures, that of the natural sciences and that of the literary disciplines. One of the main criticisms of Snow's work was not that he exaggerated the intellectual fragmentation of his day, but that he oversimplified it by focusing on literature to stand for all the humanities, and, above all, by ignoring the social sciences.[2] Recently the distinguished biologist Edward O. Wilson has revisited the gulf between academic cultures in *Consilience: The Unity of Knowledge*,[3] a book in which he makes an earnest plea for a return to the Enlightenment ideal of the unity of knowledge by building bridges across the divide between the natural sciences on the one hand, and the social sciences and humanities on other hand.

Consilience, the means Wilson chooses for working toward unity, is an obscure term coined in 1840 by William Whewell, a Victorian polymath who has also been credited with introducing, or at least popularizing, such better-known neologisms as *physicist* and *scientist*.[4] Wilson describes consilience as "literally a 'jumping-together' of knowledge by the linking of facts and fact-based theory across disciplines to create a common groundwork of explanation." He also quotes Whewell's more formal explanation: "The Consilience of Inductions takes place when an Induction, obtained from one class of facts, coincides with an Induction, obtained from another class of facts. This Consilience is a test of the truth of the theory in which it occurs."[5] As a "modest example" of consilience, Wilson offers his own work from the 1950s, in which he collaborated with a chemist and a mathematician to establish the chemical means by which ants communicate alarm signals.

To test the hypothesis that ants transmit the signals chemically rather than by sight or sound, Wilson first dissected freshly killed worker ants to obtain organs that might contain chemical releasers, now known as pheromones. He then presented the crushed organ tissue to groups of worker ants, and learned that two particular glands were active in the sense that the worker ants were galvanized into action by pheromones apparently released from the tissue. Wilson then recruited a chemist to analyze the extremely small organic samples that presumably contained the pheromones.

Using gas chromatography and mass spectrometry, the chemist identified the active substances as a medley of compounds. He then obtained samples of identical compounds that had been synthesized in the laboratory to guarantee their purity, and these were presented in minute quantities to the ants. That the same responses were obtained as in the first experiments confirmed that the compounds identified were the alarm pheromones. The next step was to involve a mathematician to construct physical models of the diffusion of the pheromone molecules, and then to use both the models and experiments to measure the rate of spread of the molecules and the sensitivity of the ants to them in order to establish with some certainty that workers release evaporated pheromones in order to communicate.[6] To Wilson,

reductionism is the cutting edge of science, involving "the breaking apart of nature into its natural constituents" and then the folding of "the laws and principles of each level of organization into those at more general, hence more fundamental, levels."[7] In isolating the pheromone compounds, and then tracing how these are diffused to transmit alarms, he and his colleagues were able to reduce the communicative behavior of ants to the molecular level, bringing it into the realm of physics and its laws.

Wilson considers that a high degree of consilience has been achieved only in the natural sciences, notably in physics, chemistry, and some branches of biology, and he points out that among these fields such hybrid domains of research as chemical physics, physical chemistry, molecular genetics, and chemical ecology are becoming commonplace. Although he laments that consilience has yet to link the natural sciences with the social sciences and humanities, he nonetheless views the boundary between them "not as a territorial line but as a broad and mostly unexplored terrain awaiting cooperative entry from both sides."[8] Given his previous work in advocating the new discipline of sociobiology, as well as the study of gene-culture coevolution,[9] it is not surprising that he believes that biology is best situated for bridging the gap between academic cultures:

We know that virtually all of human behavior is transmitted by culture. We also know that biology has an important effect on the origin of culture and its transmission. The question remaining is how biology and culture interact, and in particular how they interact across all societies to create the commonalties of human nature. What, in the final analysis, joins the deep, mostly genetic history of the species as a whole to the more recent cultural histories of its far-flung societies? That, in my opinion, is the nub of the relationship between the two cultures. It can be stated as a problem to be solved, the central problem of the social sciences and the humanities, and simultaneously one of the great remaining problems of the natural sciences.

In Wilson's view, since culture is created by the communal mind, and each mind in turn is the product of the genetically structured human brain, genes and culture are inseverably linked. Nonetheless, he admits that the exact ways genes and culture interact elude us. For instance, take the incest taboo prohibiting mating with close kin. Wilson highlights it as one of the best-documented instances of gene-culture interaction, but also as an example of how we do not yet fully understand that interaction. As anthropologists have long pointed out, this prohibition is a human universal that appears to have a natural basis, though one not necessarily mediated by a conscious realization that close-kin matings are more likely to result in unhealthy children. In careful studies that took advantage of natural experiments performed in different cultures in which unrelated boys and girls were regularly reared together from infancy, anthropologists have demonstrated that when these children mature they have no sexual interest in one another, resist being forced into marriage, and if so forced, have high adultery and divorce rates. Yet the physical basis for this aversion has yet to be discovered. Also, there remains to be answered the question of why, if there is a natural basis for avoiding close-kin mating, is there any need for explicit incest taboos. Furthermore, it is apparent that these taboos are culturally molded rules that vary widely from group to group in terms of the categories of kin included, and may even be reversed in some highly stratified cultures, such as those of ancient Hawaii and Egypt, in which elites were encouraged to mate with close kin, ideally full siblings.[10]

Not only is human gene-culture interaction proving to be difficult to unravel, but many humanists and social scientists object to what they call "reductionist" attempts to "biologize" human phenomena.[11] As adherents of Descartes' mind-body dualism, they regard culture as the superorganic product of the mind and not at all reducible to biology. In addition, some biologists charge that in the rush to link culture and biology, theorists err in regarding increasing complexity as inevitable, and in attempting to analyze cultural change in terms of Darwinian evolution.[12] Furthermore, attempts to find a biological basis for human behavior are also resisted on the grounds that such research leads to the labeling of certain races or classes as genetically inferior.[13]

At first glance, SETI (the Search for Extraterrestrial Intelligence) might not seem to have anything to do with employing consilience in the quest for knowledge unification. (Historians of science will also note that Whewell was a vigorous opponent of the "plurality of worlds" hypothesis.[14]) However, even though its technical roots are in physics and astronomy, and natural scientists have led its development, I argue that SETI has the potential for playing a major role in transcending intellectual boundaries.

Consider the primary question that SETI seeks to answer: Are there extraterrestrial civilizations? This is an old concern. Hypotheses about other populated worlds can be traced at least as far back as the Democritus, Lucretius, and other early thinkers.[15] Now, with radio SETI well underway, planet discoveries becoming almost routine, and new initiatives for detecting microbial life beyond Earth in the works, the scenario of cosmic evolution—from the Big Bang through the formation of galaxies, stars, and planets to the rise of life, complex life, and intelligence—has become what historian Steven Dick calls the "cosmological worldview" of our age.[16] That we can model such a grand evolutionary sequence, and also test parts of it, would have delighted the luminaries of the Enlightenment, for cosmic evolution links physical, biological, and cultural knowledge on a truly cosmic scale.

Whereas four decades ago Snow despaired that he could find no place where the two cultures meet, a decade ago I did not hesitate to claim that SETI is one field initiated and led by natural scientists that readily invites participation by specialists from the social sciences and humanities.[17] Since then a number of anthropologists, psychologists, sociologists, historians, philosophers, theologians, and others from across the cultural divide have participated in the SETI endeavor.[18] To be sure, they have primarily worked on such activities as examining the premises behind search strategies, considering methods for interpreting any messages received, developing procedures for breaking the news of contact, and formulating a reply, and have not been directly involved in designing search instruments and algorithms, and then actually conducting the search. Nevertheless, whatever the division of labor, this participation in SETI of specialists from disciplines scattered across the two intellectual cultures could be setting the stage for a grand experiment in consilience.

At the beginning of his book, Wilson notes that although astronomy, geology, and evolutionary biology are primarily historical disciplines linked by consilience to the rest of the natural sciences, human history stands apart as a branch of learning in its own right. "But," Wilson then rhetorically adds, "if ten thousand humanoid histories could be traced on ten thousand Earthlike planets, and from a comparative study of these histories empirical tests and principles evolved, historiography—the explanation of historical trends—would already be a natural science."[19] Although Wilson did not develop this idea, as an anthropologist sometimes involved with SETI I cannot resist exploring it further. Let us assume that during the 21st century, contact is made with a number of extraterrestrial civilizations occupying star systems arrayed around our own, and that through concerted efforts lasting many generations, if not centuries, meaningful communication is eventually established with at least some of these civilizations. This would not require that extraterrestrials be humanoid in the literal sense of the word, but only that there be sufficient convergence in intelligence, technology, and epistemology so that sharing of knowledge would be possible. We would then be in a position to learn about other biologies, societies, and cultures, as well as the ways extraterrestrials do science.

Such an endeavor would surely involve a wide array of specialists from a variety of disciplines, including new ones developed especially to meet the challenge of *learning* about extraterrestrials, as distinct from *detecting* them. Yet no matter how interdisciplinary this effort might be, it would have to go beyond the descriptive level if anything like the consilience Wilson calls for is to be achieved. To be sure, detailed descriptions of each civilization, natural/cultural histories if you will, would be valuable additions to any *Encyclopedia Galactica*, but without further analysis the real opportunity would be lost.

A science of civilizations is required, one that would compare and contrast a wide variety of independent cases in order to suggest hypotheses, which then could be multiply tested in order to investigate how diverse societies and cultures developed from their respective biological bases and how these in turn are linked to fundamental physical laws and principles. That might seem like a tall order for a species that is making such slow progress in unifying knowledge on its home planet. Yet one main reason for this may be simply that we are seriously handicapped by having only one case to study of the origin of life and then the development of complexity, intelligence, culture, consciousness, and all that. How far would the study of stellar evolution have proceeded if we could have investigated only our own star? Or the study of the planetary formation if Earth was the only planet we knew? We need extraterrestrial civilizations to introduce us to an array of possibilities and variations beyond our experience, and also to shock us out of such parochialisms as regarding ourselves as the summit and final goal of evolution, or resisting the exploration of links between human culture and

its biological roots. But would such a brave new metadiscipline be able to analyze dispassionately civilizations that might be repugnant to basic human values and experience?

Consider, for example, the possibility of encountering post-biological civilizations. Those who look forward to the day when humans will be replaced by immortal electronic machines would, of course, be delighted to learn from any civilizations composed of such creations—if they indeed exist. In contrast, most humanists, and—judging from Wilson's last sentence in *Consilience* wherein he warns against surrendering our genetic nature to "machine-aided ratiocination"—many biologists as well, would probably be repelled by machine ETs.[20] Just as anthropologists had to overcome ethnocentrism and adopt a stance of cultural relativism in order to study the myriad of human cultures and societies here on Earth, so may those who would dare to compare and contrast all nature of extraterrestrials have to be prepared to recognize and suspend their own biocentrism.

What about the shock of discovering extraterrestrials so far in advance of us that they seem godlike in their powers and intellect? When in the 1970s the Nobel laureates Wald, Ryle, and Lederberg warned that radio contact with advanced civilizations would devastate the human spirit, what they really seem to have had in mind was that learning all the secrets of nature from mature extraterrestrials would ruin the game for scientists.[21]

Such a view leaves out exobiologists, as well as adventurous anthropologists, political scientists, and other social scientists who would probably delight in having advanced civilizations to study, and perhaps also to assess as models, good and bad, for charting our own future development. Furthermore, those physical scientists willing to swallow their pride and undertake comparative science studies would be in a position to answer such fundamental questions as whether there is only one way of doing science or many. It could also turn out, as Konstantin Tsiolkovsky once optimistically suggested, that even if older extraterrestrials considered us young and childlike, they would nonetheless welcome us as newcomers who might bring to the community of advanced but jaded civilizations new solutions to the problems of existence.[22]

What if total consilience, which Wilson characterizes as the linking of all knowledge on the basis that "nature is organized by simple universal laws of physics to which all other laws and principles can eventually be reduced," proves to be an unattainable dream? He himself readily admits that consilience is a transcendental worldview rather than a science, and that it is probably an oversimplification and one day may even be proven to be wrong.[23] Perhaps, as many social scientists and humanists suspect, there are limits to the reductionism that has been so central to progress in the physical sciences. Although Wilson calls for multiple forays from both sides into the uncharted territory between the two cultures, he rejects entry by one of the main methodological contributions of social science, that of the holistic approach to sociocultural phenomena.[24] Yet at least one natural scientist also interested in unifying knowledge, Eric Chaisson, has pointed out that proposed research on cosmic evolution embodies a holistic approach that refreshingly contrasts with the myopic tendencies of reductionist science.[25]

Finally, what if all SETI efforts, from current radio and optical searches to future interstellar probes and piloted reconnaissance missions, fail to turn up any signs of advanced extraterrestrial life in our sector of the galaxy? However sobering such a discovery would be for cosmic evolutionists, those interested in human space expansion would certainly take the apparent absence of extraterrestrials in our galactic neighborhood as a green light for humanity's spreading throughout that region. Let us further imagine that through learning how to settle on and around various planets and smaller bodies of our solar system, and the development of powerful space drives and multigenerational spaceships, humans would eventually be able to migrate to nearby star systems and found viable communities there. Then frustrated would-be students of independently evolved extraterrestrials would have the opportunity to study how our descendants evolve culturally and biologically as they scatter through space.

Such an endeavor might not have all the cosmological glamour and consilient potential of a discipline devoted to analyzing autochthonous civilizations. But it would have the advantage of methodological control, for each new outpost would spring from the common biocultural base of terrestrial humanity. Moreover, it would also provide good practice for if and when extraterrestrials living elsewhere in the galaxy are eventually contacted.[26]

References

1. **Snow, C. P.** 1959. *The Two Cultures and the Scientific Revolution*. Cambridge: Cambridge University Press.

2. **Fallers, L.** 1961. "C. P. Snow and the Third Culture." *Bulletin of the Atomic Scientists* 17:306-310.

3. **Wilson, E. O.** 1998. *Consilience: The Unity of Knowledge*. New York: Random House.

4. **Whewell, W.** 1840. *The Philosophy of the Inductive Sciences*. London: Parker. **Simpson, J. A.** and **Weiner, E. S. C.** 1993. *The Oxford English Dictionary*. 2nd ed. Oxford: Clarendon Press, vol. 11:746, vol. 14:652.

5. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 8.

6. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, pp. 69-70.

7. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, pp. 64-65.

8. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 126.

9. **Wilson, E. O.** 1975. *Sociobiology: The New Synthesis*. Cambridge: Bellnap Press of Harvard University Press. **Lumsden, C. J.** and **Wilson, E. O**. 1981. *Genes, Mind, and Culture*. Cambridge: Harvard University Press.

10. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 173-180.

11. **Sahlins, M.** 1976. *The Uses and Abuse of Biology*. Ann Arbor: University of Michigan Press. **Betzig, L. L.** 1997. *Human Nature: A Critical Reader*. New York: Oxford University Press.

12. **Gould, S. J.** 1997. *Full House: The Spread of Excellence from Plato to Darwin*. New York: Three Rivers Press, pp. 167-175, 219-220.

13. **Herrnstein, R. J.** and **Murray, C.** 1994. *The Bell Curve: Intelligence and Class Structure in American Life*. New York: Free Press. **Jacoby, R.** and **Glauberman, N.** 1995. *The Bell Curve Debate*. New York: Times Book.

14. **Crowe, M. J.** 1986. *The Extraterrestrial Life Debate 1750-1900*. Cambridge: Cambridge University Press, pp. 265-299.

15. **Dick, S. J.** 1982. *Plurality of Worlds*. Cambridge: Cambridge University Press, pp. 6-13.

16. **Dick, S. J**. 1998. *Life on Other Worlds*. Cambridge University Press, pp. 261-273.

17. **Finney, B.** 1992. "SETI and the Two Terrestrial Cultures." *Acta Astronautica* 26:263-265.

18. **Billingham, J**., et al. 1999. *Social Implications of Detecting an Extraterrestrial Civilization*. Mountain View, California: SETI Institute.

19. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 11.

20. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 298.

21. **Finney, B.** 1990. "The Impact of Contact." *Acta Astronautica* 21:117-121.

22. **Lytkin, V.**, **Finney, B.,** and **Alepko, L.** 1995. "Tsiolkovsky, Russian Cosmism, and Extraterrestrial Intelligence." *Journal of the Royal Astronomical Society* 36:369-376.

23. **Wilson, E. O.** *Consilience: The Unity of Knowledge*, p. 55.

24. **Wallerstein, I.** 1996. *Open the Social Sciences: Report of the Gulbenkian Commission on the Restructuring of the Social Sciences.* Stanford: Stanford University Press.

25. **Chaisson, E. J.** 1997. "NASA's New Science Vision." *Science* 275:735.

26. **Finney, B.** and **Jones, E.** 1985. *Interstellar Migration and the Human Experience*. Berkeley: University of California Press.

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Cultural Aspects of Astrobiology

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ABSTRACT

Among the four operating principles of the NASA Astrobiology Roadmap, Principle 3 recognizes broad societal interest for the implications of astrobiology. Although several meetings have been convened in the past decade to discuss the implications of extraterrestrial intelligence, none has addressed the broader implications of astrobiology as now defined at NASA. Here we survey these societal questions, and argue that they deserve further serious study, in accordance with the National Aeronautics and Space Act of 1958. Astrobiology, already an interdisciplinary field in terms of the physical and biological sciences, should now embrace the humanities and the social and behavioral sciences in order to explore its cultural implications. Such study is part of the general need for better dialogue between science and society.

Justification for Study of Cultural Questions

Astrobiology, as defined within the NASA Astrobiology Roadmap (NASA, 1999), seeks to answer three fundamental questions: 1) How does life begin and evolve? 2) Does life exist elsewhere in the universe? and 3) What is life's future on Earth and beyond? Because the answers to these questions bear on fundamental human concerns, I argue here that NASA's Astrobiology Program, as well as exobiologists and bioastronomers in general, should address the cultural impact of their work. In doing so, they should encourage input from specialists in the humanities and the social and behavioral sciences.

It is important at the outset to define what we mean by "culture." For anthropologists, culture is "the total way of life of a discrete society—its religion, myths, art, technology, sports, and all the other systematic knowledge transmitted across generations." Put another way, "culture is a product; is historical; includes ideas, patterns, and values; is selective; is learned; is based upon symbols; and is an abstraction from behavior and the products of behavior" (Wilson, 1998, p. 130). According to Harvard biologist E. O. Wilson, each society creates culture, and is created by it. Our inquiry, then, is to determine the potential impact of astrobiology on this symbolic communal and evolving worldview that each society creates—a tall order indeed, but one that multidisciplinary study may systematically tackle in increments.

The study of the cultural impact of astrobiology is justified from many points of view. Primarily, it is an interesting and important problem that adds another dimension to astrobiology. It is well to remember that cosmic evolution does not end with astronomy or biology, but with culture; the evolution of human culture, and possibly cultures beyond the Earth, is not only part of cosmic evolution, but arguably the most interesting part. Such study is also entirely in keeping with the National Aeronautics and Space Act of 1958, in which one of the eight objectives of the U.S. space program is "the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes" (Logsdon, 1995). Though the Space Act has been amended many times, this objective has remained unchanged. It has also remained largely unfulfilled, aside from a NASA-sponsored Brookings Institution study (U. S. Congress, 1961), a NASA-sponsored study at Boston University (Berenzden, 1973), and a series of NASA workshops in 1991–1992 (Billingham et al., 1999). There is interest, however, both among the public

and at the highest levels of government, as evidenced by the Vice President's Space Science Symposium convened in December 1996 in the wake of the Mars rock, especially to discuss the cultural implications of that discovery (Lawler, 1996a, 1996b; Macilwain, 1996). We are thus faced with a golden opportunity. With the inauguration of NASA's Astrobiology Program, the time has come to focus on this objective once again.

One of the exciting aspects of astrobiology, and one of the features that distinguish it from the earlier exobiology program in NASA, is that the Astrobiology Roadmap recognizes the cultural dimensions of its work from the beginning. One of the groups at the Roadmap meeting formulated a "Question 7" in addition to the scientific questions: "How will astrobiology affect and interact with human societies and cultures?" The third of the four operating principles of the Roadmap "integral to the entire Astrobiology Program" states that "Astrobiology recognizes a broad societal interest in our subject, especially in areas such as the search for extraterrestrial life and the potential to engineer new life forms adapted to live on other worlds." This principle, as distinct from Principle 4 on education and public outreach, was presumably formulated with a view toward action, no less than the Roadmap's scientific aspects. In this paper we make a first reconnaissance of the scope of the cultural aspects of astrobiology as defined above, and issue a call for action.

Table I: Astrobiology Roadmap Questions and Their Cultural Implications

QUESTIONS	IMPLICATIONS				
Roadmap Scientific/ Representative Cultural	Philosophical	Ethical	Theological	General/Societal	
Q.1 Origin and Evolution of Life (Goals 1-4)					
Our Place in the History of Life	Schopf (1999)				
Nature of Life	Davies (1998)				
A Cosmic Imperative?	deDuve (1995)				
Chance and Necessity	Monod (1971)				
Q.2 Life in the Universe (Goals 5-8)					
A. Primitive					
B. Intelligent					
Contact	Davies (1995)	Ruse (1985)		Billingham et al (1999) Harrison (1997)	
Epistemology	Rescher (1985) Minsky (1985)				
Relation to God			McMullin (2000) Coyne (2000)		
Q.3 Future of Life on Earth and Beyond (Goals 9-10)					
Planetary Protection	Randolph, Race & McKay (1997)				
Environmental Change & Ecosystems					
Artificial Life/Bioengineering					
Terraforming		McKay (1990)			
Space Exploration				McCurdy (1997)	
Space Colonization					

POLICY

Astrobiology's Three Fundamental Questions and Their Implications

Although a good deal of thought has been given to the cultural impact of a successful SETI (Search for Extraterrestrial Intelligence) program, the impact of astrobiology, as encapsulated in its three fundamental questions, is much broader. In addition to intelligent life, we are interested in the quite different implications of microbial life and life that may be complex, but not intelligent. Moreover, astrobiology has a large historical dimension in that we are also interested in life's past, and it has a forward-looking dimension because we want to explore life's future—on Earth and beyond. These questions give astrobiology a breadth that exobiology never had, with correspondingly broader implications.

If we take each of the three questions in turn, and ask what the implications will be for society, we end up with an enormous two-dimensional matrix. Here we concentrate on only a small part of the matrix, the philosophical, ethical, and theological implications (Table I), which are also identified in the Table with each of the Astrobiology Roadmap Goals. These parts of the matrix, in my opinion, are particularly important because they form our worldview, and thus affect all other parts of society. Several aspects of this matrix merit emphasis: 1) The listing of representative studies indicates that some thought has been given to these issues; the point is that the entire problem has not been approached systematically. The study of the cultural implications of astrobiology is at a stage where exobiology was 40 years ago, with sporadic individual interest but little dialogue and thus little progress in the sense of systematic study. 2) We must recognize a third dimension to the matrix: different societies will be affected differently because they each have different cultures. Thus, the theological effects of contact with extraterrestrial intelligence would be very different for Chinese religions as contrasted with the Christianity embraced by much of the Western world. 3) An important feature of the matrix is the policy dimension: the study of cultural implications is not purely academic, but is undertaken with the idea of informing policy. For a national policy strategy, the matrix would be considerably smaller, but for global policy we can see the complexity involved. Thus we envision a very large three-dimensional matrix as the structure for our study, of which we address only a very small part in this paper.

Origin and Evolution of Life

Astrobiology's emphasis on the origin and evolution of life (Roadmap Goals 1-4) recalls the statement of T. H. Huxley in the context of Darwinism: "The question of questions for mankind—the problem which underlies all others, and is more deeply interesting than any other, is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things" (Huxley, 1863). Surely one of the overarching results of origin and evolution of life studies will be a better understanding of our temporal place in the history of life on Earth. Surely, the discovery of the ancient origins of life some 3.8 billion years ago has already had an effect on human culture, as has the demonstration that bacteria ruled the Earth for the vast majority of that period. The relatively recent rise of the genus *Homo*, much less *Homo sapiens*, surely has lessons for our worldview. Exactly what they are should be the subject of further research.

Aside from illuminating our place in nature, origin of life studies force us to ask further questions such as "What is life?" "Is there a cosmic imperative for life imbedded in the laws of Nature?" and "What is the role of chance and necessity in the origin and evolution of life?" Research on molecular biology has already produced considerable discussion on the latter (Monod, 1971), but the answer to this question and others will depend on which of the three or four theories of origin of life, or what combination of them, proves to be true (Davies, in press). Life arising from panspermia will have quite different implications than if it arose on Earth, whether in Darwin's warm pond, in hydrothermal vents, or in the hot deep biosphere (Gold, 1999). Scientists have been asking these questions for years; it is time to engage the broader scholarly world as well.

Life in the Universe

The question of life in the universe (Roadmap Goals 5-8) brings another set of concerns. In any discussion of the cultural implications of life in the universe, we immediately need to distinguish primitive from intelligent life. Given the history of life on Earth—ruled by bacteria for more than two billion years—we perhaps need to consider that the universe is full of bacteria. Anyone who thinks this has no implications for society should recall the reaction three years ago to the claim of Martian fossils. The media were full of speculations about their meaning; the Vice President specifically convened a seminar of experts

to discuss the societal implications, and funding was provided in no small part leading to the Origins and Astrobiology programs we have today. Undoubtedly part of the excitement had to do with the implications for the abundance of extraterrestrial intelligence, but the existence of extraterrestrial bacteria, possibly with their own biochemistries, would have its own set of implications. The cultural impact of primitive life, however, has received no serious study.

The impact of intelligent life, by contrast, has been the subject of much speculation, and some serious study. Different approaches to the long-term problems of contact have been explored by Almar (1995), Billingham et al. (1999), Dick (1995), Harrison (1997), and Tough (1991), among others. The short-term reaction in the event of contact has been discussed in considerable detail (Tarter and Michaud, 1990), and policy issues regarding a response to an extraterrestrial communication are under consideration (Michaud, 1998). The problem of objective knowledge, or "extraterrestrial epistemology," has been broached by Rescher (1985) and Minsky (1985), while Ruse (1985) and Randolph, Race, and McKay (1997) have outlined ethical considerations. Theological issues are coming more to the fore, and are discussed in Dick (1996, 1998, in press), Crowe (1986), Coyne (in press), McMullin (in press), and Peters (1994), among others. From this small sample, one can glimpse the scope of the problem of the cultural implications of extraterrestrial intelligence. Social scientists have only begun to think about how these problems might be addressed (Harrison, Billingham, Dick, et al., 1998).

One of the conclusions of the studies thus far is that the discovery of extraterrestrial intelligence will be very much scenario-dependent. Any serious study of the impact of extraterrestrial intelligence must categorize the types of contact; a very general categorization of scenarios as terrestrial or extraterrestrial, and direct or remote is given in Table II, together with examples from science fiction. Although terrestrial modes of contact are not currently in favor among most scientists, they are logical possibilities and the subject of both science (Bracewell, 1975; Tough, 1998) and science fiction. (There is also a considerable popular following in the case of UFOs and alien abductions). Direct extraterrestrial contact is also currently considered unlikely, but again the subject of much science fiction. Indirect contact by radio, optical, or other electromagnetic means is currently the favored scenario, and the one to which most attention has been given in terms of implications. But clearly each of the four types of contact would have its own set of implications for each of the elements in the cultural matrix. Even a brief consideration of the cultural implications of SETI demonstrates that the subject is complex, involving matrices embedded within matrices, but that these complexities may be approached systematically in discrete parts.

Table II: Modes of Contact with Extraterrestrial Intelligence (*and Some Representative Science Fiction Scenarios*)

	TERRESTRIAL	EXTRATERRESTRIAL
DIRECT	Wells, *War of the Worlds*	Clarke, *Rendevous with Rama**
	Clarke, *Childhood's End*	Bradbury, *Martian Chronicles*
	ET: The Extraterrestrial	Alien (and it's sequels)
INDIRECT	Clarke, *2001: A Space Odyssey**	Gunn, *The Listeners*
	McCollum, *Lifeprobe*	
	Hoyle, *The Black Cloud*	Sagan, *Contact**

* More than one mode of contact takes place

Future of Life on Earth and Beyond

The future of life on Earth and beyond, the subject of Roadmap Goals 9 and 10, has implications best known today in terms of planetary protection and the problems of contamination and back contamination. These indeed are important and have been given prominent attention because the problems are immediate, and the potential implications catastrophic. The ethical questions, however, have only begun to be explored (Randolph, Race, and McKay, 1997). Moreover, astrobiology's third question raises many other cultural issues. Moving beyond the planet may mean producing artificial life for bioengineering ecosystems, in its grandest vision known as *terraforming*. Probably in the lifetimes of our children, certainly in the 21st century, the issue of terraforming Mars will become real; it behooves us to begin to consider the philosophical, ethical, and broader cultural implications now. Similarly Goal 9's emphasis on the interplay of environmental change and ecosystems raises broad questions that society has already had to tackle. As McKay (1990, in press) points out, we may soon be faced with extending the principles of environmental ethics to Mars.

Movement off of planet Earth (Finney and Jones, 1984) also raises the entire spectrum of issues associated with space exploration, in terms of manned or unmanned, the problems and opportunities of space colonization, and societal spending priorities. Perhaps more than the other two questions, Question 3 raises the issue of where our species wants to go in its cultural evolution, and emphasizes that to a large extent human cultural evolution is in our own hands. I stress again that cultural evolution must be viewed as part of cosmic evolution; indeed it is indisputable that the pace of cultural evolution now rapidly outpaces biological evolution (though genetic engineering may change that in the future). An understanding of human cultural evolution is essential to understanding ourselves and our future, and it will be essential for mutual understanding in the event of extraterrestrial contact. Viewed as a part of cosmic evolution, cultural evolution fits squarely in the context of astrobiology and the famous "L" (lifetime of communicative civilizations) parameter of the Drake Equation. Indeed, many have pointed out that the number of communicative civilizations in our galaxy (N) approximates L; since L depends in large part on the success or failure of cultural evolution, an understanding of human cultural evolution is one of the few ways we have at present to study L and better determine N. The humanities and social sciences are in a position to make significant contributions to this study.

Approaches and Goals

Social scientists must ask how we can *systematically* approach these difficult questions, these questions of the "benefits, opportunities, and problems" of astrobiology, in the spirit of the National Aeronautics and Space Act of 1958 and in the interest of encouraging dialogue between science and society. Of course we cannot *predict* the short- or long-term implications of astrobiology. But is there any systematic way for at least discussing them? Given the fact that different scenarios imply different implications, let me suggest three approaches that might guide us in our thinking about implications.

First, we must make use of the humanities, for the humanities study the elements that drive cultural evolution. History may be seen as a vast set of social experiments, conducted under many conditions. Surely, the record of these experiments must be used in any assessment of the effect of astrobiology on human cultural evolution. As a start, we should ask what effect space exploration has had on human cultural evolution in the last 40 years (McCurdy, 1997). Next, we might ask how humans have reacted to particular ideas or events. The historical record of public reaction to past false alarms of extraterrestrial life, whether the canals of Mars, reaction to the Orson Welles broadcast of *War of the Worlds* in 1938, reaction to UFOs, the discovery of pulsars, and the now well-known history of extraterrestrial life debate (Crowe, 1986; Dick, 1982, 1996, 1998; Guthke, 1990), are among the events that should prove relevant. The idea of "life beyond Earth," whether termed exobiology, astrobiology, or bioastronomy, has exercised a peculiarly strong lure in American culture, a phenomenon that should itself be studied.

More generally the humanities provide us with analogues of possible futures. An analogue is no more than a model, a concept very successfully used in the natural sciences, less so in the humanities and social sciences. Astrobiologists do not hesitate to use, with caution, Antarctica and Lake Vostok as analogues to conditions on Mars and Europa, respectively. In the case of SETI, to take a well-known example of analogical reasoning, one hears a good deal about physical culture contacts on Earth. But most scientists in the SETI field think direct physical culture contacts are unlikely, though contact with an alien probe in the vicinity of Earth must be considered a logical possibility (Bracewell, 1975; Tough, 1998). In the typical radio SETI scenario, a simple "dial tone" would provide evidence of a technological civilization, while decoding a message would initiate intellectual contact. For the latter, a much better analogue in Earth history is the transmission of knowledge from the ancient Greeks to the Latin West via the Arabs in the 12th and 13th centuries (Dick, 1995), an event that led to the European Renaissance.

More generally still, I have argued elsewhere that the idea of a universe with abundant life constitutes a worldview, analogous to the Copernican and Darwinian worldviews. If one accepts the claim that the biological universe is very different from the physical universe, we can study what effect changing worldviews have had on society (Dick, 1995). Worldviews traverse various stages, from motivation to evidence to opposition and confirmation or rejection, and there are very rich studies in the history of science elaborating the short- and long-term implications of worldviews like Copernicanism or Darwinism. So the humanities offer a number of approaches to the cultural implications of astrobiology.

Secondly, aside from history and the humanities, one should use the tools of the social and behavioral sciences, which admittedly are not as robust as the natural sciences, but which should play a role in the multidisciplinary science that is astrobiology. If, as E. O. Wilson and others have argued, there is such a thing as gene-culture co-evolution, it offers a starting point for studying cultural evolution based on the natural sciences. If, as Dawkins (1976) has argued, the "meme" is the unit of cultural evolution equivalent to the gene in biology, human cultural evolution including movement off of planet Earth may be studied using this increasingly developed concept (Blackmore, 1999). Alternatively, Albert Harrison's recent book, *After Contact: The Human Response to Extraterrestrial Life* has led the way in showing how fields such as psychology, sociology, and anthropology can be used as an aid to thinking about implications of contact, an approach that may be generalized to astrobiology. In particular he advocates a kind of systems approach, called Living Systems Theory, in which what we know about organisms, societies, and supranational systems on Earth can be used to discuss the outer space analogues of aliens, alien civilizations, and the galactic club. Yet another approach envisions an "alien anthropologist," who could apply the tools of anthropology to the Earth from an alien perspective.

Third, in addition to the humanities and social sciences, human imagination, so colorfully rendered in science fiction literature, is a rich resource for studying the implications of astrobiology. Authors such as Arthur C. Clarke have given considerable thought to the consequences of contact in fictional form. *Childhood's End*, *Rendezvous with Rama*, and *2001: A Space Odyssey* all provide engaging explorations of different contact scenarios. Carl Sagan's *Contact* asks probing questions about the relation of science and religion. At the other extreme of extraterrestrial morality, we have the genre of H. G. Wells' *War of the Worlds*, *Aliens*, *Independence Day*, and *Starship Troopers*. Perhaps more realistically, Stanislaw Lem's *Solaris* is a haunting story of contact with intelligence beyond our understanding. On the issue of extraterrestrial contamination, Michael Crichton's *The Andromeda Strain* is a thought-provoking exercise. Other science fiction authors have explored extraterrestrial environmental ethics, terraforming, and the problems of space colonization. Although one can argue about which scenarios are more likely, there is an enormous database of thought in the best science fiction that should not be ignored.

Undoubtedly a group of interdisciplinary specialists would produce a more robust list of approaches to the cultural implications of astrobiology's three questions. Some may consider such study premature, since we do not yet know whether or not life exists beyond Earth, or when we will terraform planets or colonize outer space. But I think it fair to say the scientific consensus is that extraterrestrial life is likely, and that problems like terraforming and colonization will face us as real problems in the 21st century. As the anthropologist Ashley Montague said 25 years ago at the NASA-sponsored Symposium at Boston University, it is important that we think about the cultural impact of exobiology well in advance of the discovery of extraterrestrial life. With the increasing attention now given to astrobiology, that sentiment may be reiterated, and extended to all of astrobiology's broader implications.

Conclusions

In closing, I would argue that it is prudent and essential for the Astrobiology Program to support research on the implications of its work. The public supports NASA's Astrobiology Program with its tax dollars; it is interested in the implications of this research, which deserves nothing less than systematic study by experts from many fields. The need for study of the implications of science has been explicitly recognized, for example, in the Human Genome Project, which devotes 3-5% of its budget to ethical, legal, and social issues. While the genomic issues are admittedly more pressing, it may surely be argued that a small percentage of astrobiology funding should be allocated to studying cultural implications, in accordance with the National Aeronautics and Space Act of 1958.

The study of the cultural aspects of astrobiology, however, need not confine its hopes to the success of similar studies such as the Human Genome Project. As Finney argues in this volume, astrobiology is strategically placed at the boundaries between disciplines—whether of the natural sciences, the social sciences, or the humanities—and so is in a unique position to cultivate the unity of knowledge in the deep sense that E. O. Wilson has elaborated in his recent book *Consilience* (Wilson, 1998). Even if life is not discovered beyond the Earth, a fundamental role in bringing about the unity of knowledge would be a stunning success for astrobiology in the 21st century

and the third millennium. Exobiology has already brought together the physical and biological sciences in unprecedented cooperation. I urge NASA and the astrobiology/bioastronomy communities to broaden their interdisciplinary scope yet again, this time to the humanities and social sciences, and to take up the broader challenges sure to come as astrobiology moves forward with its scientific goals.

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REFERENCES

Almar, I. 1995, "The Consequences of a Discovery: Different Scenarios," in **G. Seth Shostak**, ed., *Progress in the Search for Extraterrestrial Life*, 499-505.

Berenzden, R. 1973, *Life Beyond Earth and the Mind of Man* (NASA: Washington, D.C.).

Billingham, J. *et al.* 1999, *Social Implications of the Detection of an Extraterrestrial Civilization* (SETI Press; Mountain View, Ca).

Blackmore, S. 1999, *The Meme Machine* (Oxford University Press, Oxford).

Bracewell, R. 1975, *The Galactic Club* (San Francisco), 69-83.

Coyne, G. 2000, "The Evolution of Intelligent Life on Earth and Possibly Elsewhere: Reflections from a Religious Tradition," in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and its Theological Implications* (Templeton Press).

Crowe, M. 1986, *The Extraterrestrial Life Debate, 1750-1900: The Idea of a Plurality of Worlds from Kant to Lowell* (Cambridge University Press, Cambridge).

Davies, P. 1995, *Are We Alone? Philosophical Implications of the Discovery of Extraterrestrial Life* (Basic Books, New York).

Davies, P. 1998, *The Fifth Miracle: The Search for the Origin of Life* (The Penguin Press, London).

Davies, P. 2000, "Biological Determinism, Information Theory and the Origin of Life" in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and Its Theological Implications* (Templeton Press, Philadelphia).

Dawkins, R. 1976, *The Selfish Gene* (Oxford University Press, Oxford).

De Duve, C. 1995, *Vital Dust: Life as a Cosmic Imperative* (Basic Books, New York).

Dick, Steven J. 1982. *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant* (Cambridge University Press, Cambridge).

Dick, S. J. 1995, "Consequences of Success in SETI: Lessons from the History of Science," in **G. Seth Shostak**, ed., *Progress in the Search for Extraterrestrial Life* (Astronomical Society of the Pacific, San Francisco), 521-532.

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

Dick, S. J. 1998, *Life on Other Worlds: The Twentieth Century Extraterrestrial Life Debate* (Cambridge University Press, Cambridge).

Dick, S. J. 2000, "Cosmotheology", in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and Its Theological Implications* (Templeton Press, Philadelphia).

Finney, B. and **E. M. Jones**, 1984, *Interstellar Migration and the Human Experience* (University of California Press, Berkeley).

Finney, B. This volume.

Gold, T. 1999, *The Hot Deep Biosphere* (Springer Verlag, New York).

Guthke, K. 1990, *The Last Frontier: Imagining Other Worlds from the Copernican Revolution to Modern Science Fiction* (Cornell University Press, Ithaca, N.Y.).

Harrison, A. 1997, *After Contact: The Human Response to Extraterrestrial Life* (Plenum, New York).

Harrison, A., **J. Billingham**, **S. J. Dick** *et al*. 1998, "The Role of Social Science in SETI." Paper prepared for the SETI Committee of the International Academy of Astronautics, Melbourne, published in this volume.

Huxley, T. H. 1863, *Man's Place in Nature* (London), 71.

Lawler, A. 1996a, "Building a Bridge Between the Big Bang and Biology," *Science*, 274 (8 November, 1996), 912.

Lawler, A. 1996b, "Origins Researchers Win Gore's Ear, Not Pocketbook," *Science*, 274 (20 December, 1996), 2003.

Logsdon, J. *et al*. 1995, *Exploring the Unknown: Selected Documents in the History of the U. S. Civil Space Program,* vol. I, "Organizing for Exploration," (NASA: Washington, DC).

Macilwain, C. 1996, "Goldin Wants More NASA Biologists as Gore is Briefed on Space Plans," *Nature*, 384 (19/26 December, 1996), 601.

McCurdy, H. 1997, *Space and the American Imagination* (Smithsonian Institution Press, Washington).

McKay, C. 1990, "Does Mars Have Rights? An Approach to the Environmental Ethics of Planetary Engineering," in *Moral Expertise*, ed. **D. MacNiven**, (Routledge: New York), 184-197.

McKay, C. 2000, "Astrobiology: The Search for Life Beyond the Earth," in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and Its Theological Implications* (Templeton Press, Philadelphia).

McMullin, E. 2000, "Life and Intelligence Far from Earth: Formulating Theological Issues," in **Steven J. Dick**, ed., *Many Worlds: The New Universe, Extraterrestrial Life and Its Theological Implications* (Templeton Press, Philadelphia).

Michaud, M. A. G. 1998, "Policy Issues in Communicating with ETI," *Space Policy*, 14, 173-178.

Minksy, M. 1985, "Why Intelligent Aliens Will Be Intelligible," in **Edward Regis, Jr**. ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 117-128.

Monod, J. 1971, *Chance and Necessity* (New York).

NASA, 1999, "Astrobiology Roadmap" (Ames Research Center, Moffet Field, CA).

Peters, T. 1994, "Exo-Theology: Speculations on Extra-Terrestrial Life," *Center for Theology and the Natural Sciences Bulletin*, vol. 14, no. 3, 1-9.

Randolph, R.; **M. Race**; and **C. McKay**, 1997, "Reconsidering the Theological and Ethical Implications of Extraterrestrial Life," *Center for Theology and Natural Sciences Bulletin*, vol. 17, no. 3, 1-8, Berkeley.

Rescher, N. 1985, "Extraterrestrial Science," in **Edward Regis, Jr.** ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 83-116.

Ruse, M., 1985, "Is Rape Wrong on Andromeda?" in **Edward Regis, Jr.** ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge University Press, Cambridge), 43-78.

Schopf, J. W. 1999, *The Cradle of Life* (Princeton University Press, Princeton).

Tarter, J. C. and **M. A. G. Michaud**, eds., 1990. "SETI Post-Detection Protocol," *Acta Astronautica*, 21 (February, 1990), 69-154.

Tough, A. 1991, *Crucial Questions About the Future* (Lanham, MD).

Tough, A. 1998, "Small Smart Interstellar Probes," *Journal of the British Interplanetary Society*, 51 (May, 1998), 167-174.

U.S. Congress, 1961. *Proposed Studies on the Implications of Peaceful Space Activities for Human Affairs,* a Report of the Committee on Science and Astronautics, U. S. House of Representatives, 87th Congress, First Session, prepared for NASA by the Brookings Institution (Washington: Government Printing Office).

Wilson, E. O. 1998, *Consilience: The Unity of Knowledge* (Knopf, New York).

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Speculations on the First Contact:
Encyclopedia Galactica or the Music of the Spheres?

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Introduction

The purpose of the Seminar on the Cultural Impact of Extraterrestrial Contact, sponsored by the Foundation For the Future, was the study of the long-term impact—for our terrestrial civilization—of a dialogue between humankind and a highly advanced extraterrestrial society. According to the organizers, humanity's interaction with other galactic civilizations will likely have a greater positive impact than almost any other event in the Third Millennium. Over the last 40 years, several speculations about the characteristics, contents, and social impact of the discovery of an extraterrestrial message were made by scientists and scholars all over the world.

Based on a hypothetical distribution of advanced technological civilizations in the galaxy, Sebastian von Hoerner (1961) estimated that the civilizations we will find will probably be much older than we are, and they will be more advanced. He considered that our chance of learning from them might be the most important incentive for our search. According to these ideas and due to the large interstellar distances, the extraterrestrial contacting signals would already contain high-information messages (including an introduction to a language). There might be some *speaking* and *listening*, but *mutual exchange* of knowledge would be rather limited because of the long time scale involved.

Shklovskii and Sagan (1966) and Sagan (1973, 1980) took all these original ideas and extended them into the concept of *Encyclopedia Galactica*. They imagined that a hypothetical network of civilizations in the galaxy compiled all the accumulated knowledge from each independent evolutionary history and put it at the disposal of the emerging technological societies. After the detection of an extraterrestrial message, they foresaw big technological gains, hints, and leads of extraordinary value. They speculated about all sorts of scientific and technological results, ranging from a valid picture of the past and future of the universe through theories of fundamental particles to whole new biologies. They also made conjectures that we might learn from the views of distant and venerable thinkers of the deepest values of conscious beings and their societies. Finally, the most speculative and seductive argument to pursue in the search for extraterrestrial signals is that we can obtain information that may help us to solve our political, social, or environmental global crises and thereby pass through our *technological adolescence*.

These dreams dominated the scientific and popular literature over the last 40 years, including most of the presentations made in this workshop. Very little discussion took place around the basic hypotheses behind these ideas.

The purpose of this essay is twofold: The first purpose is the introduction of restrictions to some of the original hypotheses about the technological characteristics and intentions of the extraterrestrial civilizations. The second is the construction of different communication scenarios, based on the inclusion of ethical and artistic *universal* principles.

To do that, we will analyze the proposed characteristics of the extraterrestrial supercivilizations that would have the hypothetical capability to send interstellar messages with high-information content. We will present a series of arguments to reject the concept of advanced civilizations transmitting omnidirectional signals in a full-time mode. In this way, we will place a limit on the detectability of these high-information messages. Then we will comment on the life expectancy of our contemporary terrestrial civilization, with special emphasis on the consequences generated during the last 50 years of the nuclear era. The present state of the planet Earth and the long

violent human history create an urgent need for a deep and strong ethical, societal mutation. Otherwise, our species will become extinct.

All technological civilizations that already have passed through their technological adolescence, and have avoided their self-destruction (by misuse of advanced technologies or by environmental degradation of their home planet), must have developed ethical rules to extend their societal life expectancy. In doing so, they must have learned how to respect the natural evolutionary times of other beings in the universe. To build this scenario, we will introduce the concept of *Lex Galactica*, based in Kantian ethical principles, as hypothetical guidelines for advanced civilizations in how to contact emerging societies. If the advanced galactic civilizations are unable to check the level of technical and ethical evolution of the possible recipients of their signals, they will be unable to send high-information-content messages due to the *Lex Galactica*. Using these alternative boundary conditions, we will discuss different contact scenarios and their possible message characteristics. We will consider the possibility that the first message from an advanced technological society would include some extraterrestrial artistic manifestation.

Hypothetical Characteristics of Advanced Extraterrestrial Civilizations

In order to provide a frame of reference around which we can develop different contact scenarios, according to the technological and cultural levels of development of extraterrestrial civilizations, we will make a short review of the scientific literature on this topic. In 1964, the soviet scientist N. S. Kardashev established a general criterion regarding the types of activities of extraterrestrial civilizations that can be detected at our present level of development. The most general parameters of these activities are apparently ultrapowerful energy sources, harnessing of enormous solid masses, and transmission of large quantities of information of different kinds through space. According to Kardashev, the first two parameters are prerequisite for any activity of a *supercivilization*. He suggested the following classification of energetically extravagant civilizations:

TYPE 1: a level "near" the contemporary terrestrial civilization with an energy capability equivalent to the solar insulation on Earth (between 10^{16} and 10^{17} Watts).

TYPE 2: a civilization capable of using and channeling the entire radiation output of its parent star. The energy utilization would then be comparable to the luminosity of our Sun, about 4×10^{26} Watts.

TYPE 3: a civilization with access to power comparable to the luminosity of the entire Milky Way Galaxy, 4×10^{37} Watts.

Kardashev also examined the possibilities in cosmic communication, which attend the investment of most of the available power into communication. A Type 2 civilization could transmit the contents of 100,000 average-sized books across the galaxy in a total transmitting time of 100 seconds. The transmission of the same information to a target ten million light-years distant—a typical intergalactic distance—would take a transmission time of a few weeks. A Type 3 civilization could transmit the same information over a distance of ten billion light-years, approximately the radius of the observable universe, with a transmission time of three seconds.

Sagan (1973) considered that Kardashev's classification should be completed using decimal numbers to indicate a difference of one order of magnitude in energy consumption. For example, a civilization *Type 1.7* expends 10^{23} Watts, while a civilization *Type 2.3* expends 10^{29} Watts. Sagan also suggested that, in order to be more accurate, a letter could indicate the societal information level (degree of their accumulated knowledge). According to Sagan, a Class A civilization will have 10^6 bits of information; a Class B, 10^7 bits; a Class C, 10^8 bits; and so on. Under this classification, our terrestrial civilization is *Type 0.7 H*. According to Sagan (1973), the level of the first extraterrestrial civilization that could make contact with us would be between *1.5 J* and *1.8 K*. A galactic supercivilization would be *Type 3 Q*, while a hypothetical civilization with the capacity to control a federation of galaxies would be *Type 4 Z*.

Dyson (1959, 1966) used the same hypothesis of infinite exponential expansion of technological progress and energy consumption. Instead of receiving large amounts of information by interstellar messages, he proposed to detect evidences of astroengineering technological activities. He proposed a search for huge artificial biospheres created around a central star by an intelligent species as part of its technological growth and expansion within a planetary system. This giant structure would most likely be formed by a swarm of artificial habitats and miniplanets capable of intercepting essentially all the radiant energy from the parent star. This would be

one of the typical limits to a Kardashev Type 2 civilization.

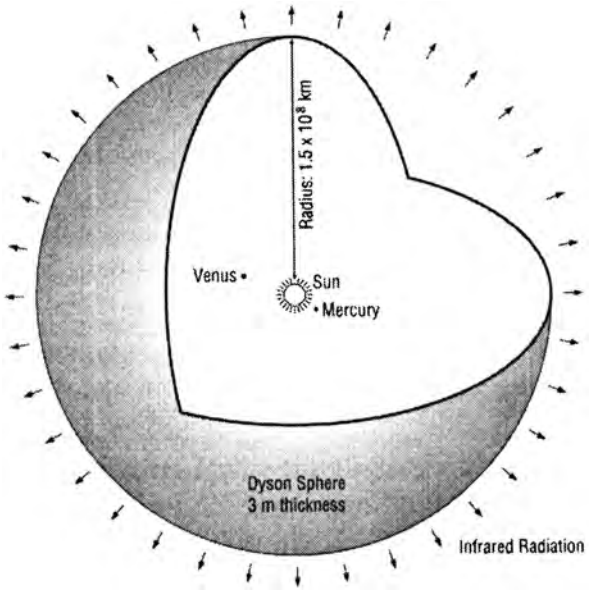

Figure 1: In 1959, Freeman Dyson suggested that very advanced civilizations, bound only by the presently known laws of physics, may surround their parent star with spherical shells made from dismantled planets. A representation of this idea applied to our solar system, using the mass of Jupiter to form a sphere at one astronomical unit from the Sun is shown in the figure. From Lemarchand (1994) ©*SETIQuest*.

According to Dyson, the mass of a planet like Jupiter could be used to construct an immense shell, which could surround the central star and have a radius of one astronomical unit. This kind of object—known as a *Dyson Sphere*[1]—would be a very powerful source of infrared radiation. Dyson predicted the peak of the radiation at 10 μm. Several searches for this kind of objects were carried out unsuccessfully during the past 30 years.

Another characteristic feature analyzed by von Hoerner (1961), Kardashev (1964), Sagan (1973, 1980), and others is that communication among galactic civilizations would be one-way only. This is due to the large propagation time of electromagnetic signals across interstellar (civilizations Type 1 or 2) or intergalactic (civilizations Type 3) distances. Under these conditions, with signal propagation times greatly exceeding the characteristic evolutionary lifetime of the transmitting civilization, exchange of questions and answers among galactic partners will be practically impossible. For Kardashev and Sagan, the transmission should carry the maximum amount of information—each side transmitting its entire knowledge at once. This is the historical reason why most people believe that the detection of an extraterrestrial intelligence signal will automatically imply the existence of a huge message with all sorts of practical knowledge for our society to consume.

Sagan (1974) put it in these words: "The most likely reason for us to use radio if alternative, more efficient means exist is this: the more advanced civilizations are looking for the dumb, emerging technical societies and seeking to give them information that may help them make their $L^{(2)}$ a large number."

But can we really believe that any of these hypothetical Type 2 or 3 civilizations are really transmitting all their knowledge in a full-time and omnidirectional mode using electromagnetic means to certain unknown emerging societies…employing energies equivalent to the total outputs of a star or a galaxy…giving the recipient civilizations very advanced knowledge without any information about their evolutionary and ethical stages…knowing that this hypothetical "practical information" could put in danger the very existence of the recipients when the new knowledge is used without adequate ethical controls?

In the following sections, I will try to show that if any of these advanced galactic societies really exist, they would never send any high-information message without knowing the societal evolutionary stage of the recipients. Before going to that particular point, let me say why these hypothetical Type 2 or Type 3 civilizations may not exist, or—if they do exist—would have a very different profile to the one described by Kardashev and others.

The arguments against the existence of Type 2 and Type 3 civilizations are the following:

1. Transmitting Strategy Arguments: Far-reaching, omnidirectional beacons are extremely energy consuming. No good arguments have ever been put forward to explain why a Type 2 or 3 civilization should not make use of the enormous economic advantage of using directional and intermittent emission beamed successively towards each target star.

1. The concept of this extraterrestrial construction was first described in 1937 in the science fiction novel *Star Maker* by Olaf Stapledon.

2. Here L indicates the lifetime of a civilization in years. This number is generally used as a factor of the Drake Equation.

2. Limits to Growth: Between the late 1950s and the early 1970s, the developed societies of planet Earth experienced an exponential growth in most of their technoeconomical indicators (Maddison, 1991 and 1995). In this societal environment, the scientific community had a sense that there were no limits to growth, and therefore, the contact scenarios proposed in the scientific literature[3] were developed using these assumptions. In the early 1970s, due to the publication of the first world models by Meadows and Meadows (1972), Mesarovic and Pestel (1974), and several others (see review by Bruckman et al., 1982), all these images were shifted into the opposite direction. Taking into account these new elements to understand the very long-term dynamics of societal systems, Kardashev's implicit assumption of exponential energy consumption growth is probably wrong. If we analyze the energy consumption per capita over the whole human history, we will find that it follows a succession of logistic-type curves with a saturation niche for each technology of energy production. From my personal point of view, a realistic scenario of the very-long-term evolution of the energy consumption of technological civilizations must consider these constraints. Those civilizations with very long lifetimes—and interest in interstellar communication—will have reached a saturation niche of energy production and consumption that will be in harmony with their own environment and societal needs. Under these circumstances, a steady state or a very low energy consumption growth should be expected. For an advanced society, the steady state niche would remain stable during periods comparable with the society's lifetime.

3. Delta *t* Estimator Argument: If whatever we are measuring can be observed only in the interval between times t_{begin} and t_{end}, if there is nothing special about t_{now} we expect t_{now} to be located randomly in this interval. Gott (1993) showed how to estimate t_{future} with a 95% confidence level as $[(1/39)\ t_{past} < t_{future} < 39\ t_{past}]$. This equation tells us that the length of time something has been observable in the past is a rough measure of its robustness not only against the calamities of the past, but also against whatever calamities may affect its observability in the future. All that is required for this equation to work is that in the end, our position as an observer turns out not to have been special. Sagan and Shklovskii (1966) defined this effect as the *Principle of Mediocrity.*[4] Using this *Delta t* argument, Gott established that space colonization is not an important factor in the sense that galactic colonists and their descendants must not dominate the numbers of intelligent observers in the universe. In this context, civilizations significantly larger than our own must be sufficiently rare that their individuals do not dominate the total. Thus, we do not expect to see a Dyson sphere civilization within our galaxy, or a Kardashev Type 3 civilization within the current observable universe's horizon.

4. Experimental Facts: Recent full-sky surveys for ultra-narrowband microwave signals at a preferred hydrogen frequency (e.g., $\nu = 1.42$ GHz) would be detectable out to 22 megaparsecs, within which there are something like 10^{14} stars. Unfortunately, no supercivilization was detected by any of the META sky-surveys at Harvard and Buenos Aires (Horowitz and Sagan, 1993; Lemarchand et al., 1997). These experiments ruled out the hypothesis of a civilization Type 2 or 3 transmitting omnidirectional, electromagnetic messages in a full-time dedicated mode at $\nu = 1.42$ GHz, within a sphere of approximately 70 million light-years. We can conclude that there are no such civilizations in the Milky Way; nor in M31, the nearest galaxy like our own; nor in M33 or M81 or the Whirlpool Nebula or Centaurus A; nor the Virgo cluster of galaxies.

Is There Intelligent Life on Earth? Earthlings as Members of a Technological Adolescent Society

Carl Sagan (1973, 1980) called attention to the fact that our civilization—for the first time in its evolutionary history—has the technological capability to destroy itself. He metaphorically defined this particular period as *technological adolescence*. Our civilization could collapse due to the failure to solve our

3. For example, Sagan (1974) used these words: "...However, an expanding technology would seem to be characterized by increasing energy consumption. This is indeed a major aspect of the current environmental crisis. The expanding technology of a civilization much in advance of ourselves would be able to channel enormous amounts of energy into interstellar communication."

4. The *Principle of Mediocrity* is an extension of the *Copernican Principle*, where it is established that the Earth does not occupy a privileged position in the universe. Darwin established, in terms of the natural selection mechanism, that we are not privileged above other species. Our position around an ordinary star in an ordinary galaxy in an ordinary supercluster continues to look less and less special.

mutual aggressions (e.g., human maldevelopment, arms race, population explosion, starvation, global warning, ozone depletion, etc.). If most of the galactic civilizations fail in their pass through this evolutionary path, the possibility of making contact among them would be negligible. Herein, we will develop a brief description of one of the most dangerous planetary challenges: the military arms race.

Lewis F. Richardson (1881-1953), British meteorologist and founder of mathematical sociology, conducted an interesting study about the temporal distribution of deaths caused by interhuman violent events (from individual murders to world wars). The results of the study were published posthumously in *Statistics of Deadly Quarrels* (1960). Using data from 1820 to 1945, he found that the historical statistics could be explained by a simple mathematical power law. The extrapolation of this distribution shows that if humankind does not make a deep change in its social behavior to eliminate violence, humankind will disappear in less than a thousand years. Unfortunately, the evolution of technologies of mass destruction (nuclear and biological arms) has dropped the curve to a shorter horizon of 100 years or so. Figure 2 shows an account of these findings.

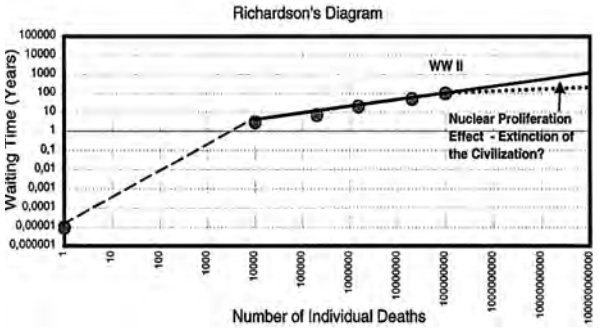

Figure 2: Richardson's diagram of the distribution of deaths caused by interhuman violent events (from individual murders to world wars). The data may be explained by a mathematical power law. The extrapolation indicates that if we do not change our social behavior, we will disappear as a civilization in the next thousand years. Due to the spreading of nuclear and biological mass destruction arms, this temporal horizon was shortened to only 100 years. The time scale goes from 30 seconds to 100,000 years, while the number of deaths rises from 1 to 10^{10}. Cohen (1995) estimated Earth's maximum Human Carrying Capacity between 3×10^9 and 4×10^{10} inhabitants. A very interesting result, found by Gott (1993), shows that the extraterrestrial civilization populations would have the same size as the terrestrial one.

From an evolutionary point of view, if our society does not start generating a strong and deep *mutation* in its social and environmental attitudes, its life expectancy is something between 30 and a thousand years. This is a very short time to exchange information and wisdom across interstellar distances by electromagnetic means.

Is there intelligent life on Earth? A short look to human history shows that the largest organized human efforts so far have always been self-destructive. The worst example was the nuclear arms race that took place during the Cold War. Figure 3 shows the evolution of the destructive power of nuclear arsenals in the United States and the former USSR/Russia after World War II. The destructive power is expressed in millions of TNT tons or megatons (MT). During the 1970s, we reached the absurd and irresponsible value of 25,000 MT. For comparison, all of the shells, missiles, and bombs (including the atomic bombs of Hiroshima and Nagasaki) used in World War II had only 3 MT. An estimate was developed of how much destructive power would be needed for a second-strike capability, or Mutual Assured Destruction (MAD), which means that each country, after having been fully attacked by the enemy, could strike back and successfully destroy the enemy. The level of 400 MT was the size of retaliatory force estimated to achieve MAD's level required for deterrence (Levi, 1983).

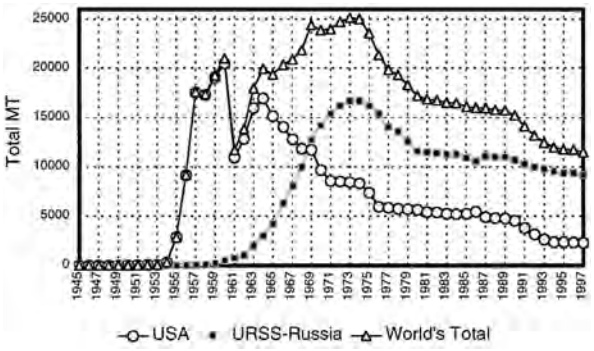

Figure 3: Evolution of the destructive power of nuclear arsenals in the United States and the former USSR/Russia after World War II, expressed in millions of TNT tons (megatons). From Lemarchand, based on data published over several years by *The Bulletin of Atomic Scientists* and *SIPRI Yearbook*.

Using the data of the total nuclear destructive power provided in Figure 3 and the evolution of the population on planet Earth during the period 1954-1997, we built a new indicator: *the destructive power per each living person*. Figure 4 shows the nuclear destructive power in tons of dynamite for every individual human.

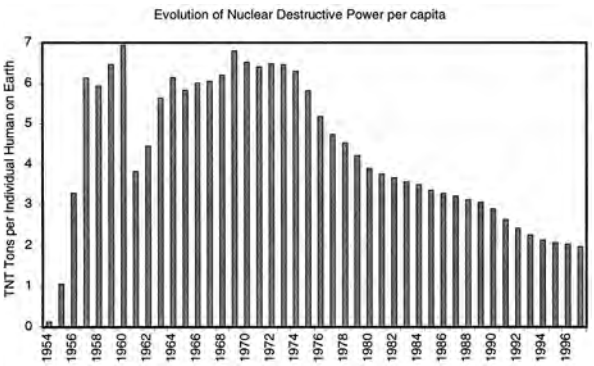

Figure 4: Nuclear destructive power per capita on planet Earth. The indicator is expressed in tons of dynamite per individual living person. It shows a decrease from almost 7,000 kg of dynamite per capita in 1969 to 2,000 kg in 1997. From Lemarchand, based on data published over several years in *The Bulletin of Atomic Scientists*, *SIPRI Yearbook*, and Maddison (1995).

Table I shows the geographical distribution of military expenditures, expressed in 1995 constant dollars, as a good measure of human aggression—although we usually call it "defense." World military expenditure is still declining, but the rate of decline is slowing down. Estimates of world totals indicate that the rate of decline was less than 1% in real terms in 1997, compared to an average annual reduction of 2.5% during 1993–1997. Military expenditures in 1997 corresponded on average to 2.6% of the world's gross national product and $125 per capita.

The waste of human, technological, and economic resources in military activities is not the only evidence against intelligent life on Earth. A few other shocking examples are the following: more than one billion persons live in absolute poverty (three times the European Community's population); more than 100 million have no shelter; 950 million are chronically malnourished; more than 900 million are unable to read or write; a third of the whole planet's population does not have access to safe water (two billion people); more than 800 million are starving every day; 150 million children under age five have malnutrition; the 20% of the world's population that live in the most-developed countries control 90% of the total world's gross national product. As a consequence of irresponsible human activities, we have also generated environmental degradation, greenhouse effect, ozone depletion, etc.

Geographical Regions	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
World Total	1066.0	1047.0	1003.0	887.0	810.0	779.0	756.0	716.0	708.0	704.0
Africa	12.6	13.3	12.3	11.2	10.6	10.7	9.7	9.2	9.4	8.8
Americas	410.0	405.0	386.0	338.0	358.0	342.0	325.0	309.0	295.0	290.0
North America	390.0	385.0	369.0	325.0	342.0	325.0	307.0	289.0	273.0	268.0
Central America	0.8	0.8	0.9	0.6	0.6	0.6	0.6	0.6	0.5	0.5
South America	19.2	18.9	16.0	12.1	15.3	16.5	16.6	19.6	21.2	21.9
Asia (excluding Central Asia)	95.0	99.5	102.0	105.0	108.0	110.0	112.0	115.0	119.0	120.0
Europe	500.0	483.0	447.0	360.0	279.0	265.0	259.0	235.0	235.0	234.0
Middle East (excluding Iraq)	39.6	36.9	47.0	64.2	45.0	42.1	41.2	38.5	42.1	43.3
Oceania	8.9	8.8	8.8	8.8	9.1	8.9	9.2	8.9	8.7	8.8

Table I: Military expenditure by region. The figures are in billion U.S. dollars at constant 1995 exchange rates. From *SIPRI Yearbook* 1998, p. 214.

According to the conclusion of seven world models (Bruckman et al., 1982), there is no known physical or technical reason why basic needs cannot be supplied for all the world's people into the foreseeable future. These needs are not being met now because of social and political structures, values, norms, and worldviews—not because of absolute physical scarcities. Continuing "business as usual" policies through the next few decades will not lead to a desirable future—or even to meeting basic human needs. It will result in an increasing gap between the rich and the poor, problems with resource availability, environmental destruction, and worsening economic conditions for most people.

Finally, the vital arena to understand in order to work on almost any global problem is that of values; goals; and individual, social, and political will: why people are what they are and make the decisions they make, and especially, how such things can be changed.

I do not think we should be very proud in communicating these truths about planet Earth to our galactic fellows. Obviously, we have many things to be solved on our home planet before dreaming of becoming a member of any hypothetical *Galactic Club*. On the other hand, it is utopian to think that the extraterrestrials would tell us their recipes on how we should solve these and other main "local" problems. Our species is responsible for them and it is our duty to solve them. We must not look into the sky for answers to the problems we have here in front of our eyes.

From Kantian Ethics to Lex Galactica

If most of the galactic societies have a similar destructive evolutionary trajectory, the number of communicative civilizations will be very small. If the metaphor of *technological adolescence* is correct, we may consider that we are living in a very particular moment of our civilization's history when we may

start our self-destruction. In order to avoid it, our species must make a deep transformation of human individual behavior in three main aspects,[5] which are *Intra-individual* or *Somatic, Interindividual* or *Social*, and *Exosocial* or *Habital*.[6]

In order to improve the lifetime of a technological civilization, it is impossible to have superior science and technology, and inferior morals. This combination is dynamically unstable and we can guarantee self-destruction within the lifetimes of advanced societies (10^5 to 10^6 years?). At some point, in order to avoid their self-destruction, all intelligent species in the universe must produce this ethical breakthrough among the members of their societies in order to achieve harmony in their planetary environment. Otherwise, the probability of global extinction would be very high and consequently their societal life expectancy would be very short. What kind of ethical principles should guide this transformation or *social mutation?* We consider that Kantian ethics provides some good elements to start the discussion.

Kant's outstanding contribution to moral philosophy was to develop with great complexity the thesis that moral judgments are expressions of practical, as distinct from theoretical, reason. For Kant, practical reason or the rational will does not derive its principles of actions by examples from the senses or from theoretical reason; it somehow finds its principles within its own rational nature. Kant argued that willing is truly autonomous if, but only if, the principles that we will are capable of being made universal laws. Such principles give rise to *categorical imperatives,*[7] or duties binding unconditionally, as distinct from hypothetical imperatives, or commands of reason binding in certain conditions that we desire for certain ends. Kant seemed to hold that *universalizability* is both necessary and sufficient for moral rightness. Kant arrived at the ideal of "the kingdom of ends in themselves" or of people respecting each other's universalizing wills. This has been an enormously influential idea, and its most distinguished recent exponent has been John Rawls (1980).

The exploration and development of ideas related to ethical principles regarding cultures beyond the Earth is in its childhood. Only Fasan (1970), Lupisella and Logsdon (1997), Narveson (1985), and Ruse (1985) have presented some speculations in these directions.

My thesis is that all the civilizations should evolve ethically at the same time they evolve technologically. When these civilizations reach their technological adolescent stage, they must perform the *societal mutation* or become extinct. After learning how to reach a synergetic harmony among the individual members, their groups and their habitat, they would extend this *praxis* to the rest of living beings, including their hypothetical galactic neighbors. Their own evolutionary history will teach them the Kantian principle of respecting each other's universalizing wills. Being aware that each planetary evolutionary path is unique, these advanced civilizations will have a noninterference policy with the evolutionary process of underdeveloped societies. This galactic quarantine hypothesis—based in Kantian ethics—is defined here as *Lex Galactica*.

Some useful ideas in the direction of the evolution of societal ethical stages—applied to the study of several terrestrial cultures—were developed originally by Piaget (1971) and extended by Kohlberg (1973). In his pioneer works, Kohlberg established a correspondence between Piaget's cognitive evolutionary stages and his moral judgment stages. According to his view, the final ethical evolutionary stage is based on "universal principles." Besides the formal criticism that these ideas received by other scholars (Carracedo, 1989), I consider that these are good starting approaches for the exploration of our speculations about the concept of *Lex Galactica*.

If the *Lex Galactica* principle is used, we might expect that very limited amounts of practical information would be available for emerging societies to consume. Obviously, we can expect great exchange of information between advanced civilizations at the same level of development. Those civilizations with large lifetimes can establish dialogues with interstellar partners and evaluate which kind of information can be shared with each civilization.

Earthlings' electromagnetic transmissions have revealed their existence to the universe only within a sphere of approximately 70 light-years around the Sun.[8] Distant advanced societies will be unable to recognize that some primitive intelligent life is around our Sun, and consequently they will be

5. For a complete description of these aspects see C.A. Mallmann, "On Human Development, Life Stages and Needs Systems" in F. Mayor (Ed.), *Human Development in Its Social Context*, UNESCO, Paris, 1986.

6. Here we use the word "*Habital*" in reference to the concept of *Habitat*.

7. In its most famous formulation, a categorial imperative states that "the *maxim* implied by a proposed action must be such that one can will that it become a universal law of nature."

unable to "calibrate" our technological and ethical evolutionary level to start sending their "knowledge" to us. As shown in the previous section, access to technologies thousands of years more advanced than our present ones could cause our self-destruction if those technologies become available to terrorists or other deranged leaders. These advanced civilizations would not want to place potentially destructive knowledge at the disposal of any "ethically underdeveloped" society. Such knowledge could be a threat to the emerging society's survival. Any civilization needs time to work out adequate moral restraints on its own behavior.

Message Contents: Encyclopedia Galactica or the Music of the Spheres?

Based on the arguments presented in the previous section, if there is something resembling Sagan's concept of *Encyclopedia Galactica*, it would probably be encrypted in such a way as to allow detection only by the ethically more advanced civilizations, those civilizations that already know how to be responsible with the power of knowledge and high technology. To avoid detection by the emerging societies, they will probably use exotic technologies, based in subtle, unknown—to us—laws of nature (Lemarchand, 1992, 1994, and 1997). In any case, these advanced civilizations will be totally "transparent" for us.

A different possibility is the case in which advanced civilizations might try to contact emerging civilizations by sending only beacon signals: a typical artificial signal, very easy to recognize among the galactic cacophony, but without any message or content. This signal will attract our attention and will let us introduce ourselves to this unknown galactic partner. In this way, the extraterrestrials will have a chance to calibrate our technological and ethical development. In a second run, they could send practical knowledge according to our needs, using the Kantian ethical principles or *Lex Galactica*.

We can also include, in the last group, those nearby advanced civilizations that are within a sphere of 70 light-years and have already detected us by our military and planetary radar signals, TV carriers, etc. They will probably have devices with the sensitivity needed to decode our weakest signals and obtain more information about us. Again, their transmissions will be designed specifically for our needs.

Finally, these advanced societies could use a different approach to call our attention. Instead of sending hundreds of Terabits of scientific and technical knowledge, they could send us some manifestations of their artistic production.[9] For example, some piece of their "Music of the Spheres" or some images of their pictorial arts. Would it be possible for us to get a correct interpretation of these art creations? (Lewis, 1972; von Hoerner, 1974; *The New York Times*, 1989; Lemarchand and Lomberg, 1996; Vakoch, 1999). An attempt to send not only a beacon signal, but also a "compact" of art productions could be an interesting solution to the limitations imposed by *Lex Galactica*. Of course this should also be done in a delicate way in order not to generate a deep cultural shock to the recipient society by sending them complete art galleries. A few manifestations will be enough to initiate "conversations."

It has been shown that there are several patterns in art and nature that can be considered as universal as mathematics for their employment in interstellar communication attempts (von Hoerner, 1974; Lemarchand and Lomberg, 1996). Our species has a much longer tradition in dealing with the arts than with science and technology. Manifestation of human symbolic thinking started with our first artistic expressions. It could be natural to think that it would be much easier to "contemplate" an extraterrestrial piece of art than to "interpret" the correct application of an extravagant technology.

For example, the technologically and symbolically superior *Homo sapiens* began to populate Europe some 40,000 years ago. According to anthropologists, the reason for our species' success was the development of language, not simply the intuitive level of understanding and rudimentary communication characteristic of Neanderthals, but symbolic, syntactic language. This innovative characteristic is fundamental to our ability to think; it is more or less synonymous with symbolic thought, and the intelligent property is simply impossible in its absence.

8. Considering the description earlier about the way we waste our human, economic, and technological resources in military programs, probably none of the hypothetical technological civilizations within this 70 light-years sphere will be interested in contacting us.

9. A special Round Table to discuss this particular topic between artists and scientists was organized by G.A. Lemarchand and J.G. Roederer during the First Iberoamerican School on Astrobiology: Origins from the Big Bang to the Civilizations, Instituto de Estudios Avanzados (IDEA), Caracas, Venezuela, November 28–December 7, 1999.

Read (1954) considered that art, or more precisely the aesthetic experience, is an essential factor in human development, and, indeed, a factor on which *Homo sapiens* has depended for the development of his highest cognitive faculties. The "creative explosion" responsible for modern humans is perhaps most dramatically witnessed in the Upper Paleolithic art. The oldest known painted image was found in December 1994 in the Ardèche Valley of southeast France (Chauvet et al., 1996). These staggering images proved to be doubly remarkable, for not only have radiocarbon tests established them to be over 36,000 years old—nearly twice as old as those found at Lascaux—but they also are powerful, sophisticated works of art rather than crude sketches.(10)

Art and science are creative activities. In the act of creation, a sentient being brings together two facets of reality and, by discovering a likeness between them, suddenly makes them one. This act is the same in Bach, Einstein, or Leonardo da Vinci. The spectator who is moved by the finished work of art or the scientific theory relives the same discovery; his appreciation is also a re-creation.(11) The work of art or of science is *universal* because we have the possibility to re-creation it. We are moved by the symphony, we follow the theorem because we discover again and seize the likeness that the creator first seized. The act of creation is therefore original but it does not stop with its originator. The act of appreciation reenacts the act of creation, and we are (each of us) actors; we are interpreters of it.

An extraterrestrial symphony, an abstract image, or a new aesthetic manifestation will help us to expand our symbolic capacities to new, unexpected frontiers.

Figure 5: Detail from "Panel with the Horses," slide n. 12, of the Grotte Chauvet-Pont-d'Arc cave pictures and one of the oldest known paintings on planet Earth. Used by permission and elaborated with the support of the French Ministry of Culture and Communication, Régional Direction for Cultural Affairs–Rhône-Alpes, Régional Department of Archaeology.

Humans' art age is at least one order of magnitude older than the invention of mathematics and more than two orders of magnitude older than the invention of radio waves technologies. If we place the value of 36,000 years as the first known manifestation of human symbolic thought(12) in Upper Paleolithic art, we can use the Principle of Mediocrity or the Delta *t* argument to estimate with a 95 percent confidence level that our species' interest in the arts will last between 923 and 1,404,000 years into the future. Obviously, the pleasure that each artistic manifestation generates is highly dependent on our individual cultural values. Extraterrestrial art would be completely different from any other artistic experience we have had before. In one way or another, each single artistic creation is always unique. The essential issue is that in the process of contemplating any art manifestation, we are participating in some kind of recreating activity. We always are rediscovering a new

10. The first age estimate was only 32,400 years, but recent recalibration of the Carbon 14 method determined this new age of 36,000 years. (E. Bard, La Datación por Carbono 14 se Renueva, *Mundo Científico*, No. 206, pp. 37-41, November 1999).

11. This view, that science is as integral to the culture as the arts, was the theme of Jacob Bronowski's address to the British Association for the Advancement of Science in 1955, "The Educated Man in 1984," and of Sir Charles P. Snow's eloquent Rede Lecture, *The Two Cultures and the Scientific Revolution*, Cambridge University Press, New York, 1959. Recent versions of the same statements were published—among others—by A. C. Crombie, "Experimental Science and the Rational Artist in Early Modern Europe," *Daedalus*, Vol. 115 (3), p.49-74, 1986; A. I. Miller, *Insights of Genius: Imagery and Creativity in Science and Art*, Copernicus, New York, 1996; and A. I. Tauber (Ed.), *The Elusive Synthesis: Aesthetics and Science*, Kluwer Acad. Pub. Dordrecht, 1996.

12. We are using factual data only. Probably symbolic thought started much earlier. Recently, Dr. Ivan Turk, a paleontologist at the Slovenian Academy of Sciences in Ljubljana, found an ancient bone flute segment at a Neanderthal campsite. It is the first flute ever associated with Neanderthals and its age was estimated at 43,000 to 82,000 years. The confirmation of this discovery could show that a second terrestrial species (Neanderthal) developed music much earlier than *Homo sapiens* developed painting. The most amazing thing is that four holes of the flute match our modern diatonic musical scale.

pattern, a subtle new order, or a new hidden symmetrical-asymmetrical organization.

Conclusions

According to the scenarios explored in this essay, we consider that there are good theoretical and empirical reasons to think that the original hypothesis of a universe populated by supercivilizations making omnidirectional transmissions is incorrect. Those original scenarios imposed the view that the discovery of an extraterrestrial signal will be strongly associated to the existence of a message with all sorts of advanced scientific, technological, and sociological recipes. In this view, all the advanced galactic (and extragalactic) societies would be irresponsibly spreading all their accumulated knowledge across the universe, knowing nothing about the technological and ethical characteristics of the possible recipients.

The existence of very advanced technological civilizations is highly conditioned by very large societal lifetimes. The analyses of the history of our incipient technological human society shows that we are facing the dangerous *technological adolescent era*, when our civilization could become extinct in the following 30 to a thousand years. Probably most of the technological civilizations have to pass through a similar *adolescent era*. In any case, the only possibility to avoid self-destruction is a deep and strong societal mutation, based in some sort of Kantian ethics. The long-term application of these ethical principles to the societal dynamics will generate some kind of *Lex Galactica*. The implementation of these ethical guidelines would prohibit placing potentially destructive knowledge at the disposal of any ethically underdeveloped society. This knowledge could be a threat to the survival of the recipient civilization.

From these assumptions, we can derive the following observational predictions:

- No omnidirectional electromagnetic transmissions with high-information content will be observed.
- Only beacon, low-information signals should be sent, in an intermittent and target mode, to those stars that have planets suitable for life. For detecting terrestrial-type planets, extraterrestrials can use advanced space interferometry techniques (Beichman et al., 1999). We should expect this type of signals from all the stars at distances over $[35 + (t_f\text{-}2000)/2]$ light-years, where t_f is the observing date in years and $t_f \geq 2000$.
- An alternative transmission strategy could be the addition of some extraterrestrial artistic creations to the beacon signals. Extraterrestrial art contemplation would help us to expand our perceptive horizons.
- Those nearby advanced societies that have already received our initial radio transmissions, with the technical capability to detect and decode our weakest signals, will have some idea about our technological and moral level of development. These civilizations may be transmitting to us high-information messages or those chapters from their *Encyclopedia Galactica* that our civilization is in a position to understand—but only those stars at distances $R_t < [35 + [(t_f\text{-}2000)/2] + \tau]$ light-years, where R_t is the distance at the observing date t_f and τ is the time that the extraterrestrial society needs to analyze and evaluate our technological and ethical stage.
- We may also be able to detect some radiation leakage from nearby civilizations, but this will probably be with very low-information content. The same thing would happen with any serendipitous detection of evidences of technological extraterrestrial activities (Dyson, 1959; Lemarchand, 1994 and 1997).

Indeed, our position relative to the SETI outcome is very much like that of an adolescent setting out on life's journey: the possibilities are infinite, the future is wide open, and we have grand plans, but much of the shape of that future hangs not only on what we do, but also on what the "others" are doing. Today we have no answer to the question: Are we alone in the universe? Until we have that answer, we must do what most adolescents do very poorly: we must wait.

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REFERENCES

Beichman, C. A., Woolf, N. J., and Lindensmith, C. A., *TPF: Terrestrial Planet Finder,* JPL Publication 99-3, Pasadena, (1999). Also available at http//tpf.jpl.nasa.gov/.

Bruckman, G., Meadows, D. H., and Richardson, J.M. (eds.), *Groping in the Dark: The First Decade in Global Modeling*, John Wiley and Sons, Chichester, (1982).

Carracedo, J. R., "La Psicología Moral de Piaget a Kohlberg," in V. Camps (ed.), *Historia de la Ética*, Vol. 3, pp. 481-532, Editorial Crítica, Barcelona, (1989).

Chauvet, J. M., Deschamps, E. B., and Hillaire, C., *Dawn of Art: The Chauvet Cave***,** Harry N. Abrams, Inc., New York, (1996).

Cohen, J. E., "Population Growth and Earth's Human Carrying Capacity," *Science*, Vol.269, pp. 341-346, (1995).

Dyson, F. J., "Search for Artificial Stellar Sources of Infrared Radiation," *Science*, vol.131, pp.1667-1668, (1959).

Dyson, F. J., "The Search for Extraterrestrial Technology," in *Perspectives in Modern Physics* (Essays in Honor of Hans Bethe), R. E. Marshak (ed.), John Wiley & Sons, New York, (1966).

Fasan, E., *Relations with Alien Intelligences*, Berlin Verlag, Berlin, (1970).

Gott III, J. R., "Implications of the Copernican Principle for Our Future Prospects," *Nature*, Vol. 363, pp. 315-319, (1993).

Hoerner, S. von, "The Search for Signals from Other Civilizations," *Science*, Vol.134, pp. 1839-1843, (1961).

Hoerner, S. von, "Universal Music?" *Psychology of Music*, Vol.2, No.2, pp.18-28, (1974).

Horowitz, P. and Sagan, C., "Five Years of Project META: An All-Sky Survey Narrow-Band Radio Search for Extraterrestrial Signals," *Astrophysical Journal*, Vol. 415, pp. 218-235, (1993).

Kardashev, N. S., "Transmission of Information by Extraterrestrial Civilizations," *Soviet Astronomy*, Vol.8, No.2, pp. 217-220, (1964).

Kohlberg, L., "The Claim to Moral Adequacy of the Highest Stage of Moral Judgment," *Journal of Philosophy*, Vol. 70, pp.630-645, (1973)

Lemarchand, G. A., *El Llamado de las Estrellas*, Lugar Científico, Buenos Aires, (1992).

Lemarchand, G. A., "Detectability of Extraterrestrial Technological Activities," *SETIQuest*, Vol.1, No.1, pp. 3-13, (1994). Also available at http://www.coseti.org/lemarch1.htm.

Lemarchand, G. A., "Possible Scenarios for the Detectability of Extraterrestrial Intelligence Evidences," in *Round Table Forum SETI and Society* in the 48th International Astronautical Congress: "Developing Business from Space," 6-10 October 1997, Turin, Italy, preprint IAA-97-IAA.7.1.02, (1997).

Lemarchand, G. A., "Is There Intelligent Life out There?" *Scientific American Presents*: *Exploring Intelligence*, Vol.9, No.4, pp.96-104, (1998).

Lemarchand, G. A. and Lomberg, J., "Are There any Universal Principles in Science and Aesthetics that Could Help Us to Set the Unknown Parameters for Interstellar Communication?" In *5th International Conference on Bioastronomy: Astronomical and Biochemical Origins and the Search for Life in the Universe,* International Astronomical Union Colloquium 161, poster p. 4-12, Capri, Italy, July 1-5, (1996).

Lemarchand, G. A., Colomb, F. R., Hurrell, E. and Olalde, J. C., "Southern Hemisphere SETI Survey: Five Years of Project META II," in C. B. Cosmovici, S. Bowyer, and D. Werthimer (eds.), *Astronomical and Biochemical Origins and the Search for Life in the Universe*, Proceed. of the IAU Colloquium 161, Editrice Compositori, Bologna, Italy, (1997).

Levi, B.G., "The Nuclear Arsenals of the US and USSR," *Physics Today*, March 1983; reprinted in Hafemeister (Ed.), *Physics and the Nuclear Arms today: Readings from Physics Today*, pp. 79-85, American Institute of Physics, New York, (1991).

Lupisella, M. and Logsdon, J., "Do We Need a Cosmocentric Ethic?" *48th International Astronautical Congress*, Turin, Italy; October 6-10, preprint IAA-97-IAA.9.2.09, (1997).

Maddison, A., *Dynamic Forces in Capitalist Development: A Long Run Comparative View*, Oxford University Press, Oxford, (1991).

Maddison, A., *Monitoring the World Economy 1820-1992*, OECD, Paris, (1995).

Meadows, D. L. and Meadows D. H., *The Limits to Growth*, Pan Books Ltd., London, (1972).

Mesarovic, M. and Pestel, E., *Mankind and the Turning Point: The Second Report to the Club of Rome*, Dutton, New York, (1974).

Naverson, J., "Martians and Morals: How to Treat an Alien," reprinted in E. Regis (ed.), *Extraterrestrials: Science and Alien Intelligence*, Cambridge University Press, Cambridge, (1985).

Piaget, J., *El Criterio Moral en el Niño,* Fontanella, Barcelona (1971).

Rawls, J., "Kantian Constructivism in Moral Theory," *The Journal of Philosophy*, Vol.77, pp. 515-572, (1980).

Read, H., "Art and the Evolution of Consciousness," *The Journal of Aesthetics & Art Criticism*, Vol. 13 (2), pp. 143-155, (1954).

Richardson, L. F., *The Statistics of Deadly Quarrels*, Boxwood Press, Pittsburgh, (1960).

Ruse, M., "Is Rape Wrong in Andromeda?" reprinted in E. Regis (ed.), *Extraterrestrials: Science and Alien Intelligence*, Cambridge University Press, Cambridge, (1985)

Sagan, C. E., *The Cosmic Connection: An Extraterrestrial Perspective***,** Doubleday, New York, (1973).

Sagan, C. E., "An introduction to the Problem of Interstellar Communication," in C. Ponnamperuma and A.G.W. Cameron (eds.), *Interstellar Communication: Scientific Perspectives*, Houghton Mifflin Co., Boston, (1974).

Sagan, C. E., *Cosmos*, Random House, New York, (1980).

Shklovskii, I. S. and Sagan, C. E., *Intelligent Life in the Universe*, Holden-Day, Inc.; San Francisco, (1966).

Thomas, L., "Notes of a Biology-Watcher: CETI," *New England Journal of Medicine*, Vol. 286, pp.306-308, (1972), also reprinted in his book *The Lives of a Cell*, Bantam Books, New York, (1974).

The New York Times, Editorial: *Bach to Bach*, p. A24, Wednesday, August 16, (1989).

Vakoch, D., "The Aesthetics of Composing Interstellar Messages," *50th International Astronautical Congress*, 4-8 October 1999, Amsterdam, The Netherlands, preprint IAA-99-IAA.8.2.03, (1999).

Roman Catholic Views of Extraterrestrial Intelligence:
Anticipating the Future by Examining the Past

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The United Nations required years to come to a decision that the Society of Jesus reached in ten days. In New York, diplomats debated long and hard, with many recesses and tablings of the issue, whether and why resources should be expended in an attempt to contact the world that would become known as Rakhat when there were so many pressing needs on Earth. In Rome, the questions were not whether or why but how soon the mission could be attempted and whom to send…

The Jesuit scientists went to learn, not to proselytize. They went so that they might come to know and love God's other children. They went for the reason Jesuits have always gone to the farthest frontiers of human exploration. They went ad majorem Dei gloriam: for the greater glory of God.

— from the prologue of the novel *The Sparrow*[1]

Why Theology?

When one first considers using theology to advance the scientific Search for Extraterrestrial Intelligence (SETI), this seems like an improbable partnership indeed. SETI scientists pride themselves in their reliance on empirical evidence gathered through advanced technologies to answer the question, "Are we alone?" In contrast, theology is often seen as being founded upon personal faith or subjective beliefs, which are not readily subjected to verification by a community of objective scientists. How then does theology have any relevance to scientific concerns with the possibility of extraterrestrial intelligence? It would seem that there are at least four benefits to be gained by a study of theological perspectives on extraterrestrials.

First, a better understanding of the range of possible extraterrestrial intelligence—whether biological or artificial—may influence the search strategies employed by SETI scientists. For example, if we come to the conclusion that other species are likely to be naturally inclined to avoid strife and discord, and instead to show altruistic concern for others, then we have some basis for searching for freely beamed signals, intentionally directed our way. In contrast, if we expect extraterrestrial civilizations to be guided by more selfish motivations, then they might be willing to engage in interstellar communication only if their species has something to gain from it—such as information transmitted by us as part of an interstellar barter. Given that we cannot know for sure about the nature of extraterrestrial intelligence before making contact, these often implicit assumptions about extraterrestrials may have a significant impact on the amount of resources we allocate to various search strategies, e.g., to active vs. passive searches. Even if we do not think of our underlying assumptions about extraterrestrials in specifically religious terms, nevertheless theological reflections may help make our *implicit* assumptions more *explicit*, which is an important process in the evolution of any scientific enterprise.[2]

A second motive for examining theological perspectives is to help anticipate the consequences of future contact. As I have noted previously, "in the event of a detection of a signal from ETI [extraterrestrial intelligence], there would probably be a significant religious response. If there is discussion of these complex issues prior to signal detection, the SETI community will be better prepared to deal with them in the event that a SETI experiment is successful."[3]

1.**Mary Doria Russell**, *The Sparrow* (New York: Villard Books, 1996), p. 3.

2.**Douglas A. Vakoch** and **Hans H. Strupp**, "The Evolution of Psychotherapy Training: Reflections on Manual-Based Learning and Future Alternatives," *Journal of Clinical Psychology* (in press).

Empirical research has shown that religious individuals are less likely to believe that extraterrestrial life exists than are less religious people. When presented with a hypothetical scenario about the detection of an information-rich signal from extraterrestrials, the more religious American undergraduates in the study—as compared to their less religious counterparts—were more likely to assume that the senders of the message had hostile intentions. In addition, these more religious Americans were more resistant to sending a reply message.[4] In short, religious and nonreligious individuals may respond quite differently to news that we have detected extraterrestrial intelligence, with these differences possibly affecting public policy decisions that will be made after signal detection. This is particularly true in perhaps the most likely scenario, in which we know little about the beings sending the message, if for no other reason than that it would probably be difficult to decode their message and thus learn about them.[5]

Moreover, we may benefit from "thought experiments" about the nature of extraterrestrials, because such exercises may allow us to expand beyond our habitual assumptions about ways that intelligent beings will encounter the world and one another. In the process, we can expect to gain a better perspective on ourselves: "If we can understand that our way of encountering the universe and our views of spirituality only begin to express the range of ways that intelligent beings deal with Ultimate Reality, we are guaranteed to gain something very powerful: a more humble, more realistic, and yet paradoxically more complete and more extensive understanding of our own place in the universe."[6] This may hold true even if we never actually make contact with life beyond Earth, but "encounter" other forms of life only in hypothetical scenarios of our own construction.

Finally, in the process of attempting to imagine alien forms of intelligence that evolved independently on other worlds, we may be better prepared to anticipate and effectively deal with new forms of Earth-based intelligence—whether natural, artificial, or genetically modified. These new life-forms could evolve either naturally or through intentional design, both on Earth and beyond our home world. Theological speculations may be particularly fruitful for helping to imagine forms of intelligence having their origins on Earth, but evolving under very different, perhaps hostile conditions in extraterrestrial environments.

The Age of Space

At the beginning of the Space Age, the possibility of life beyond Earth increasingly became a topic for serious discussion among scientists. But scientists did not have a monopoly on the subject. Starting in the 1950s, theological speculations about extraterrestrials were seen in response to increased space exploration. For example, Father T. J. Zubek began his "Theological Questions on Space Creatures" by citing recent accomplishments of space exploration.[7] Another author noted that the theological implications of extraterrestrial life were being considered "with a heightened interest in this beginning of the Age of Space."[8] Writing in 1962 on conjectures about the existence and nature of extraterrestrials, the Executive Secretary of the American Rocket Society maintained that the "liveliest speculation" came from Roman Catholic theologians.[9]

Though theologians have continued this conversation through the present day, most of the issues central to contemporary discussions were identified decades ago. Thus, it is the beginning of the modern concern with the theological implications of extraterrestrials, and not more recent developments, that will be the central focus of this paper. To illustrate the variety of views that can be held within a single religious denomination, I will focus on perspectives maintained by Catholic clergy and others writing in Catholic publications between 1955 and 1965. In addition, I will briefly note more recent Catholic

3.**Douglas A. Vakoch**, "Communicating Scientifically Formulated Spiritual Principles in Interstellar Messages," Paper IAA-99-IAA.9.1.10 presented at the SETI I: Science and Technology Session of the 50th International Astronautical Congress, Amsterdam, The Netherlands, October 1999.

4.**Douglas A. Vakoch** and **Yuh-shiow Lee,** "Reactions to Receipt of a Message from Extraterrestrial Intelligence: A Cross-Cultural Empirical Study," *Acta Astronautica* (in press).

5.**Douglas A. Vakoch**, "Signs of Life beyond Earth: A Semiotic Analysis of Interstellar Messages," *Leonardo* 31 (1998): 313-319.

6.**Douglas A. Vakoch**, "Framing Spiritual Principles for Interstellar Communication: Celestial Waves," *Science & Spirit* 10 (November/December 1999): 21.

7. **T. J. Zubek**, "Theological Questions on Space Creatures," *American Ecclesiastical Review* 145 (December 1961): 393.

8. **John P. Kleinz**, "The Theology of Outer Space," *Columbia* 40 (October 1960): 28.

9. **James Harford**, "Rational Beings in Other Worlds," *Jubilee: A Magazine of the Church and Her People* 10 (May 1962): 19.

views about extraterrestrials, and I will suggest ways that we might draw upon these past theological reflections as we prepare for the possible future success of SETI.

To preview my more detailed discussion, the dominant position of this group was that belief in extraterrestrial beings is consistent with both science and Christian theology. Most of those who took a position on whether such life is probable argued that it is. Moreover, it was generally agreed that if extraterrestrials exist, such beings would be made in the image of God with the purpose of glorifying their creator. There was less consensus about the extent to which such beings would be successful in this task. But in spite of differences of opinion about the nature of the relationship between extraterrestrials and God, there was most often a common framework for such speculations.

Ad Majorem Dei Gloriam

While scientists were interested in a wide range of extraterrestrial life, theologians had much narrower concerns. Zubek—a priest whose views will be noted repeatedly in this paper—was interested "only in creatures similar to us, composed of spirit and body." Another priest whose name will reappear often in the following pages, Father Daniel C. Raible, shared this view, saying he was concerned neither with "subhuman life," because it has no eternal destiny, nor with angels, because they are not material beings. The position that Raible stated explicitly, that he would focus on beings with both a material and a spiritual nature, was also accepted by others, often implicitly.[10]

A recurring view in writings of the time was that there is nothing in the Catholic faith to dismiss the possibility of extraterrestrial beings.[11] According to one priest, "Revelation, the common teaching of the Fathers, tradition, the solemn pronouncements of the Popes—none of these say there cannot be life other than on earth."[12] One anonymous author, writing in *America: A Catholic Review of the Week*, compared the silence of the Bible on extraterrestrial life to its silence on the indigenous people of the Western Hemisphere.[13]

Some went further and maintained that the existence of extraterrestrials is not only *consistent* with Catholic theology, but there are good reasons to think that such beings *actually* exist.[14] The most common argument was that extraterrestrials would add to the glory of God. In the words of one Catholic theologian, "The supreme world aim is the glorification of God through rational beings…. Should we assume there to be nothing but deserts in all these [other] worlds?"[15]

Two ways were identified that extraterrestrials might glorify God. First, simply by existing they would unconsciously give glory to God. Second, as rational beings they would also have the duty to glorify God consciously.[16] Some held that extraterrestrials might even glorify God better than humans do.[17] Father L. C. McHugh, whose views will be elaborated throughout this paper, used the glory of God to suggest that extraterrestrials may be common. He conceived of the glory of God not as the *adoration* of God, but as a *gift* of God to God's own creation. "After all, God made this gigantic material fabric for His glory," wrote McHugh, "not for His glory as a benefit to be gained by Himself, but as one to be spread abroad, especially among beings capable of knowing and loving Him."[18] This argument for the existence of extraterrestrials was not universally maintained, however. One Jesuit suggested that even if humans were the only rational beings in the entire universe, God would still be sufficiently glorified.[19]

10.**Zubek**, p. 394; **Daniel C. Raible**, "Rational Life in Outer Space?" *America: A Catholic Review of the Week* 103 (13 August 1960): 352 (article condensed in **Daniel C. Raible**, "Men from Other Planets?" *Catholic Digest* 25 (December 1960): 104-108 and summarized in **George Dugan**, "Priest Suggests Rational Beings Could Well Exist in Outer Space," *New York Times* (7 August 1960): 14.

11.**A. Carr**, "Take Me to Your Leader," *Homiletic and Pastoral Review* 65 (December 1964): 256; **J. D. Conway**, "The Question Box," *Catholic Messenger* 82 (6 August 1964): 10; **Harford**, p. 18; **John J. Lynch**, "Christians on Other Planets?" *Friar* 19 (January 1963: 29; **L. C. McHugh**, "Life in Outer Space?" *Sign: A National Catholic Monthly Magazine* 41 (December 1961): 28; "Space Theology," *Time* 66 (19 September 1955): 81; **Zubek**, p. 393-394.

12.**Kleinz**, p. 36.

13."Messages from Space," *America: A Catholic Review of the Week* 111 (12 December 1964): 770.

14.**Carr**, p. 255; **Conway**, p. 10; **Angelo Perego**, "Rational Life beyond the Earth?" *Theology Digest* 7 (Fall 1959): 178 (summary of **Angelo Perego**, "Origine degli esseri razionali estraterreni," *Divus Thomas* (Piacenza) 61 (1958): 3-24).

15."Space Theology," p. 81.

16.**Zubek**, p. 395.

17.**Carr**, p. 255; **Conway**, p. 10.

18.**McHugh**, "Life," p. 29.

19. **Perego**, "Rational," p. 177.

Others used the glory of God as an explanation for why extraterrestrials would *not* exist. One priest maintained that one would not "be able to understand the logic of the divine plan of man's salvation" if extraterrestrials were able to glorify God. From this, he argued they simply would not exist: "It is fantastic to suppose that God would place such men on other planets. Remember that the world was created by God for God's glory. What glory would God derive from men deprived of supernatural gifts?"[20]

While the Catholic journalist Joseph A. Breig did not use the term *glory*, he did ask whether there are extraterrestrials capable of adoring God consciously. He contended that there is no need to assume the existence of extraterrestrials, because humanity provides a sufficient locus for the meeting of spirit and the entire created order.[21]

Lonely Planet

Another of Breig's arguments for the uniqueness of humans concerned their status as images of God. It was inconceivable to him that God would populate the universe with images of God other than those descended from Adam; Breig argued that humanity was an image of God by virtue of both spiritual and physical aspects.[22] One priest believed that extraterrestrials would resemble humans insofar as they both have spiritual and material natures, "but in their bodily formation they could be as different from us as an elephant is from a gnat."[23] When McHugh explained how extraterrestrials could be images of God, he did not even mention their physical nature. Rather, he said that humans are made in God's image "radically through the possession of mind and will, accidentally through the doing of virtuous deeds."[24] Unlike Breig, McHugh thought this image could be replicated many times. Another priest noted that even this spiritual component of extraterrestrials could differ from that of humans.[25]

Breig's denial of the possibility of extraterrestrials relied upon more than his opposition to multiple incarnations. He felt there was no room in the universe for nonhuman forms of intelligence. In his words:

To me, there is a divine rightness to this concept of the singular unity of mankind, of the cosmos, and of the Creator, which cannot be present in any theory that there may be one or more races of thinking beings composed of matter and spirit.

McHugh saw this desire for uniqueness as a remnant of the belief that the Earth is at the center of the universe. It is a prejudice, he said, to which people still cling on the basis of a feeling of intellectual superiority. McHugh preferred to think that the "family of Adam, or *Homo terrenus*, as I shall dub him, is not a lonely wayfarer in a wilderness of glowing cinders and icy cosmic dust." Zoologist and psychologist Vincent G. Dethier, writing in *Catholic World*, was more explicit about the implications of being unique:

To be unique is to be lonely. It is a chilling thought that in all the universe man and his biosphere are the only living things. As long as all men believed in heaven man was not alone in the universe. Could it possibly be in this age of scientific materialism that man's desperate search for extraterrestrial life stems from a fear of being alone? That he is searching for a substitute for heaven?[26]

For one priest, the central point was not simply that humans want to make contact with other equals. Instead, he said people have a need to worship superior beings, and some try to meet this need through postulating extraterrestrials that are wiser and more powerful than humans. Accordingly, they can hope for either a delivery from their Earthly suffering or "complete annihilation through some tremendous eschatological conflict."[27] Others raised the possibility of superior extraterrestrials who might adore God better than humans do.[28]

While some individuals had either extreme positive or extreme negative expectations of making contact with extraterrestrials,[29] others were more ambivalent about encountering them. One writer

20."Space Theology," p. 81.

21.**Joseph A. Breig**, "Man Stands Alone," *America: A Catholic Review of the Week* 104 (26 November 1960) : 294.

22.**Breig**, p. 294.

23.**Raible**, "Rational," pp. 532-533.

24.**L. C. McHugh**, "Others out Yonder," *America: A Catholic Review of the Week* 104 (26 November 1960): 296-297.

25.**Zubek**, p. 394.

26.**Breig**, p. 295; **McHugh**, "Others," p. 295; **Vincent G. Dethier**, "Life on Other Planets," *Catholic World* 198 (January 1964): 250.

27.**J. Edgar Bruns**, "Cosmolatry," *Catholic World* 191 (August 1960): 286.

28.**Carr**, p. 256; "Space Theology," p. 81.

29.For a general discussion of extreme views of contact with extraterrestrial intelligence, see **John Billingham**, **Roger Heyns**, **David Milne**, **Stephen Doyle**, **Michael Klein**, **John Heilbron**, **Michael Ashkenazi, Michael Michaud**, **Julie Lutz**, and **Seth Shostak**, *Social Implications of the Detection of an Extraterrestrial Civilization* (Mountain View, CA: SETI Press, 1999), pp. 48-52.

was uncomfortable with the prospect of meeting beings who are biologically very different from humans. But simultaneously, he gained a sense of hope that even if humans destroy the Earth in a nuclear disaster, humankind "might continue in the life of other planets."[30] Similarly, the author of an article in *America* regarded the idea of a plurality of kinds of intelligent beings as both "engaging" and "intimidating."[31]

Some writers gave theological reasons for thinking humans are or are not unique, but many turned toward science to determine whether extraterrestrials actually exist. Often, the question of whether habitable planets exist around other stars was taken as a starting point, with authors emphasizing that the prevailing opinion of astronomers was that such planets probably do exist.[32] The legitimacy of such claims was not universally accepted at the time. An anonymous writer in the Catholic magazine *Sign* said that such conclusions are unscientific, noting that a "scientist who makes such a claim is betraying the standards of exactness claimed for his profession."[33] One Jesuit priest, however, thought a focus on planets habitable by life as we can conceive of it was an unjustified restriction of God's power. He reasoned that if God is capable of endowing human bodies with properties that will enable people to exist after their Earthly lives, then certainly God could create beings suitable for any planet.[34]

Risen, Fallen, Redeemed?

In addition to biological differences between humans and extraterrestrials, many said the two groups might have fundamentally different relationships with God. Some references were relatively unelaborated. One priest simply noted the possibility of extraterrestrials being either "in the state of original grace" or "fallen into sin."[35] Another writer wondered "whether they would be better or worse than ourselves."[36] While there was certainly no consensus about the actual spiritual status of extraterrestrials, there was often a common, implicit framework within which to discuss these possibilities. Most schemes postulated beings that originally existed in either a natural state or a supernatural state. Of the latter, it was thought some might remain in God's grace and some might fall from it. Further, the possibility of redemption was discussed for those who fell. Two priests noted that different races of extraterrestrials could well fit two different categories.[37]

Gifted Children

According to this categorization, extraterrestrial races that were never endowed with supernatural gifts would be in a state of pure nature. For three of the priests who raised this possibility, beings in this state were compared to human infants who die before baptism. Like such infants, these extraterrestrials would naturally know God in eternity.[38] This destiny would apply to extraterrestrials in a natural state, according to one of these priests, "if they remained faithful to God."[39] While Zubek acknowledged the possibility of eternal bliss for these extraterrestrials, he did not think it was inevitable. In his view, "God would eternally reward such creatures with natural happiness or punish them forever, according to whether they did or did not serve Him in their lives."[40]

Within this basic framework of the different states in which extraterrestrials could exist, Raible and Zubek added the possibility of extraterrestrials being endowed with gifts that others did not mention. The quality of these preternatural gifts is most easily seen in Raible's writing. He contended that beings with an integral nature would be endowed with one or more gifts possessed by angels. Raible described some of the characteristics they might have:

For example, they might enjoy infused knowledge (they would literally be born with extensive knowledge and would find the acquisition of further knowledge easy and enjoyable); they might be blessed with harmony and concord in the working of their bodily and spiritual faculties; they might be spared the ultimate dissolution of death, passing to their reward at the end

30.**Harford**, pp. 19, 21.

31."Messages," p. 250.

32.**Bruns**, p. 284; **Dethier**, p. 249; **Harford**, pp. 17-18; **McHugh**, "Life," p. 28; "Other Worlds, Other Beings?" *Newsweek* 60 (8 October 1962): 113; **Raible**, "Rational," p. 532.

33."No Room for Christian Faith," *Sign: A National Catholic Monthly Magazine* 36 (November 1956): 14.

34.**Perego,** "Rational," p. 177.

35."Space Theology," p. 81.

36."Messages," p. 770.

37.**Perego**, "Rational," p. 178; **Zubek**, p. 396.

38."Missionaries to Space," *Newsweek* 55 (15 February 1960): 90; **Raible**, "Rational," p. 533; "The Theology of Saucers," *Time* (18 August 1952): 62.

39.**Raible**, "Rational," p. 533.

40.**Zubek**, p. 396.

of their time of trial as peacefully as the sun sinks below the horizon at the end of the day. They might possess all these preternatural gifts or only some of them in any of various combinations that are limited only by the omnipotence and providence of God.[41]

The difference between pure nature and integral nature is less clear in Zubek's distinction. Though he specifically noted that beings in a natural state would have no preternatural gifts, he did say that they might receive "a sort of natural help by God."[42] This help, he wrote, might be offered to extraterrestrials in a state of pure nature whose natural appetites conflict with God's will.

The third type of gift that many thought God could bestow upon extraterrestrials is of a supernatural form. For Raible, beings in this state of supernature "would be elevated, either at the moment of creation or shortly thereafter, to a condition surpassing absolutely all the natural needs and power of any existing or possible creature." The priests who maintained that preternatural gifts were a possibility also said that both preternatural and supernatural gifts could be given to the same beings, placing them in a "state of innocence."[43]

Paradise Lost?

Extraterrestrials in either a state of innocence or a state of supernature, some priests contended, would have something in common with Adam and Eve: the freedom either to pass or to fail a test, along with all of the consequences of that choice. Supernaturally endowed extraterrestrials who passed their test, said Father Domenico Grasso, would be immortals "far ahead of us in science and related fields."[44]

Grasso also considered another possibility: a race that had fallen and not been redeemed. For these beings, Grasso stressed, "crime, war, and hate would rule…. Compared to the vast nonterrestrial hell, our world would appear to be a privileged globe…."[45] Another priest compared them to fallen angels: "creatures with keen intellects, but with wills strongly inclined to evil."[46] Also comparing them to fallen angels and calling them "a sort of devil incarnate," Zubek raised the possibility of their passing on their state to offspring who also might be denied redemption. McHugh regarded unredeemed extraterrestrials as theologically defensible on the grounds that it would demonstrate God's justice and holiness. Though Raible acknowledged the possibility of fallen but unredeemed extraterrestrials, he thought it unlikely given the infinite mercy God has shown to humanity.[47]

The last possibility that was considered—a race fallen but redeemed—raised questions about the significance of Jesus Christ for extraterrestrials. Grasso said that only humans, descended from Adam, could share in redemption through Jesus Christ. Other beings, not tainted by Adam's original sin, would be outside the church.[48] Though Zubek concurred that extraterrestrials would not share in the sin of the human race, nevertheless he held that God could have saved such beings through Jesus Christ if God so wished.[49] A professor of dogma at the University of Munich said that Christ is the head of the universe, and thus would also be the head of extraterrestrials. This writer did note, however, that this does not automatically mean that Christ is also their redeemer.[50] When asked in an interview about the relationship between extraterrestrials and "Jesus Christ, the Incarnate Word," McHugh replied that extraterrestrials would be "under the universal dominion of Christ," but McHugh said he would leave further conjectures to theologians specializing in the incarnation. So too did Father J. Edgar Bruns affirm the universal dominion of Jesus Christ without taking a position about Christ's status as redeemer.[51]

Grasso denied the redemptive power of the Earthly incarnation of Christ for extraterrestrials, but he kept open the possibility of their salvation through other means.[52] Some believed that this could occur through other incarnations of any one of the persons of the Trinity.[53] Breig found this notion totally unacceptable. Most inconceivable to him, it

41.**Raible**, "Rational," p. 533.

42.**Zubek**, pp. 396-397.

43.**Raible**, "Rational," p. 534; **Zubek**, p. 397.

44."Missionaries," p. 90.

45."Missionaries," p. 90.

46.**Bruns**, p. 286.

47.**Zubek**, p. 398; **McHugh**, "Others," p. 296; **Raible**, "Rational," p. 534.

48."Missionaries," p. 90.

49.**Zubek**, p. 398.

50."Space Theology," p. 81.

51.**McHugh**, "Life," p. 29; **Bruns**, p. 297.

52."Missionaries," p. 90.

53.**McHugh**, "Others," p. 296; **Raible**, "Rational," pp. 534; **Zubek**, p. 398.

seems, was the idea of more than one Mother of God, an idea that was no problem for McHugh.[54] Raible and Zubek thought God could redeem fallen races simply by forgiving their sins with or without requiring them to ask for forgiveness. They also said God could require a partial satisfaction for their sins by one or more members of the race. Only if God required an infinite satisfaction, they thought, would an incarnation be necessary. Raible added that if God chose to re-elevate a race, God could decide to return any or all of the gifts that were originally given.[55]

A number of people commented on the theological implications of extraterrestrials between 1955 and 1965, but that number must not be overestimated. McHugh contended that "hard-headed Catholic theologians" had not considered the topic. He claimed that without more evidence that extraterrestrials actually exist, most theologians studying the incarnation "would regard such speculation as idle."[56] A spokesman for the Vatican called the issue "slightly premature" in 1955.[57] While acknowledging that thinking about extraterrestrial beings is "in its way fascinating," another writer concluded that "it's all too nebulous and far out to worry much about."[58] Although the Jesuit priest and paleontologist Teilhard de Chardin said he did not want to discourage such hypotheses, he thought the probability of extraterrestrials existing was so unlikely that it did not seem worth becoming engrossed in.[59] Another writer saw this lack of attention as a reluctance of theologians to raise difficult questions.[60]

Toward the End of the Millennium

In the years following the decade that is the primary focus of this paper, there were additional voices added to theological discussions about extraterrestrial beings. For example, in 1969 Father Clifford J. Stevens provided a view of theology quite different from those writing just a few years earlier. He believed that extraterrestrials should be judged on the basis of their *own* theologies, and not by terrestrial standards. In fact, he believed that theology as humans know it could expand markedly if contact were established with extraterrestrial theologies. While he looked forward to an expansion of theology as a result of contacting extraterrestrials, he also acknowledged that this could be dangerous. "In human history," Stevens wrote, "the discovery of a new race has always meant the exploitation of one by the other, or at least an immediate state of hostility between the two groups. No one can yet gauge the effects of a cosmic hostility." But after presenting this scenario, he hoped that conflict with a race of nonhumans might bring humans together.[61]

For most other Roman Catholic priests, however, the central concerns voiced at the start of the Space Age were reiterated. For example, Father Theodore M. Hesburgh, President of the University of Notre Dame, provided the foreword to an early NASA study on SETI. In it, he noted the compatibility of belief in God and the scientific quest for intelligent life beyond Earth, concluding that "Finding others than ourselves would mean knowing Him better."[62] Similarly, Father Thomas F. O'Meara, a theologian at the same university, summarized the range of possibilities that could characterize extraterrestrials in a manner reminiscent of the categories we saw earlier: "Distant creatures might be without grace and revelation, and they might be without evil, suffering, and sin."[63] Moreover, he cautioned against assuming that human experience is sufficient to allow us to imagine all possible relationships between extraterrestrial beings and God: "The ways in which supernatural life touches sensate intellect and will, the modes of contact in revelation may be quite diverse, and it is a mistake to think that our understanding…exhausts the modes by which divine power shares something of its infinite life."[64]

As we move beyond those who *published* on theological implications of extraterrestrials, and instead examine the views of priests who were contacted for their comments, we again see a similar range of responses to those already documented. Victoria

54.**Breig**, p. 294; **McHugh**, "Others," p. 296.

55.**Raible**, "Rational," p. 534; **Zubek**, p. 398.

56.**McHugh**, "Life," p. 29.

57."Space Theology," p. 81.

58.**Carr**, p. 255.

59.**Pierre Teilhard de Chardin**, *The Phenomenon of Man*, trans. Bernard Wall (New York: Harper and Row, Publishers, Inc., 1959), p. 286.

60.**Kleinz**, p. 28.

61.**Clifford J. Stevens**, *Astrotheology: For the Cosmic Adventure* (Techny, IL: Divine Word Publications, 1969), pp. 32-34.

62.**Philip Morrison**, **John Billingham**, and **John Wolfe**, *The Search for Extraterrestrial Intelligence: SETI*, NASA SP-419 (Washington, DC: U.S. Government Printing Office, 1977), p. vii.

63.**Thomas F. O'Meara**, "Christian Theology and Extraterrestrial Intelligent Life," *Theological Studies* 60 (1999): 23.

64.**O'Meara**, pp. 23-24.

Alexander conducted one such study, in which she sent a questionnaire to a thousand Roman Catholic priests, Protestant pastors, and Jewish rabbis throughout the United States.[65] Although the title of her report suggests that she queried clergy about their attitudes about UFOs, in fact the questions were asked in such a way that they also shed light on attitudes about extraterrestrial life that does not travel to Earth, and thus is relevant to SETI.

In a manner reminiscent of Hesburgh's comment about knowing God better through contact with extraterrestrials, one priest in Alexander's study maintained that, "The thought of more than one civilization expands the greatness of the God I believe in." Other priests emphasized the range of possible moral states in which extraterrestrials could exist. As one priest from Pennsylvania put it, "In the event they sinned, they would need redeeming…. If they did not sin, there would be no need for redemption and they would not suffer the effect of sin—death, a darkening of the intellect, pain, disease, etc." This assessment was partially reiterated by a priest serving a small congregation in Wisconsin, who expressed the view that it is "possible that life on another planet did not fall as on earth and had no need of redemption."

Several priests considered the implications that would follow from other civilizations not being in need of redemption. A priest from Illinois suggested, "Perhaps there is a race of intelligent beings out there who have never fallen from grace and who have made very great technological progress over many thousands of years." Similarly, another priest concluded, "if you placed 'Intelligent life on other planets' and these beings 'obeyed' Him then such beings would be inexplicably more intelligent than us and far more scientifically advanced." One priest suggested that extraterrestrials not in need of redemption would be so different from sinful humans that there might be problems in understanding one another: "any form of communication with, association with, or even minimal contact with [them] would be impossible in this material existence; they being so vastly different—their very life would be unintelligible to us and us to them."

Although a number of priests participated in Alexander's study, some questioned its usefulness or appropriateness. A priest from Michigan responded to the request to participate in the study by suggesting that other priorities are more important: "Try raising funds to feed hungry and clothe naked!" Similarly, a priest from Florida offered the view that the "survey is a waste of money that could be given to the poor and homeless here on this planet." A colleague from the same state replied simply by saying, "I think the whole thing is absolutely ridiculous." Apparently, some still agreed with the Vatican representative who said 40 years earlier that these issues are "slightly premature."[66]

Prophets of the Future

At a seminar on the cultural implications of contact with extraterrestrial intelligence, sponsored by the Foundation For the Future in 1999, the value of both theological and historical perspectives was reflected in the choice of the participants, which included both a Buddhist priest and an historian of science. The purpose of the present paper has been to examine religious attitudes about extraterrestrials in an historical context, in the hope of preparing for some future date when actual contact might occur.

But exactly *how* can a theological discussion from several decades ago help us anticipate the future? One possibility is that such speculations may aid us in moving beyond the narrow constraints of our human experience of the world. Whether we are attempting to envision the range of forms that extraterrestrial intelligence may take, or whether we are trying to anticipate the impact of advances in genetic engineering and artificial intelligence on Earth in the coming centuries and millennia, we are constrained by the limitations of our imagination. Theological speculations may provide one way of expanding beyond those preconceptions:

> *…we may gain insights from theology into the possible nature of extraterrestrials that we might not consider if we focused only on human nature as studied by science. For instance, an extraterrestrial might have characteristics that theologians attribute to angels, such as immortality or innate knowledge. Because we are mortal and we acquire knowledge through learning, we are likely to overlook such possibilities on other worlds. And yet, such "gifts" as extremely long lives and a greater reliance on implanted or intrinsic knowledge*

65. **Victoria Alexander**, *The Alexander UFO Religious Crisis Survey: The Impact of UFOs and Their Occupants on Religion*, 1995, <http://www.accessnv.com/nids/articles/alexander/survey_religion.html>.

66. "Space Theology," p. 81.

might well occur elsewhere, either naturally or through artificial adaptations (e.g., through genetic engineering or in the form of artificial intelligence). In short, one benefit of theological reflections on extraterrestrials is to challenge—and thus potentially expand—implicit scientific assumptions about the nature of extraterrestrial intelligence. In the case of Catholic theology, such concepts as the preternatural and the supernatural—whether taken literally or metaphorically—can help us see beyond nature as depicted by science.[67]

If the scope of historical analyses is extended to centuries, rather than restricted to merely a few years, then we may begin to see recurrent patterns in people's views. For example, commonalities in ways of imagining the possible moral status of extraterrestrials, as seen in writings over the course of several hundred years (rather than just a decade), may be less influenced by the vicissitudes of the specific cultural milieus in which these views are discussed. And indeed, arguments for and against the existence of extraterrestrials—and about their nature if they do exist—have been raised by religious individuals in the past, sometimes in a framework consistent with that found in the current study. Nevertheless, within these broader frameworks covering large expanses of time, we should also continue to conduct more circumscribed analyses, carefully documenting the divergences from more typical views. Such is the attempt of the current study, which is focused on a single decade during a critical time at the beginning of the Space Age, and limited to a single denomination of one major world religion.

Given the global impact that detection of a signal from a distant civilization would have on Earth, it is important that future studies be expanded to examine the responses we might expect from a range of cultures and religions. In one recent empirical study of university students' attitudes about the implications of receiving an information-rich radio signal from an extraterrestrial intelligence, we concluded that "those Americans who viewed message receipt as spiritually significant were both more open to life existing beyond earth, and less apprehensive about making contact."[68] No such pattern was found for a matched group of Chinese respondents. Additional studies are needed to identify the factors responsible for this difference.

When attempting to prepare for the future, we are limited in how adequately we can generalize from comparable situations in the past or the present. Since there are no instances of a confirmed detection of a signal from a distant extraterrestrial civilization, people engaged in discussions about the theological status of extraterrestrials could easily see the question as still very hypothetical. However, there *have* been situations in which—for at least a short time—people *believed* that extraterrestrial intelligence had been detected by very reputable scientists. If Lord Byron was correct, and "the best of Prophets of the future is the Past,"[69] then more detailed studies of those "false alarms" could be very enlightening.

One particularly promising historical incident that may help us anticipate the future detection of a signal from extraterrestrial intelligence is the Moon Hoax of 1835.[70] In that year, the *New York Sun* printed a series of articles reporting the discovery of life (including intelligent life) on the Moon by the eminent astronomer Sir John Herschel.[71] This provides a useful analogue for signal detection at interstellar distances, because in the early 19th century, the Moon was viewed as a very distant celestial body with which humans could have no physical contact. Several accounts have been written indicating that for a short time, there was widespread acceptance of the existence of extraterrestrial intelligence due to the Moon Hoax.

However, these accounts have focused on *media reports* of the Moon Hoax, rather than on *individual responses*. To remedy this limited view of the event, one might contact archivists and historical scholars having access to diaries and journals of individuals who made regular entries during the 1830s. Because the event can be clearly delimited to a few days, it would be relatively easy to determine whether each diarist made reference to the news of an inhabited Moon. Using standard methods for coding the content of such diary entries, one could then characterize the range of responses. For those diarists who are sufficiently well known by at least one historian (e.g., by their biographers), a personality profile can be

67.**Douglas A. Vakoch,** "The Dialogic Model: Representing Human Diversity in Messages to Extraterrestrials," *Acta Astronautica* 42 (1998): 707.

68.**Vakoch** and **Lee.**

69.Diary entry dated January 28, 1821.

70.**Douglas A. Vakoch**, "Predicting Reactions to the Detection of Life beyond Earth," Paper presented at the Societal Implications of Astrobiology Workshop, NASA-Ames Research Center, Moffett Field, CA, USA, November 1999.

71.See "Celestial Discoveries," *New York Sun* (25 August 1835): 2 for the first installment.

obtained using standard psychological assessment questionnaires, with the historian completing the surveys as he/she believes the diarist would have responded. This psychohistorical approach would allow an examination of such questions as: Were more religious individuals more skeptical about the news report?

The degree of interest that theologians have in speculating about extraterrestrial intelligence may well vary with changes in the perceived likelihood of actually making contact. In the view of one Roman Catholic priest, theology must wait, with respect to extraterrestrial beings, for "actual discovery before attempting studies of any practical significance; but theology, like the other sciences, must be prepared for new horizons of thought—however unfamiliar they may be."[72] In the late 1950s and early 1960s, the reality of knowing about extraterrestrial beings was remote enough to make in-depth analyses seem premature. But simultaneously, the possibility of some day contacting life beyond Earth was real enough for a few people to begin discussing some of the theological implications of such a discovery. As searches for extraterrestrial intelligence continue to expand, we might expect—and hope for—a comparable increase in attention to the theological questions that would come to the fore if some day one of these searches succeeds.

72.**Stevens**, p. 34.

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Section VI

Participant Biographies

Ragbir Bhathal

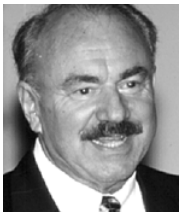
Ragbir Bhathal, an award-winning author and astrophysicist, is Foundation President and Chairman/Director of the Australia-Singapore Centre at the University of Western Sydney, and a member of the five-year multi-beam project at the Parkes Radio Telescope. He is also Foundation President of the OZ SETI Society, a society devoted to the promotion of the scientific and social aspects of the search for extraterrestrial intelligence, and a member of the SETI Committee of the International Academy of Aeronautics and Astronautics. His observatory at UWS will be home for the dedicated Australian Optical SETI (OZ OSETI) Project. In 1998, he chaired the international committee that organized the first international conference to examine the scientific and social aspects of the search for extraterrestrial intelligence. Dr. Bhathal's many publications include *Profiles, Australian Astronomers*, *John Tebbutt*: *Australian Astronomer*, *Under the Southern Cross*, *Astronomy*, *Search for ET*, *Australian Scientists and Inventors,* and numerous papers. In 1988 he was awarded the Royal Society of New South Wales Medal for research and services to science.

John Billingham

John Billingham received his medical education at Oxford University and specialized in aviation physiology and medicine in the Royal Air Force before joining NASA's Lyndon B. Johnson Space Center in Houston, Texas. There he headed the Environmental Physiology Branch and worked on the Mercury, Gemini, and Apollo programs. In 1965 he moved to the NASA–Ames Research Center in Northern California to head the Biotechnology Division, then the Extraterrestrial Research Division, and later the Life Science Division. After a sabbatical year at Stanford, Dr. Billingham returned to Ames to become Chief of the Office for the Search for Extraterrestrial Intelligence (SETI). Upon retiring from NASA, he joined the SETI Institute as Senior Scientist to help with the now privately funded SETI program, Project Phoenix. He was elected to the Board of Directors of the SETI Institute in 1995. A visionary scientist, he helped design spacesuits for the astronauts and was a Stanford University lecturer on Life in Space from 1969 to 1995. With Dr. Bernard M. Oliver of Hewlett-Packard, he designed a system to Detect Intelligent Extraterrestrial Life, known as Project Cyclops.

Eric J. Chaisson

Eric J. Chaisson is Director of the H. Dudley Wright Center for Innovative Science Education at Tufts University, where he is also Research Professor of Physics and Astronomy, and Research Professor of Education. In addition, Dr. Chaisson is an Associate of the Harvard College Observatory, and Co-director of the MIT Space Grant Consortium. Trained initially in condensed-matter (atomic) physics, Chaisson obtained his doctorate in astrophysics from Harvard University in 1972. Before assuming his current position, he spent a decade as a member of Harvard's Faculty of Arts and Sciences. During his tenure at Harvard, Chaisson's research concentrated largely on the radio astronomical study of interstellar gas clouds. This work won him fellowships from the National Academy of Sciences and the Sloan Foundation, as well as Harvard's Bok Prize for original contributions to astrophysics and Harvard's Smith Prize for literary merit. He has also held research and teaching positions at MIT and Wellesley College and, before joining Tufts, was for five years senior scientist and director of educational programs at the Space Telescope Science Institute at Johns Hopkins University.



Bob Citron

Bob Citron, Executive Director of the Foundation For the Future, co-founded Kistler Aerospace Corporation and served as President and Chief Executive Officer from 1993 to 1995. Among successful companies he founded previously were SPACEHAB, Inc., builder of three space laboratories that routinely fly aboard the Space Shuttle, and EARTHWATCH, a worldwide scientific and educational organization. Citron spent 20 years with the Smithsonian Institution involved in many of NASA's pioneering space projects, including the Apollo lunar landing program, the Space Shuttle program, and the International Space Station program. While at the Smithsonian, he helped establish and manage the global Satellite Tracking Network (STN) and was responsible for the design and construction of satellite tracking stations around the world. He was a principal investigator on NASA's Apollo, Skylab, and Landsat programs from 1968 to 1974, and was the founder and first director of the Smithsonian Institution's Center for Short-Lived Phenomena, a global science communications network. He has written and published extensively in scientific subjects.

Kathleen Connell

Kathleen Connell is Director of Strategic Communications in the Astrobiology Integration office at NASA–Ames, and the lead for the Societal Implications of Astrobiology Workshop. She serves as Policy Director for the Aerospace States Association. Connell has had varied program and mission development responsibilities both at Ames and NASA headquarters. Prior to joining NASA, Connell worked throughout the Americas with several nongovernment organizations, enabling economic development for emerging and impoverished populations, including women of lesser developed countries, farm workers, and immigrants to San Francisco's inner city. She is currently an advisor to the San Francisco Human Rights Commission, as well as a Ph.D. candidate with the Fielding Institute. Connell is an employee of Indiana Business, Modernization and Technology, Inc., the economic development unit of the State of Indiana, and a graduate of the University of California at Berkeley.

Paul Davies

Paul Davies is Visiting Professor at Imperial College London and Honorary Professor at the University of Queensland. He formerly was Professor of Mathematical Physics and Natural Philosophy at the University of Adelaide, and has held academic appointments at Cambridge and London universities, and the University of Newcastle upon Tyne. Professor Davies has published over 100 research papers in cosmology, gravitation, and quantum field theory, with emphasis on black holes and the origin of the universe. His monograph *Quantum Fields in Curved Space*, co-authored with Nicholas Birrell, remains a seminal text in the field of quantum gravity. He is also well known as an author, broadcaster, and public lecturer. Among his 25+ books are *God and the New Physics*, *The Cosmic Blueprint*, *The Mind of God*, *About Time*, and *Are We Alone?* His latest book, *The Fifth Miracle*, is about the origin of life and the possibility of life on Mars. He was a longstanding contributor to *The Economist*, and is a familiar columnist in *The Guardian*. Dr. Davies has been honored with numerous awards, including the Templeton Prize for progress in religion, awarded to him in 1995 by Prince Philip at Buckingham Palace.

Steven J. Dick

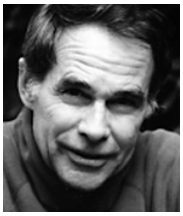
Steven J. Dick is the Historian of Science at the United States Naval Observatory (USNO). He studied astrophysics at Indiana University and received a Ph.D. in the history and philosophy of science there in 1977. In 1979 Dr. Dick joined the scientific staff of the Naval Observatory as an astronomer, a position he held until being named Historian of Science in 1989. In the early 1990s, Dick acted as historian of the National Aeronautics and Space Administration's High Resolution Microwave Survey-Search for Extraterrestrial Intelligence program. He is a member of the SETI Committee of the International Academy of Astronautics and its Subcommittee on Issues of Policy Concerning Communication with Extraterrestrial Intelligence. Dick has written several books, including *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant*; *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science*; and *Life on Other Worlds*. Currently Dick is President of the International Astronomical Union's Commission 41(History of Astronomy).

Ben Finney

Ben Finney earned a Ph.D. in anthropology at Harvard University. Since then he has taught at the University of California at Santa Barbara, Australian National University, French University of the Pacific, International Space University, and, currently, University of Hawaii. His primary anthropological work has been conducted in the Pacific Islands; he is particularly noted for his pioneering experiments in Polynesian voyaging, which revolutionized views about Polynesian migration and settlement. Since the late 1970s he has pioneered an anthropological approach to human issues involved in exploring and eventually settling space, as well as in SETI. In the mid-1980s he was awarded an NRC fellowship to work on issues of space settlement and SETI at NASA's Ames Research Center. He founded and currently chairs the Space and Society Department at the summer sessions of the International Space University, and periodically lectures in ISU's Masters of Space Studies program. Dr. Finney is co-editor of *Interstellar Migration and the Human Experience*. Among honors awarded to him are Russia's Tsiolkovsky Medal, Britain's Royal Institute of Navigation's Bronze Medal, the Medal of the French University of the Pacific, and the Regents Medal of the University of Hawaii.

Albert A. Harrison

Albert A. Harrison is Professor of Psychology at the University of California at Davis. He earned B.A. and M.A. degrees in Psychology from the University of California, Santa Barbara, and a Ph.D. in Social Psychology from the University of Michigan. Harrison is a member of the SETI Committee of the International Academy of Astronautics, a Director of the nonprofit organization Contact, a Regent of United Societies in Space, a member of the Science Advisory Board for the National Institute of Discovery Science, and Deputy U.S. editor of Systems Research and Behavioral Science. He has also been active at *Case for Mars* conferences. His current interests include the psychological, social, and political determinants of beliefs about the cosmos and the reality of extraterrestrial life. Dr. Harrison's books include *High Expectations: Human Spacefaring in the New Millennium*; *Living Aloft: Human Requirements for Extended Spaceflight* (with M.M. Connors and F. R. Akins); *From Antarctica to Outer Space: Life in Isolation and Confinement* (edited with Y. A. Clearwater and C.P. McKay); and *After Contact: The Human Response to Extraterrestrial Life.* His articles on humans in space and on the search for extraterrestrial intelligence have appeared in numerous journals.



David Hines

David Glenn Hines has a B.A. in English Literature and a B.F.A. and M.A. in Fine Arts, all from the University of New Mexico. He makes his living as a painter of landscapes, mostly of the western Mojave Desert and Central Valley regions of California. He is represented by galleries in Los Angeles, California, and Santa Fe, New Mexico. His work has been featured in numerous solo exhibitions and group exhibitions in California and the U.S. Southwest, including several major museum shows. In his paintings of the landscape at night, the land is almost overwhelmed by the infinitude of the space above it, a space that melds with the land in an uncertain horizon. Isolated lights denoting human presence are mirrored by stars making manifest the vast desert of the cosmos and perhaps denoting life there as well. By contrast, his daytime landscapes are close, comfortable, and familiar, with a plenitude of detail and relative abundance of life. Light plays a key role in all of his paintings, revealing by both its presence and its absence the deep love and sense of mystery the Earth and our universe inspire in him. Hines is an avid reader of science books.

Guillermo A. Lemarchand

Guillermo A. Lemarchand received his Ph.D. in physics from the University of Buenos Aires in 1991, and in 1998 received a Master's in Science and Technology Management and Policy. His achievements include being a researcher and lecturer at the Center for Advanced Studies; coordinator of the META II SETI Project at the Argentine Institute for Radioastronomy (CONICET); Visiting Fellow at the Center for Radiophysics and Space Research from Cornell University, working with Carl Sagan; co-director of the first Ibero-American School on Astrobiology, Universidad Simon Bolivar in Caracas, Venezuela; and editor of *Bioastronomy News*. He is a member of the International Academy of Astronautics (IAA) SETI Committee and of the Long-Term Dynamics of Societal Systems Study Group at the University of Buenos Aires. In 1989 he received the first National Award for the Peaceful Uses of Science and Technology. Books co-authored or edited by Dr. Lemarchand include *Inteligencia Extraterrestre*; *Scientists, Peace and Disarmament*; *El Llamando de las Estrellas Cosmos*; *The Search for Extraterrestrial Intelligence in the Optical Spectrum II*; and *Origins: From the Big Bang to the Civilizations, an Introduction to Astrobiology.*

Claudio Maccone

Claudio Maccone earned degrees in physics and mathematics from the University of Turin. A Fullbright scholarship enabled him to research the theory of stochastic processes at the Department of Electrical Engineering of the Polytechnic Institute (now Polytechnic University) of New York, and a Council of Europe Higher Education Scholarship, awarded by the British Council, led to Ph.D. studies in London. Maccone joined Space Systems Group of Aeritalia (now Alenia Spazio) in Turin as a technical expert for the design of artificial satellites. Among projects he is involved in currently at Alenia are the design of a space mission like the Quasat satellite for radioastronomy, the Tethered Satellite flown by the U.S. Space Shuttle in 1992 and 1996, and the design of a Solar Sail to reach Mars while being pushed by sunlight. Elected Corresponding Member of the International Academy of Astronauts, he is currently serving as Secretary of the Interstellar Space Exploration Committee and as a Member of the SETI Committee. Dr. Maccone has published two books, *Telecommunications, KLT and Relativity* and *The Sun as a Gravitational Lens: Proposed Space Missions*, and over 60 scientific and technical papers.

Jill Tarter

Jill Tarter earned a Bachelor of Engineering Physics Degree from Cornell University and a Master's Degree and Ph.D. in Astronomy from the University of California at Berkeley, where her major field of study was theoretical high energy astrophysics. In 1984 she helped found NASA's nonprofit SETI Institute. She served as Project Scientist for the SETI High Resolution Microwave Survey (HRMS) until its termination by Congress in 1993. Today she serves as the Director for Project Phoenix, the SETI Institute's privately funded continuation of the Targeted Search portion of HRMS. Among awards and recognition, Dr. Tarter received in 1989 the Lifetime Achievement Award for her contribution to the field of exobiology, and in particular to the search for extraterrestrial intelligence, from Women in Aerospace, a professional association in Washington, DC. In 1997 the Board of Directors of the SETI Institute appointed Dr. Tarter to a new endowed position: the Bernard M. Oliver Chair for SETI. Dr. Tarter has written and lectured extensively on SETI, Project Phoenix, and more conventional astrophysical topics.

Keiko Tokunaga

Keiko Tokunaga is a Buddhist priest in Hawaii. At the Seminar on the Cultural Impact of Extraterrestrial Contact, she presented fresh and insightful ideas, emphasizing the need for each of us to prepare for contact by enhancing our compassion, our openness to new experiences, and our ability to deal with anything alien. Tokunaga, who studies with a Zen master, suggested that one aspect of Zen is training ourselves to be more sensitive and to watch the kinds of signals we are sending, since the first impression is the one that lasts and there will be long-range impacts of whatever the first signal or contact is. Tokunaga asked what kind of signals we as a planet are sending out currently, making reference to mind-to-mind communication that occurs in the signals we send in interactions with each other. In terms of humanity right here and now, she said, how are we going to send signals to each other and make ourselves more receptive to contact? Though most people will keep on doing whatever they are doing, she put forth the hope that perhaps what we do could be done with more compassion.

Allen Tough

Allen Tough focuses on three interrelated issues. (1) The very-long-term future of human civilization. In addition to writing and conferences, he serves on the Foundation For the Future's Humanity 3000 Organizing Committee and the Millennium Project's Planning Committee. (2) The scientific search for extraterrestrial intelligence. He is the founder and coordinator of the Invitation to ETI, an innovative SETI project at http://members.aol.com/WelcomeETI. He presents papers at most SETI conferences and at the annual Contact conference, and serves on several international committees. (3) Humanity's search for meaning and purpose on the individual and societal levels. He weaves this theme into much of his writing within his other two interests. In his personal life, Dr. Tough particularly enjoys reading, walking, music, wilderness, hiking, skating, conversations, the World Wide Web, and his two grown children.

Douglas A. Vakoch

Douglas Vakoch, a Social Scientist with the SETI Institute, conducts and promotes research on the cultural aspects of SETI. He has a B.A. in Comparative Religion from Carleton College, an M.A. in the History and Philosophy of Science from the University of Notre Dame, and a Ph.D. in Clinical Psychology from State University of New York at Stony Brook. Vakoch's work in SETI began over 20 years ago with his creation of interstellar messages for communicating with extraterrestrial intelligence. He also conducts research on the history of the extraterrestrial life debate, policy issues related to SETI, and possible psychological and religious responses to detecting a signal from extraterrestrial intelligence. Prior to joining the SETI Institute, he conducted research on the evolution of speech perception and therapeutic communication at Vanderbilt University, funded by the National Institute of Mental Health. He is a member of the International Academy of Astronautics SETI Committee, as well as IAA Subcommittees on Issues of Policy Concerning Communications with Extraterrestrial Intelligence, Media and Education, and the Arts and Literature.

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