SETI AND THE MEDIA: IMPROVING SCIENCE COMMUNICATION

by

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Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree of diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Carol Ann Oliver 30 June, 2003

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Bobbie's passion for the public understanding of science was evident from the day we met, as was her remaining goal in life to become a good science communicator. It was a source of great pleasure to both of us that she won the Australian Science Communicators' Unsung Hero award in 1995. She received it for her contribution to science communication, mostly television work, undertaken at the Parkes radio telescope as an observer on the SETI Institute's Project Phoenix team from February, 1995 to June, 1995.

SETI Australia sprung from her award in September, 1995. From that point I remained in the university environment with life in the universe researchers, first at the University of Western Sydney and then at the Australian Centre for Astrobiology at Macquarie University. Undoubtedly had I gone back into my career in mainstream journalism as I intended, this thesis would have never been undertaken.

Carol Ann Oliver

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Abstract

From its beginnings, the scientific Search for Extraterrestrial Intelligence has faced the ‘giggle factor’ – that all it amounted to was ‘looking for Little Green Men’. Yet SETI has gained credibility as well as recognition that the endeavour is very much part of the rapidly emerging science of astrobiology. SETI is also unusual among areas of science in that almost from the beginning, researchers have considered the social and cultural implications of the experiment. Over the past 15 years, the SETI Institute in Mountain View, California, the largest organisation among a group of independent international efforts, has developed formal education curricula reflective of its research, which continues today. The Institute is also engaged in public outreach in an effort to improve the public understanding of SETI and SETI-related science. In particular, SETI has encouraged mass media attention through a variety of initiatives. This thesis will view science communication through the experiences of SETI – and mostly the SETI Institute. This - probably unique - approach will explore relevant elements of SETI and science communication to show that the current perspective of promulgating the public understanding of science via the mass media may be flawed and worthy of further investigation.

Carol Ann Oliver
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Introduction

Commentators on science from the fields of media and science agree variously that it is important – indeed imperative – that public audiences be informed about the discoveries of science. Perhaps more crucially, these audiences should have at least a general understanding of the process of science – what doing science really means, why scientists eschew pseudoscience and how the scientific method may be a tool to enable audiences to evaluate what they hear, see and read as the truth or otherwise.

The cosmologist and science popularist, the late Dr Carl Sagan, promulgated the idea that the scientific method could provide a basis for critical thinking in democracy as well as for science. Among others, he fervently believed the very survival of democracy depended on the ability of the public to question what was put before them as the truth (Sagan, 1996, pp 423-434). He also regarded scientific literacy as key to enabling consideration of the ethical and social issues surrounding scientific discovery and to separate science from pseudoscience. Support for this notion comes from another field of science – Geoscience – where Warren Wood maintains bringing the 'scientific method to bear on important societal questions' is an issue. He sees the public making decisions based on ‘value systems rather that the scientific method,’ and comments that the public’s thought structure is ‘extremely varied, often inaccurate and might be better referred to as misperceptions’ (Wood, 2001, p 1).

Another scientist and science communicator Margaret Wertheim maintains scientific literacy contributes to our psychological well-being. She notes, ‘As long as our culture continues to refract reality through the lens of science there is an obligation to make the science accessible to everyone. What is at stake here is not just individual sanity, but ultimately social cohesion’ (1997, p 8).

Wertheim goes further, asserting that science today is the cultural worldview that we need for a sense of place. She says that among the Aborigines of Australia, for instance, it is common to teach the worldview and morals to their children from a tapestry of mythology stretching back over 40,000 years of Dreamtime. All societies use this method, influenced by their own culture and religious beliefs. In Western society if science is essential to our worldview as Wertheim claims, our children are maturing to adults without the benefit of the stories of science to underpin it.

The best scientist communicators tend to use story telling as a key to connecting with the public. Two of the best-known storytellers in the factual sense were Dr Jacob Bronowski and Dr Carl Sagan who both wrote books that would result in the benchmark for the popular television documentary series genre – Bronowski, *The Ascent of Man* and Sagan, *Cosmos*. Many have since followed. Sagan noted,

> '…where possible, (science) popularisers should try to chronicle some of the mistakes, false starts, dead ends, and apparently hopeless confusion along the way. At least every now and then, we should provide the evidence and let the reader draw his or her own conclusion. This converts obedient assimilation of new knowledge into personal discovery. When you make the finding yourself – even if you're the last person on Earth to see the light – you never forget it' (Sagan, 1996, p 335).

Bronowski's and Sagan's methods were aimed at dispelling the public perception of science being an unfathomable culture and the keepers of it – the scientists – as having all the answers.

Curiously, in spite of general agreement that science communication is a good thing on all sides – including governments and science organisations – most experts in the field also agree that there is a gap in communication between the protagonists, the scientists and the science journalists. There are a myriad of reasons put forward including a mismatch of needs and goals (Cunningham in Friedman et al, 1986, p 210). These include the slow, considered pace of science against the deadlines of the media, and scientists using caveats in their comments when the journalist (and the public) expects straight yes or no answers.

In this thesis, I propose to take a single area of science that has an active approach to considering the societal and cultural consequences of the science being undertaken as well as a significant employment of resources in vigorously pursuing science education in formal and informal settings. SETI, the Search for Extraterrestrial Intelligence, fulfills these parameters.

SETI is a science with a long cultural and social history stretching back more than 3,000 years. Only in the last half century has it been possible to take it out of the realm of fiction and scientific debate to scientific enquiry using the world's largest radio telescopes to tap into the unmistakable signature of intelligence. A single tone in a specific construction could answer the question 'Are we alone in the universe?'

SETI is also an exploration that requires all of the sciences in its endeavour. It has wide public appeal, experience in science education, outreach and in handling the media and a commitment to studying the societal and cultural implications of the success of its experiment. It is embedded in the emerging science of astrobiology. The Drake Equation (formulated by Dr Frank Drake, a founder of the SETI Institute), describes an astrobiology roadmap in its terms.

$$N = R^* . fp . ne . fl . fi . fc . L$$

This means (from left to right) the number of communication civilisations in the galaxy is equal to:

- the rate of star formation in the galaxy
- times the fraction of those stars with planetary systems
- times the number of those planetary systems that have planets suitable for life
- times the fraction of suitable planets on which life actually appears
- times the fraction of life bearing planets on which intelligence emerges
- times the fraction of that intelligence that develops a technology that allows them to be detected in space
- times the length of time those civilisations remain communicating

(Ekers et al, 2002, p xxv).

SETI emerged as a scientific endeavour at an interesting turning point for science communication, at least in the US. Although there appears to be no available survey of numbers of science journalists immediately before the launch of Sputnik 1 on October

4, 1957, a sharp increase was recorded in the years immediately afterwards. A survey by the US-based Science Service news agency charts the numbers of newspaper science writers jumping from a mere 34 in 1939 to 375 in 1960 (Friedman et al, 1986) – the same year as SETI was born at the National Radio Astronomy Observatory in Green Bank, West Virginia – Drake's Project Ozma (Drake et al, 1993). It is impossible to say whether this increase in numbers of science journalists was a slow increase or the result of the beginning of the Space Age. However, it does indicate an increasing demand for science journalists over several decades and perhaps the Space Age was responsible for at least a degree of the increase. Sputnik catapulted science news onto television (*Science Education News*, 1997) as well as sparking renewed efforts to improve science education.

In the 1970s and 1980s it appears the interest in science among public audiences continued to increase, indicated by a rising number of new popular science magazines in the US. However, there may have been contributing factors. *Current Comments* (1981, p 5) notes, 'the generation that went to school in the Sputnik era is now buying magazines.'

Media interest in SETI

Drake's SETI experiment at Green Bank and a seminal paper in Nature the previous year (Morrison and Cocconi, 1959) each attracted much media coverage. Project Ozma spawned the first popular science book on SETI published in 1964 and written by the *New York Times* Science Editor Walter Sullivan – the journalist who broke the news of Sputnik's successful launch. At the same time the idea of life elsewhere in the universe was gaining some media attention via the work of Nobel Prizewinner Joshua Lederberg. He was concerned with extraterrestrial life of the microbial kind and preventing forward and backward contamination between planets in exploration of the solar system rather than intelligence elsewhere in the universe.

The strong cultural component to SETI, particularly in the link to science fiction over the past four centuries, undoubtedly contributes to its immediate public appeal. Walter Sullivan's SETI book notes how the idea of the plurality of worlds is an old one in terms of science fiction. The book also includes a chapter on the social consequences of success of the SETI experiment integrating such aspects as the reaction of various religions to a discovery and the possible effects of coming into contact with a technologically very advanced society, albeit via radio rather than physical contact.

While the methodology of SETI is science, SETI Institute astronomer Dr Seth Shostak confirms the aim and motivation are sociological. He comments: 'A good example is mathematics – you do that to understand it. With SETI we want to know something. There is a difference' (personal interview, 2003). The sociological and cultural considerations - particularly in preparation for possible success of the SETI experiment - is an aspect rarely undertaken by other sciences in spite of the social consequences they may face later as has been seen for genetically modified foods. For SETI it is a risk communication strategy designed to assess public reactions to a discovery as far as possible and to anticipate that in communications with the public via the media and other communication strategies. It is not easy, however, to measure the success of that strategy specifically among other influences. These are many and include the role of science fiction, discoveries such as planets around other stars and news of the increasing likelihood of past or present microbial life elsewhere in the solar system. The public is certainly primed for the idea of life elsewhere. Most North Americans and Europeans accept the idea of intelligence elsewhere in the universe (NSF, 2002, http://www.nsf.gov/sbe/srs/seind02/start.htm; Eurobarometer 55.2, 2001, http://www.icpsr.umich.edu:8080/ICPSR-STUDY/03341.xml). It has been noted that in the event of discovery it is likely the public would largely view it as confirmation rather than shocking news (Shostak, 1997).

SETI, unlike most other areas of science, straddles the *Two Cultures* debate sitting between science and the arts with its mix of science and culture as has been noted. The debate was sparked by CP Snow's lecture of the same title at Cambridge University in

1959 and the subject of media coverage at the time and the resulting book being reprinted three times in 1959, another three the following year and two more reprints each in 1961 and 1962. However, four decades ago it was an intellectual debate. Today closing the cultural gap has become an imperative with the increasing pace of science knowledge and the impact of that on society.

Anecdotally it is said the science knowledge base is now doubling once every seven years. If this is true, the increase in the rate of growth in science knowledge implies that it is now impossible for students to go through K-12 without scientific knowledge changing, perhaps dramatically and at a rate that no text book could keep up. It makes lifelong learning and the role of science communication critical. In this thesis I will suggest how the information is flowing forwards and back again across mass media, formal education and public science communication in informal settings such as museums and at public talks by scientists. The Internet, too, plays a role in this information flow and has the potential to change the face of science communication. There are now more than half a billion people worldwide connected to the web (Neilsen, 2003) and 9% of US adults using it as the main source of science and technology information (National Science Foundation, 2002).

Former Speaker of the US House of Representatives Newt Gingrich supports this anecdotal notion. He told the US National Science Foundation in 2001 that the new science knowledge gained in the first 25 years of the 21st Century would almost certainly equal that of the entire 20th Century. This was a century, he noted, that went from no aircraft to landing men on the Moon and the development of television, mass produced cars and home computers. Gingrich further commented on how little science really knows, and that this was not reflected in media stories, citing reports that the human genome project was complete. 'Being told you've mastered the alphabet at the foot of the Library of Congress suggests you have a lot of reading to do' (Gingrich, 2001, http://www.spaceref.com/news/viewpr.html?pid=5191). Science, and the technology it fuels, now pervades and guides our daily lives. SETI provides a number of examples. One is SETI@home, which splits SETI data into tiny packets to send to more than three million home computers to enable large amounts of data to be processed – the most successful example of distributed computing that could aid other research, such as evolutionary development and long-term climate change (Planetary Society, 2002). Another is the Allen Telescope Array - formerly known as the One Hectare Telescope - now being built in Hat Creek in California. It is forging a path for a new generation of radio telescopes that will bring our view of the universe into sharper focus (Ekers et al, 2002, p 199).

Scientific illiteracy

While science plays an increasing role in our daily lives US and European governments and science institutions have recognised scientific illiteracy among the adult population is at a high level (National Science Foundation, 2002; Eurobarometer 55.2, 2001). Concerns about science communication are universal. For example, in Germany the government responded to 'apparent deterioration in the public's regard for science' with a public education program (Koenig, 1999, p 1748). In China, the issue is separating science from pseudoscience and superstition (Ning, 1999) and in Japan about falling numbers of young people regarding science as a career (Imura, 1999).

Nevertheless, surveys in the UK, USA and Europe indicate that public audiences are interested in science. A survey carried out by AGB McNair on behalf of CSIRO in Australia, in 1997, showed science, technology, medical advances and pollution together outranked sport, politics, employment and crime as subjects of the greatest interest to readers. The survey of 1060 people across all Australian cities, regional Australia, male and female, all ages and socioeconomic groups showed 54% very interested in medical discoveries, followed by environmental pollution 47%, technology 46% and basic science 43%. A repeat of the survey two years later produced very similar results according to Julian Cribb, Director of CSIRO Public Relations (personal communication, 2001). This is reflected in the 2001 *Science and Society in Europe* survey carried out by the European Union across its 15 member states. Among the 16,029 (an average of 1,000 per member state) 45.3% said they were ‘rather interested’ in science and technology whereas less find politics (41.3%) and economics (37.9%) interesting. However, culture (56.9%) and sports (54.3%) outrank all of them (Eurobarometer 55.2, 2001).

In the survey carried out for the US National Science Foundation (2002) the biennial Science and Engineering Indicators show there is higher level of interest in science in the US than either Australia or Europe, with nine out of ten Americans saying they are interested in science though, paradoxically, most also agree they do not understand science. According to the NSF figures, 75% of the adult population in the US is scientifically illiterate. This compares to Europe where similar tests for scientific illiteracy indicate a lower level of less than 50% of the population.

There is an obvious dichotomy between high levels of public interest in science and high levels of scientific illiteracy. The implications for the way science is communicated will be explored in this thesis through the SETI experience and will form the backbone and conclusions for this thesis.

SETI provides a unique prism through which to examine the interaction between science and the public via the mass media. I will propose the SETI experience changes our perceptions of the role of mass media in such communication, and will demonstrate in Chapter Three that this is most clearly seen during periods of intense media attention by presenting several cases that are the closest analogies of a SETI success. In reporting of the two Viking lander spacecraft on Mars and the announcement that a rock from Mars carried hints of past life on the red planet, the goal was - and always is - information, not education.

Why choose SETI for this analysis? SETI is engaged in examining a question that is meaningful to everyone but also most of the scientists and experts engaged in the quest are eloquent and accomplished science communicators. If there is a chance the media is a method of improving the public understanding of science, such a vehicle of high public interest should allow the easy passage of information from scientist to science journalist to public audiences. In fact, while SETI is a science that frequently attracts media attention its researchers are no less frustrated by their interactions with journalists than researchers from other fields of science. There is the same unspoken gulf between scientists and science journalists, who each believe they have precision with the English language and they seek the truth. This is the epitomy of Snow's *The Two Cultures*. Snow comments that scientists and literary people, '… have a curious distorted image of each other' (2002, p 4).

How do SETI scientists communicate with the public and how has this commitment to public outreach shaped SETI today and for the future? More specifically, what can be learned about mass media science communication in the needs and the goals of SETI scientists and the challenges they face? What impact could this information have for other areas of science? These questions are central to the prevailing perception of the role of the media in the public understanding of science.

This thesis sets out to discuss these questions, drawing on SETI as the context throughout. Chapter One reviews ways in which SETI has addressed these. In Chapter Two I will explore the proposal that the mass media is probably not a good educational medium. I will discuss how, in practice, the mass media is not used as a tool for the public understanding of science by scientists, science journalists or public relations experts. Changes in science communication will be addressed, including the relationship between formal and informal education as well as the increasing use of the Internet by the public to obtain science information. More depth is acquired in Chapter Three on the proposal that the media informs but does not educate by considering what happens in the mass media when SETI and related areas of science come under the media spotlight. Chapter Four draws overall conclusions from the information in the previous three chapters to indicate that perhaps the most valuable lesson of all from the SETI experience is that while the media informs it can only aid the public understanding of science by default at best. A fundamental change in the way science communication is viewed may be required in order to achieve significant improvements.

CHAPTER 1

Scientists, journalists and the Internet

As already stated, the aim of this thesis is to show how the perspective of the actual practices of researchers involved in science communication can enable access to a ‘big picture’ view of science communication itself, using the SETI as the case study. To explore this premise in later chapters it is necessary in this chapter to discuss elements of the traditional approach to science communication compared to the actual practice at the SETI Institute (the largest SETI research organisation). I will do this through a review of the relevant literature on science communication via the media and presenting SETI from available literature and interviews with SETI researchers. I will also explore the effects of the Internet in science communication.

In 2000 a science journalist, Jim Hartz and a NASA scientist, Dr Rick Chappell produced *World’s Apart: How the Distance Between Science and Journalism Threatens America’s Future.* They describe how a scientist views a journalist and vice versa. They note,

> ‘The scientist sees the journalist as imprecise, mercurial and possibly dangerous – ‘a man who know the price of everything, and the value of nothing,’ to borrow Oscar Wilde’s phrase. The journalist sees the scientist as narrowly focused, self-absorbed, cold-eyed and arrogant. Or as Ted O’Brien, news director for Boston’s WABU-TV, noted on the survey form he returned to the First Amendment Centre in the US: ‘They are somewhat superior in their attitude to those not of their world‘ (Hartz and Chappell,1997, p 13).

Science journalists believe most scientists are poor communicators, who are generally unable to clearly explain their news or how it fits into the big picture; but science journalists have a deep respect for science too, so they are unlikely to research and present science in the same way as, for example, politics (Friedman et al, 1986, pp 160-163). Journalists struggle for objectivity despite their own values. As one science journalist reports, ‘My ideas about the role of the public and private sphere, my values concerning the environment, all help to organise my material,’ but says scientists don’t realise they carry similar baggage (Nelkin 1986, p 96). Science is these day, unavoidably, everywhere and part of our cultural worldview (Wertheim, 1996, p xi). At the heart of science communication is the way scientists communicate; the way science journalists report; and the way the public assimilates and uses science information at a time of significant change.

Science communication has been evolving since Sputnik; but today the Internet and the advent of an information-rich technological age has quickened the pace of change from a steady walk to a break-neck run. It demands, too, not just scientific literacy but media literacy with science communication morphing from a one-directional and prescriptive approach into a multi-directional endeavour. The Internet, for example, is able to display information in a multi-dimensional mode rather than a two-dimensional fixed mode of other forms of communication, and it is interactive (and therefore at least a two-way communication tool). While scientists urge critical thinking on what purports to be science there is also a need to evaluate media reporting of science. As one science communicator notes, mass communication pervades our lives. While it should not tell us what to think, it can tell us what to think about and this applies to all reporting, including science (Jimoh, 2003).

There is much literature on the issues discussed above including case studies in addition to several in-depth independent and government reports and a number of regular international surveys concerning the public understanding of science. Studies include *Worlds Apart* for North America's First Amendment Centre (Hartz and Chappell, 1997), *Who's Misunderstanding Whom* for the UK's Economic and Social Research Council (Hargreaves, 2000) and *Science and the Public: A Review of Science Communication and Public Attitudes to Science in Britain* (UK Office of Science and Technology, 2000). Government inquiries include the USA Congressional Hearing on *Communicating Science and*

Engineering in a Sound-bite World (Blum, 1998, and Hartz and Chappell, 1998) and the UK's House of Lords' *Science and Technology Third Report* (2000). The most extensive regular surveys are carried out by the USA (National Science and Engineering Indicators, 2002) and in Europe (Eurobarometer 55.2, 2001). However in spite of all these reports and surveys, there appears to be little or no data on how the public receives and makes sense of science stories in the media. It also appears there is little or no data on the actual science communication practices by scientists as a group inside a single branch of science. SETI provides a good case study because of its cultural driver. If public audiences cannot understand this area of science via the media, there seems little hope for more esoteric science. SETI also has a community of researchers small enough to gain a coherent view of how they communicate using a wide spectrum of communication techniques. It therefore offers a unique lens through which to view the process of science communication and participate in their experiences, as hinted in the introduction. It may lead to a deeper understanding of the communication between the researchers and the public and in the way the public receives, perceives and assimilates science news and information and uses it to make sense of other science.

SETI's evolution and the emerging science of astrobiology

To appreciate how and why SETI research provides a good case study in science communication, it is necessary to take a brief look at SETI's evolution in a field that has now expanded into the emerging science of astrobiology. Up until 2003, no long-term SETI experiment has taken place where SETI researchers have control of the telescope rather than gathering data by sitting on the back of other radio astronomy experiments. It will be possible on the SETI-dedicated large Allen Telescope Array due for completion in 2007 http://www.seti.org/seti/our_projects/allen_telescope_array/Welcome.html. For the moment, the SETI Institute gets 40 days a year at the Arecibo radio telescope in Puerto Rico, the world's largest radio telescope (telescope time won competitively against other research projects). The telescope largely determines the search space because its 1,000-foot diameter collecting area is fixed in the landscape. The Institute's Project Phoenix has also spent six months at the Parkes 210 foot radio telescope in New South Wales, Australia in 1995 and undertaken observation runs at the National Radio Astronomy Observatory in Green Bank, West Virginia. While SETI has yet to do an Allen Telescope Array-style experiment, the computing and engineering capability has improved dramatically. Drake's Project Ozma studied two nearby star systems – Tau Ceti and Epsilon Eridani – with one radio channel in 1960. Today, Project Phoenix is capable of scanning a total of 56 million radio channels simultaneously. In recent years *SETI@home*, run by astronomers at UC Berkeley, has used the distributed computing project to analyse data collected at the Arecibo telescope as a parasitic project (piggy-backing on other radio astronomy) (Werthimer, 2003, http://seti.ssl.berkeley.edu/serendip/serendip.html).

Dr Jill Tarter, Director of the Centre for SETI Research at the SETI Institute, frequently finds herself explaining to reporters why, even after 43 years, the search is still in its infancy. The best metaphor Tarter has is, ‘We haven’t scratched the surface yet,’ but says it doesn’t really get close to giving an accurate picture of the task at hand. Tarter has done the calculation. Putting all the time spent actually doing SETI anywhere in the world in 43 years actually amounts to about 1.7 years (Tarter, 2003, private communication). When the Allen Telescope Array is operational, SETI will have access to deeper and quicker searching – and on a continuous basis. The Square Kilometre Array – a larger version of the Allen Telescope Array, one of which is planned for Australia by an international consortium - may well open the way to detecting stray radiation similar to that emitted from Earth-based activities such as radio, television and radar (Tarter, personal interview, 2003). The chances of success could improve dramatically if detection proves not to be dependent on a deliberate message from other intelligent civilisations, and all the assumptions that carries about the motivation and context of communicating intelligences elsewhere in the universe. As yet, there is no internationally agreed media plan, although informing the media is mentioned in the *Declaration of Principles* (Billingham, J., Michaud, M., Tarter, J., 1989) to which most of the SETI groups are a signatory. I explore this more fully in Chapter Three.

SETI is not one homogenous organisation but a number of independent groups (although some have received funding support from the SETI Institute). The largest cluster is in the US – the SETI Institute http://www.seti.org, UC Berkeley SERENDIP Group http://seti.ssl.berkeley.edu, Harvard http://seti.harvard.edu, and the SETI League http://www.setileague.org. The others are in Australia http://seti.uws.edu.au , Italy http://www.seti-italia.cnr.it/, the UK and Argentina. The SETI Institute in California houses three major centres – one for the study of life in the universe, another for SETI and the third for education. Tom Pierson, Chief Executive Officer of the SETI Institute notes,

> 'Since 1984 we've been engaged in the search for the electromagnetic signals from a distant world that would indicate the presence of transmitters, evidence of extraterrestrial intelligence made manifest by its communications technology' (http://www.seti.org/about_us/info_for_media/backgrounders/seti_and_astro.html).

This is part of one of the goals in the 2002 Astrobiology Roadmap of the NASA Astrobiology Institute. The NAI http://nai.arc.nasa.gov/, created by NASA in 1998, is a virtual organisation bringing together 15 lead teams and international partners with a total of about 700 astrobiology researchers. The SETI Institute was not one of the lead teams up until June, 2003 but carries out 35 other astrobiology projects, in addition to the SETI experiment, many conducted at NASA's Ames Research Centre.

Funding might universally be an objective of researchers wanting to communicate with the public – those in government research need public support to encourage continued funding of their research. For the SETI Institute the funding issue is more direct. The whole US$12m a year required to operate NASA's SETI program was withdrawn in 1993 after Nevada's Senator Richard Bryan successfully introduced an amendment, effectively ending the SETI project under NASA. SETI had survived an earlier similar attempt by Senator William Proxmire in 1981 to end NASA's involvement, his mind changed by protests from astronomers led by cosmologist and SETI advocate Dr Carl Sagan. Bryan's mind was not changed and he pressed his case home, accusing NASA of 'failing to bag a single little green fellow' (Shostak, 1998, p 160). Since then, the SETI Institute has needed around US$4m a year to undertake the Project Phoenix search, depending on successfully attracting corporate sponsors and private donations. As an aside, it is worth considering whether NASA would have lost the SETI program had the issue come up a few years later. In late 1995 the first extrasolar planet was discovered and the following years the NASA Mars rock team announced that a Martian meteorite may indicate evidence of past life on Mars in a wet and warmer epoch billions of years ago. These announcements marked the point where astrobiology began to emerge, culminating in the formation of the NASA Astrobiology Institute in 1998. Dr Chris Chyba, Director of the Centre for the Study of Life in the Universe at the SETI Institute, gave testimony to a hearing on Life in the Universe by the House of Representatives Committee on Science under the auspices of the

Subcommittee on Space and Aeronautics. Chyba spoke of the science, emphasising the interest from students, 'We view this kind of interest as a tremendous opportunity to teach students and the general public about science and the scientific method that blend of openness to new ideas coupled with an insistence on hard evidence and skeptical analysis of data' (http://www.house.gov/science/jul12/chyba.htm).

Although SETI does not involve more than a few dozen researchers worldwide, it undertakes science communication in as broad a range as any science. For example, long before 'science wars' SETI researchers had identified and acted on the cultural and social consequences of possible success of its research efforts – an experiment that is itself a cultural undertaking – with a series of three workshops in 1991 and 1992. The *Social Implications of Detecting an Extraterrestrial Civilisation* drew together experts from the arts and sciences to consider societal preparation for success of the experiment including mass media interactions (Billingham et al, 1994). SETI has been characterised as one of the best examples of a socially-constructed science (Grinspoon, 2001). Harrison et al (1999) describe astrobiology, of which SETI is a part, as affecting our view of science, culture and ourselves.

SETI's media successes provide an intriguing example for other areas of science wishing to create a public profile. Today the SETI Institute regularly receives TV crews (see later in the chapter). Media interest remains strong. My own sampling of the archives of the *New York*

Times, the *Washington Post* and the *Los Angeles Times* using their archival search engines shows that over a five-year period, the three papers collectively ran 150 SETI-related stories. Nor is this restricted to the US. Around 80 national and international media interviews, mostly on SETI, were generated at the International Astronomical Union's Symposium 213 *Bioastronomy 2002: Life Among the Stars* on the Great Barrier Reef in Australia July 8-12. SETI media and public outreach are also undertaken at the International Astronautical Congress with the twin objectives of developing media relationships in whatever country the Congress is meeting and in understanding perceptions of SETI through local public interaction. This started in 2000 in Rio de Janeiro, Toulouse in 2001 and Houston in 2002 and will continue onto Bremen 2003, Vancouver 2004 and beyond under the auspices of the International Academy of Astronautics' SETI Permanent Study Group (http://www.setileague.org/iaaseti/index.html).

For most of its history, SETI has had – at the very least – a continuing sense of the interconnectivity of science communication across its communication efforts as evidenced in the 1991 and 1992 NASA workshops where education, news and entertainment are grouped in one study. It has had a persistent presence in the national and international mass media for more than four decades. In addition, the SETI Institute has experience in developing high school level science curricula and in providing learning experiences for the public via public talks, television documentaries, a public special interest group (Team SETI), e-mail responses from scientists to the public and a weekly one-hour SETI show broadcast on Radio America. The approach provides a broad platform to broadcast its key message. ‘We want SETI to be a household name,’ says Tarter (private interview, 2003).

Interlocking issues in science communication

There is a plethora of intertwined issues in the communication of science to the public. These include conveying the process of science to the public; language; communication of uncertainty; dividing science from pseudoscience; public attitudes towards science and what the public hears when scientists speak. Among other issues are the cultural approach of the laboratory and the newsroom, issues in science reporting, science wars, public trust of science, media literacy, and the cultural importance of science. Little is known about how the public digests and integrates science information and education into their worldview, decision-making and use in evaluation of other science information. An increasing barrage of science information and the way it is rapidly sent, received and exchanged, overlies it all. The selling of science (Nelkin, 1986) has never been higher and as science writers often report, it is easy to tell in the newsroom which reporter is covering science by the weight of mail in his or her mailbox. But is science communicated to the public only via the mass media?

Bruce Lewenstein, a communications professor at Cornell University and owner of the long running listserve the *Public Communication of Science and Technology* thinks not, supporting the idea that mass media is only a part of the science communication process, connected in a web of communication from within science as shown in figure 1.

Figure 1: The communication web as proposed by Lewenstein

(Source: Hargreaves, 2000 ***http://www.esrc.ac.uk/esrccontent/publicationslist/whom/whofirst.html)***

Professor Ian Hargreaves, writing in the public understanding of science report *Who is Misunderstanding Whom?* http://www.esrc.ac.uk/esrccontent/publicationslist/whom/whofirst.html for the UK's Economic and Social Science Research Council goes further. He notes, 'As Lewenstein says, the task ahead involves reconceptualising our idea of what science communication is. This cannot possibly be achieved without a sustained pan-disciplinary approach from scientists and social scientists.' Hargreaves, Director of the Centre for Journalism at Cardiff University, Wales, also takes to task the House of Lords Science and Technology Committee Third Report

(2000) for failing to recognise the interconnectivity of science communication and the influence of the Internet, underscoring the changes now underway.

> 'The requirement is not for scientists to learn to work with the media as they are…but for scientists to learn to work with the media **as they are becoming**' (ibid http://www.esrc.ac.uk/esrccontent/publicationslist/whom/whofirst.html).

The SETI Institute has demonstrated an awareness of this influence from an early stage of the availability of the World Wide Web to the public. It has had a long-term presence on the Internet, and responded to changes in communication with multiple audiences, including the media. For example, for Arecibo observation runs it uses a pair of cameras linked to its website so that Internet users can view the work going on from anywhere in the world. It also provides a media kit online http://www.seti.org/about_us/info_for_media/Welcome.html and information to teachers about life in the universe science curricula http://www.seti.org/epo/Welcome.html. The first SETI Institute site appeared in 1994 as the web began to emerge into what it is today, recording approximately two million hits a month. As mentioned in the introduction, more than half a billion people – a twelfth of the world's population - are now connected to the Web and it is growing dramatically http://www.nielsen-netratings.com.

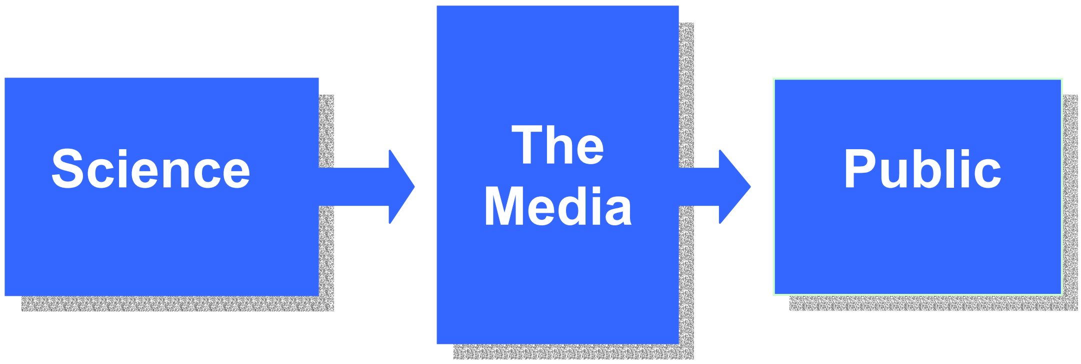
These changes in communication are identified in a number of respects. The NSF Science and Engineering 2002 Indicators show, for the first time, 9% of respondents to a public understanding of science survey say the Internet is their primary source of science information, although the majority of respondents (44%) say television news is their primary source. In Europe, 16% of respondents in the Eurobarameter 55.2 study (2001) use the web as their main source of science information. Journalists are using the Internet for research. Between 1994 and 1999 e-mail usage by active science journalists belonging to the US-based National Association of Science Writers jumped from 18% in 1994 to 80% in 1999 with membership remaining steady at the 900 mark (Trumbo, 2001). A survey by PR News supports the findings. In a 1999 survey of 3,000 journalists, it found only 2% were without Internet access compared to 9% in 1998 and 37% in 1995 (PR News, 1999).

Trumbo also reports comments from science journalists and editors that indicate that almost all communication is via the Internet due to the ease of collecting information from multiple sources at once and to access a wide range of visuals worldwide at the press of a key. The Internet is used for research too as well as a news source through such services as 'Eurekalert' http://www.eurekalert.com.

The activity Trumbo notes among science journalists is also reflected in professional science journals with most now having a version of the journal online. Early on, the professional journals like *New Astronomy* realised the benefits of electronic publication, such as the ability to include short mpegs to demonstrate points visually and dramatically. In a video simulation accompanying a paper in the first issue of *New Astronomy* in 1996 (Elsevier Science) the author of a paper on binary pulsars demonstrated how the stars rotate, evolve, and how one sucks up matter from the other and then the gorged star explodes supernova-style. Internet editions of a journal are not only able to provide more information than is possible in print but is cheaper than the print version. The Internet is also an efficient method of collecting pictures, on-camera commentary and news from places where it might have otherwise proved impossible, or at least in the instance of on-camera commentary required the presence of a camera team, as witnessed in the reporting of the recent wars in Afghanistan and Iraq. Journalists use mobile workstations that interface with the Internet via satellite without the need for a telephone line. Taubes (1996, p 764) predictively summarises it, 'this electronic wave isn't just a change in medium; it is also a force that is transforming the nature of scientific communication.'

If the Internet is changing science communication, how does that affect relatively recent attempts at modeling science communication? Bucchi (1998) posits that it has reinforced the proposition that the canonical model of communication, in which there is one-way communication from the scientist to the science journalist to the public, is outdated.

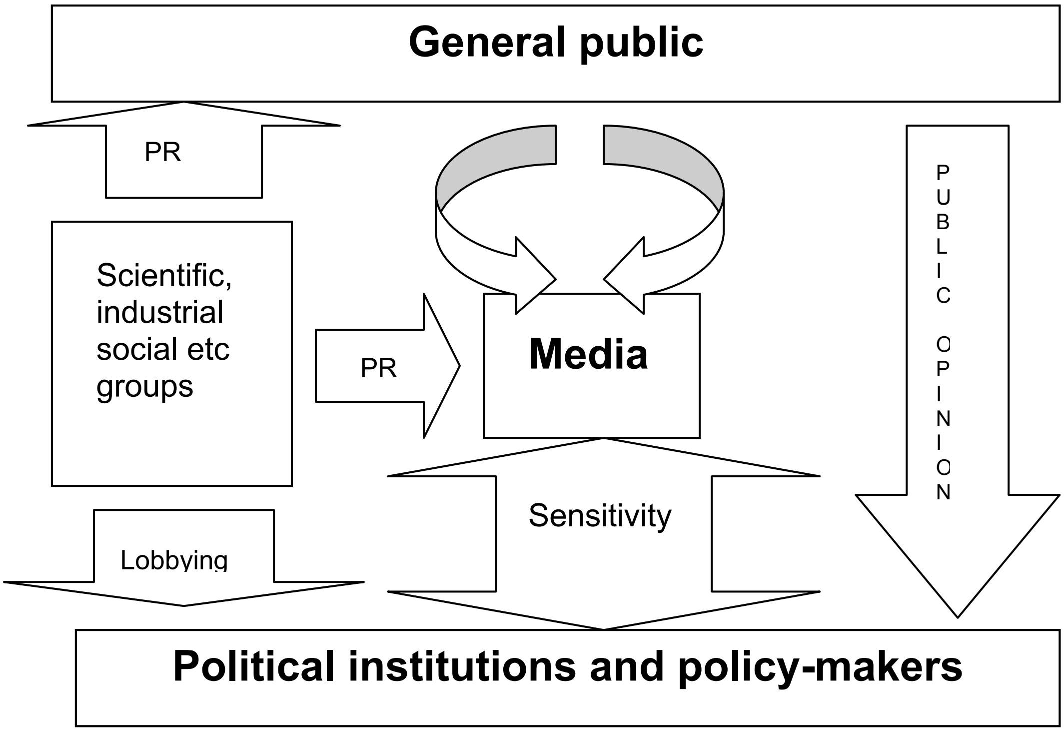
Figure 2: The canonical account according to Bucchi (1998, p5)



Einsiedel and Thorne (1999, pp 43-57) argue science literacy models also suggest science communication is a one-way process but that in an interactive model science in society is taken into account, implying the information is actually shared or even multidirectional. The UK government believes the latter is true too, encouraging discourse between scientists and the public as a route to recovering public trust in science after such unsettling episodes as BSE (mad cow disease) and Genetically Modified (GM) foods. The UK government's Office of Science and Technology asked the British Association for advice on how to tackle this issue and a range of activities was proposed. These included discussion events, laboratory visits, public consultations, work experience in areas of science and provision of information to and through the media (British Association, 2002, p 6).

Professor John Durant's model of science communication (see figure 3) takes an alternative view to the canonical account. He sees the communication process interacting with the public and the media central to reflecting and generating public opinion, which in turn affects policy-making – a point that appears to be reflected in the UK experiences.

Figure 3: Durant model of science communication



(Source: Hargreaves, 2000, Chapter 2,

http://www.esrc.ac.uk/esrccontent/publicationslist/whom/whofirst.html**)**

SETI researchers, in a report on the series of the already mentioned NASA SETI workshops in 1991 and 1992 (Billingham, et al, 1994), note the specific influence of the media that are central to Durant's model,

> ‘It is important to recognise that in societies with advanced media technologies and a relatively autonomous and unregulated press, the information media are crucial both in *reflecting* those societies’ emotional contexts and *establishing* those contexts’ (p 5 -15).

However none of the models offers a complete picture of science communication at work. For example, none include the concept of the general public being more than one type of audience, although this has been pointed out by a number of science communication scholars, including Jon Miller, a Chicago University professor who has undertaken the public understanding of science study for the US National Science Foundation for the past four biennial studies. He identified three types of public audience – a science attentive public that is generally well-educated, and reads science at the level of popular magazines and watches science documentaries; a science interested public, obtaining science news from newspapers and TV news; and a science non-attentive public. Of the latter he says very little is known and ‘… their scientific needs may be characterised as consumer-oriented or practical in nature’ (Friedman et al, 1986, p 62). This is reinforced by a panel of science communication experts brought together between 1998 and 2000 at the Space Sciences Laboratory of the NASA George C. Marshall Flight Centre. The team comments,

> ‘… there is no such thing as a one-size-fits-all public communication message for a mythical lay public. Single messages designed to reach all public audiences typically end up

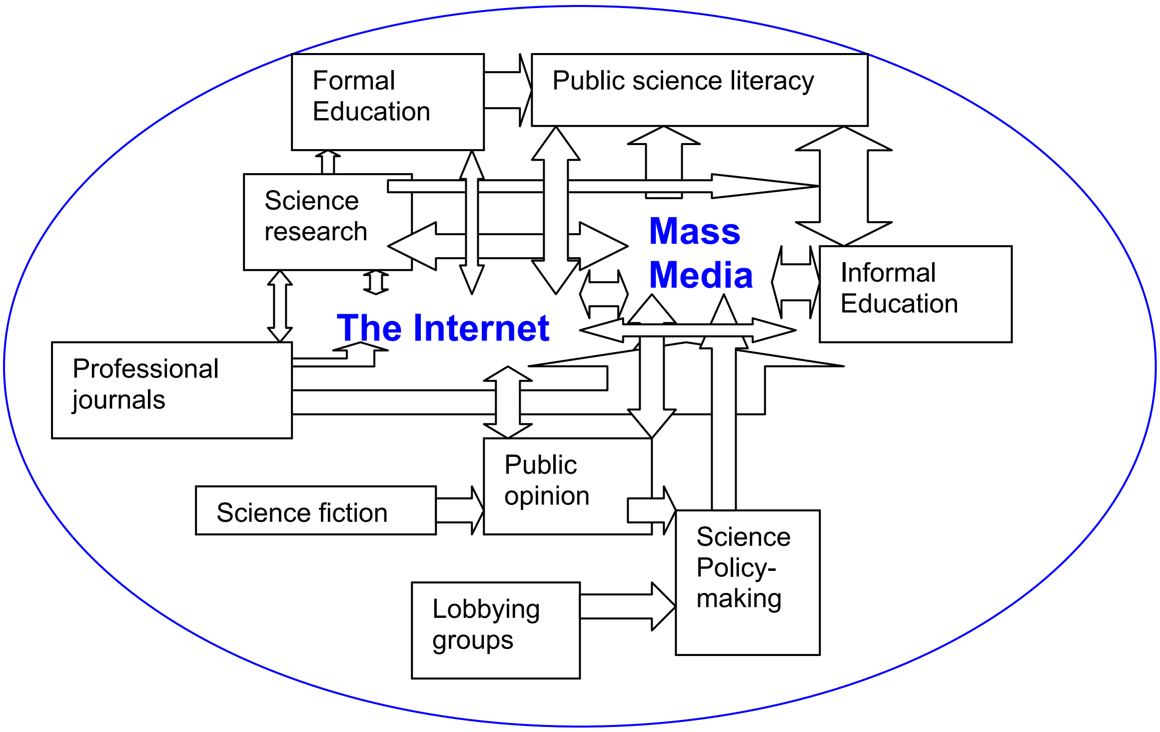
> reaching none of them very well, especially in an information environment with a myriad of media channels (which is growing daily) from which an audience may choose what suits it' (Borchelt, 2001, p 198).

Wilkie, former Science Editor of the Independent (UK daily newspaper) draws out the convergent conclusion, 'Only by understanding the way that different sorts of media interact with each other and with different sorts of public can we possibly progress towards understanding the ways in which different publics acquire knowledge and form opinions about science, or indeed any other subject. Communication is always (at least) a two-way street' (2000, Ch 2, http://www.esrc.ac.uk/esrccontent/publicationslist/whom/whofirst.html)

The model may be more complex

Perhaps the communication model, if there is one that can give an overall scenario is actually more complex as suggested in figure 4. This emphasises how the Internet is beginning to take a significant role in science communication and the interconnectivity of forms of communication – a roadmap to how messages from science can be assimilated into society and even influence public opinion via a variety of information and education settings. Informal education includes a wide variety of public education opportunities including museums, television and radio documentaries, public talks, popular science books and informal adult education classes. In particular, it emphasises how interconnected science communication can be.

Figure 4: A suggested model of communication lines



(Source: Carol Oliver, 2003)

Uneasy scientist-journalist relationship

While science communication is clearly in a state of flux and change, the scientist/science journalist relationship remains an uneasy one, though strangely symbiotic. Scientists and science journalists work in two entirely different environments as characterised in the literature mentioned earlier. Scientists work methodically and slowly in their particular research area, carefully checking and cross-checking. There are no deadlines for the science – the aim is research excellence. Science journalists, on the other hand, work quickly - often with little or no background on a particular story - aiming to produce the best piece in the deadline-oriented time available. Barbara Wold, a biologist at Caltech, describes a typical interaction with the media.

> ‘What do you think about this?’ the reporter asks.
>
> ‘Well, I haven’t seen it,’ Wold responds. ‘Can you show me a paper? Can you show me a press release?’
>
> ‘No, it’s being reported on CNN’
>
> (Buck, 2002 http://www.facsnet.org/tools/sci_tech/2002_institute.php3).

Dr Seth Shostak of the SETI Institute, complains, ‘(Reporters’) questions are usually imperfectly formulated or they are trivially formulated. They tend to ask either questions anyone could have asked, which means they know nothing about the subject and have done no research – they have simply been put on the story. Or else they have done some research and know enough to ask good questions but are not sufficiently schooled on the subject to understand the standard responses.’ He says his expectations of reporters are ‘not terribly high’ but even accuracy is ‘expecting too much.’ However, Shostak ‘almost never’ prepares for a media interview. ‘Often there is no time – I pick up the phone and they want to do the interview right there and then’ (personal interview, 2003).

Dr Jill Tarter, Director of the Centre for SETI Research at the SETI Institute also often feels frustrated with media interaction,

> 'They pretty much know what they want to do when they come in (to the Institute). What takes my time is making physics understandable. It is a complex process. Why is it we can't turn on some kind of universal decoder and listen for any type of signal? Just showing why after 43 years we're not discouraged that we haven't found anything – trying to make the point that we've hardly begun the search in spite of all the effort. I haven't found any good analogies. We as human beings don't have a good capacity for imagining the scope of the search' (Tarter, personal interview, 2003).

Tarter, who tends to be characterised as the real life version of the leading role played by Jodie Foster in the film *Contact*, undertakes hundreds of interviews, many of which begin an interview 'with that line running around in their heads' (ibid).

On the other hand, science journalists like Roger Highland – science writer at *The Telegraph* in London since 1986 – provide an insight to the other side of the story.

> 'To carve out a slot among column inches of murder, politics, and mayhem, I file three or more stories daily. Every day my efforts

are judged against three direct competitors and two mid-market tabloids as we fight for the attention of 14 million readers. Every day, my news editor compares my stories, angles, and intros with those in the other nationals. Every day, I have to justify my existence' (Highland, 2000, p 59).

Highland, in a survey by Professor Ian Hargreaves (2000), was voted by his peers as the most respected science writer in the UK. As Hargreaves points out though, the peers number only 11 science journalists in the UK against 22 on the *New York Times* alone. In Australia the number is even lower than in the UK with two science specialists on the *Sydney Morning Herald* and one each on *The Australian*, the *Melbourne Age*, the *Canberra Times,* the *Adelaide Advertiser,* the *West Australian,* the *Brisbane Courier Mail* and *ABC Science Online,* making a total of nine in the world of Australian daily news.

Highland's experience reflects the experience of other science journalists like Leigh Dayton on *The Australian.* Many are handling a number of stories together over diverse disciplines with one or more deadlines each day. Their aim is to report accurately, and on time – which usually means little time for detailed research.

US science writer William Allen concurs saying science communication is 'history on the run.' He goes on, 'Although science thrives on details and precision, journalists generally have to simplify ideas in lay language at the expense of dumping details. We're faced with the immutable constraints of time and space with the differing capacities of our readers (a very diverse group) to absorb complex ideas' (Allen, 2001, p 289).

The symbiotic relationship

For SETI the obvious mismatch between science and the media is an irony. Should the experiment succeed, a signal that has traveled hundreds, perhaps thousands of light years across space might well meet its most difficult journey right here on Earth. Humanity will learn of this story in the media, which will have gleaned most of their information, hopefully, from scientists (Oliver, 1997).

In spite of the mismatch, the scientist-journalist relationship is a strangely symbiotic one. The science journalist has to avoid upsetting valued scientist sources – the contacts – as well as convince the often science illiterate news editor that science is worth covering in the first place. It is tough to sell science. So the journalist is dependent on the sources in getting news from the lab into print or on air (Nelkin, 1987).

Like any other journalist, the science journalist lives in a world of searching for the new, the controversial, the novel, the interesting, good talent, good visuals, good quotations, good sound bites and dealing with tight deadlines. But it is also a struggle in getting the story in the first place, as characterised by Julian Cribb, former science editor of

The Australian and now a consultant to CSIRO. In the Bureau of Rural Resources Working Paper *Communicating Science to Non-Scientists* (1992) he writes,

> 'Many scientists still seem to think that the media is somehow responsible for many of society's ills, an object to be avoided and disdained, frequently abused and criticised, but at best kept at a careful arms-length and told only those things considered good for it to know. Journalists are often mistrusted by scientists.'

Cribb says the latter arises because the scientist fears being misunderstood or misreported. And so the tug 'o war goes on, with neither scientists nor journalists really fully understanding the needs and goals of each other. In the cases of Tarter and Shostak, for example, even in situations where there is complete willingness to be of assistance, the necessarily non-specialist position of the science journalist (either from a science or arts background) means the communication process is a sometimes lengthy and complicated ballet between the scientist and the science journalist. Short sound-bites must be undertaken at times - difficult even for media-savvy scientists to do. The task is formidable, and suggests it is unreasonable to expect researchers with little or no media training to undertake it with ease.

Science itself discourages science communication via the mass media. It happens via peer pressure and the lack of recognition for attempting to communicate. Peer pressure is particularly evident in the university environment where publicity seems to somehow trivialises the scientific work and/or there are undercurrents that suggest the scientist is big-noting him or herself. Associate Professor Frank Stootman, Director of SETI Australia at the University of Western Sydney has felt such pressure even though Southern SERENDIP, the SETI project he undertakes, was respected enough to be allowed ongoing use of the Parkes radio telescope, the largest radio astronomy telescope in the southern hemisphere. However, it did not affect eventual promotion – he gained his Associate Professorship while still engaged in the SETI work (Stootman, personal communication, 2002).

At the SETI Institute, no such pressure exists – in fact it is quite the opposite because as an organisation dependent on private and corporate donations it wants to raise its visibility. Tarter's main frustration is not being able to track media interactions against funding and therefore not knowing where to best place her time when getting media requests. Generally, she keeps to the obvious – more time for a reporter from a large circulation newspaper like the *New York Times* than the *Sacramento Bee*. If she has a complaint about reporters in general it is because they do not report SETI 'for the exploration it is.' But she agrees accuracy is good more than half the time, although glaring errors still happen (Tarter, personal interview, 2003).

A persistent presence in the media, plus the emergence of astrobiology, means that the SETI Institute is now achieving more frequent media coverage with a higher accuracy rate. Dr Frank Drake, former Chair of the Board of Trustees of the SETI Institute, comments,

> 'Over the decades media coverage of SETI has expanded a great deal. This can be explained largely as a result of the much larger number of SETI projects now in existence, and there has been some significant impact from seti@home, since it is news relevant to its many users. The quality of reporting has improved. SETI used to be reported often in the category of 'news of the weird', complete with implied chuckles. Nowadays it is almost reported in an unbiased way as a regular part of science' (Drake, private communication, 2003).

Shostak agrees with Drake. He began handling the Institute's media calls for about ten years from 1991 during which time there was a gathering interest in SETI. This may be partly because Shostak is considered 'talent' by the media and the tendency is for the media to keep note of talent. This means someone able to present his or her science area in a concise and interesting way without using jargon. But there have been other factors such as the movie *Contact*, the *X-Files*, the *Art Bell* radio show and other media 'the strengthened the image that aliens might exist (although in a non-scientific way)' (Shostak, personal interview, 2003). The fiction and non-scientific media reports encouraged new cable network shows like *Discovery*, the *Learning Channel* and the *National Geographic Channel* to make documentaries. By 2001 TV crews were visiting the Institute from around the world at the rate of about one every two weeks.

Other influences are at work. Dunwoody (1999) and others have pointed out that science journalism is unlike any other type of journalism. In science it is more difficult to separate the prevailing thought from dissent, making ‘balance’ or investigative reporting difficult to undertake. It is even more difficult to determine the importance of a story very easily. Shostak, a trained astronomer, notes ‘… it would be very difficult for me to assess a development in say biology, microbiology or chemistry even though I’m trained in science. I wouldn’t be able to tell if it was a small advance or something at the edge of our knowledge or something very fundamental’ (Shostak, personal interview, 2003). The real art is in understanding the story in the context of the big picture and writing about it well, he adds, but admits it is difficult to do where the story is in a broad circulation newspaper rather than in the narrower focus of popular interest magazines like *New Scientist* (ibid).

Dunwoody (Friedman et al, 1986) notes a tendency for science reporting to centre on science meetings or events, with little generated beyond this, particularly in bad news stories that tend to be reported only in a crisis like Three Mile Island. David Perlman, science writer with the *San Francisco Chronicle*, cites sources for his own science newsgathering as scientific journals, universities, research institutions, science-based companies and government agencies who ‘…are all eager to let us know the achievements of their scientists and engineers, and reporting them fills our days' (Blum et al, 1997, p 4). It is worth noting the objective he sees in communication – it is to publicise 'achievements' rather than promote the public understanding of science. The style of reporting also challenges the notion of education content in the mass media. Science journalists find themselves needing to evaluate claims, to find a middle course in allegations, to report on controversies such as creationism in the science classroom and to maintain objectivity. Perlman notes 'How do we keep our own feelings in check – pro or con – when we write about the deaths of the superconducting supercollider and the near death of SETI?' (Blum et al, 1997, p 5).

Scientists and science journalists may be 'worlds apart' (Hartz et al, 2000) but they are inseparable in their passion for science, as mentioned earlier. Perlman reflects thoughts common among his peers. His real joy is in the opportunity to be there when discoveries unfold from being in the laboratory when tests are done for a potential vector for gene therapy in a mouse model to standing by 'the consoles of mission controllers interrogating an interplanetary spacecraft' (Blum et al, 1997, p 4). Claudia Dreifus agrees, and says of scientists, 'at the end of the day, what makes science interviewing such a blast is how marvelous the people are and how many of the important changes for our lives and societies in the 21st Century will, very likely, come from them – revolutionaries, indeed' (Dreifus, 2002 p 28). She added that 'just about every major policy issue' for the George W. Bush administration had a science component, from stem cell research to global warming.

CONCLUSIONS

In this Chapter I have explored SETI interactions with the media and shown that even with experienced scientist communicators and science journalists there are difficulties in communication. While science communication workshops, courses and work experience (journalists in the laboratory, scientists in the newsroom) may be beneficial for both scientists and journalists, none address the problem of a science journalist being able to be a specialist for all areas of science.

The scientist-science journalist relationship itself is different to normal journalism. Science journalists are biased by their interest in science, and curtailed in their reporting by the fact that often the interviewee is also considered to be an ongoing source of science stories. Scientists are different in their expectations of the media in that they expect the media to reflect their views without the same methodology they would apply to a hypothesis. In tight deadline situations journalists expect definitive answers immediately while scientists request a paper to read, consider and then comment on. Scientist and science journalists have needs and goals that are polar opposites, but both claim to seek truth and objectivity.

I have also explored and discussed in this Chapter how science communication takes place at many levels, including two-way communication with the public. Media is a node on a web of communication, though a central one. Combined with the changes in communication unfolding through the Internet, I have explored how the traditional view of science communication via the media as a process from scientist to science journalist to the public is too simplistic, even as an overview.

I have described the indications that the Internet is changing the way science is communicated by the way public audiences use it. With more than a twelfth of the world's population now connected to the Internet I have discussed how changes in science communication might be expected. This has already happened with major news organisations having an Internet presence such as the *BBC* in the UK (http://news.bbc.co.uk/2/hi/science/nature/default.stm), the *ABC* in Australia (http://www.abc.net.au/science/), *CNN* in the US (http://www.cnn.com), the *New York Times* (http://www.nytimes.com/pages/science/index.html), the *San Francisco Chronicle* (http://www.sfgate.com/science/), *Washington Post* (http://www.washingtonpost.com/wp-dyn/nation/science/) and the appearance of specialist news services such as space.com (http://www.space.com). Science organisations like the SETI Institute are using the web as a method of informing both the public and the media. The latter usually does not involve a science journalist in the traditional interpretation role in delivering science news and information to public audiences.

CHAPTER 2

Science, pseudoscience and public audiences

This Chapter is aimed at exploring areas of science communication through the experiences of SETI. It will contribute to the conclusion in Chapter Four that the media is probably not a suitable vehicle for mass remedial science education or even as part of a science communications strategy aimed at education (Billingham, et al, 1994) and building on Perlman's comments in Chapter One (p 54). I will explore scientific illiteracy, the implications of belief in science as well as pseudoscience among the public and the role of defining the audience or audiences for the messages of science. I will do this by discussing the widespread science illiteracy among the adult population claimed by major surveys in the US and Europe on the public understanding of science. The actual term 'science illiteracy' is not well defined and open to debate so the methodology of determining 'science illiteracy' is also questioned (National Science Foundation, 2002; Eurobarometer 55.2, 2001). I will further review the literature to show how the messages from science are often driven by the need to raise the profile of a science institution rather than aimed at improving the public understanding of science and that unfounded assumptions are made about the benefits of good science communication (Borchelt, 2001). Audience selection is another critical aspect that will contribute to the final conclusion of this thesis in Chapter Four. The public is often treated as one audience, though Miller (1986), the UK Office of Science and Technology Report (2002) and others have pointed out there are well-defined multiple audiences within the label 'public' and therefore multiple levels of science communication needs. Furthermore, science is communicated in a backdrop of popular culture including science fiction where specific outcomes for science communication can be identified (Friedman et al, 1999; Shostak, 2003).

Surveys from the UK, USA and Europe all report an apparent high interest in science - in the case of the USA, nine out of ten adults (National Science Foundation, 2002). However, these surveys also report a high science illiteracy rate as mentioned in the introduction to this thesis. One explanation – provided by the survey respondents themselves – is that the interest is high but the understanding is low. However, the methodology of the measure of science illiteracy is questionable as are models that suggest the public is an empty vessel into which one pours scientific knowledge (Turney, 1996).

The US survey results raise a range of questions that are relevant to science communication. For example, how do societal attitudes and context affect science communication? What role does visual and media literacy play in bringing scientific literacy to the public? Does the mass media have an educational role, and what evidence exists that it is a suitable vehicle for any science communication strategy? What are the objectives of science in communicating via the mass media, and to whom are scientists trying to communicate? How do these questions relate to the apparently high scientific illiteracy rate and the effort to improve science communication?

Perhaps the ‘big picture’ aspect of the public reception of science information is societal attitudes. This sets the framework for more detailed description on the apparent dichotomy of a scientifically illiterate, yet science interested, public.

Science communication is often thought of in terms of what is happening today and that nothing much has changed. However, when viewed over decades, changes in societal attitude emerge. A flow of societal mood is an effect analogous to a wave function with peaks and troughs mirrored in the reporting of science, as noted by Gregory and Miller (1998) and Nelkin (1987). These changes may be relevant to science communication today and in the future and have been recognised by SETI researchers as having implications for the way the public will respond to news of successful detection of an extraterrestrial civilisation, as mentioned later on in this Chapter. Gregory and Miller's analysis is based on a study supported by the Science Museum in London aimed at tracking science stories in the media between 1946 and 1990. It was led by Martin Bauer and his team. This collection indicates that until the mid 1960s science news coverage was generally positive and stressed the benefits of science. Then coverage changed to a more negative tone in the 1970s with the reporting of the risks of science becoming more prominent before flipping back towards positive attitudes towards the end of the study in the 1980s. This concurs with Nelkin's observations of one science journalist's stories, which she says are characteristic of other science news in the same time period. She notes that David Perlman's stories (*San Francisco Chronicle*) in 1960 'expressed the general post-Sputnik optimism' (1987, p 99). Terms used included scientists being referred to as 'detectives and wizards seeking clues', 'probing secret structures', 'unlocking stubborn secrets', operating with 'flashes of insight'.

Change in tone of media reporting

By 1972 a change had occurred in the tone of reporting – one of criticism, insisting on the limits of science, ethical considerations in genetics and public hostility on the rising costs of some science projects. Nelkin comments, 'He wrote on the hazards from oil spills, food additives, pesticides, nuclear power and air and water pollution, always emphasising the controversies surrounding these issues' (1997, p 100). By 1982 the mood had swung again towards the positive with adjectives such as 'revolutionary', 'frontier', 'explosive growth' and 'cosmic mysteries'. Nelkin argues that science journalists '… adapt their writing to the spirit of the times and use their instinct on what readers – and opinion leaders – will find interesting' (1997, p 100). This concurs with the authors of *Societal Implications of Detecting an Extraterrestrial Civilisation (*Billingham et al, 1994*)* who note, 'The tone of media reporting has significant influence on public perceptions of whether times are 'good' or 'hard' (1994, p 5-5). For SETI the positivity or negativity prevailing has a significant impact, according to the authors. They maintain individuals and groups change their outlook on the same given stimuli, so the tone of reporting an event will change in response as Gregory, Miller and Nelkin have noted earlier in this Chapter. Premature reporting of a potential extraterrestrial civilisation detection, which subsequently proves negative, could trigger a negative response in either a societal attitude of pessimism or, to a lesser extent, in one of optimism. Billingham et al note that the potential for reinforcing a negative emotional context (or undercutting a positive one) seems high (1994, p 3-9).

But what does the public remember of what they read and does it matter? Billingham et al argue that '… the final practical effects of any strategy to use media as a mode of public information are questionable' (1994, p 5-14). They point to little or no data on the effects of mass reporting of the type that Tarter (2003, private interview) wants to use to foster SETI becoming a household name. 'Visibility is totally important for an organisation that lives on public donation for funding,' she says. But she admits to also being frustrated by not knowing what impact any particular story has, leaving only size of audience and audience profile as guides to granting time to reporters.

The SETI Institute's objective in communication characterises a comment made by the blue ribbon panel of Pulitzer prize-winning journalists and other experts, brought together between 1998 and 2000 by the Space Sciences Laboratory at the George C. Marshall Spaceflight Centre in Florida, mentioned in Chapter One. That panel were charged with considering how to improve science communication between the laboratory's researchers and public audiences. The panel, nicknamed the R2 Group and chaired by science communicator Rick E. Borchelt, pointed out that the objectives of institutions were generally not aimed at improving public understanding of science, but at enhancing reputation or, as in this case, raising dollars to support a scientific enterprise. This concurs with Perlman's comments in Chapter One (p 54). In the case of the SETI Institute it appears that the media are not part of any strategy to enhance the public understanding of science. The Institute, instead, concentrates its efforts on a well-established high school science curricula program currently centred on its *Voyages Through Time* year-long curriculum, the development of which was largely funded by NASA and the US National Science Foundation. In addition the Institute undertakes a range of informal education efforts including public talks, museum exhibits, participation in television documentaries, and in its weekly Radio America show *Are we alone?* So it is perhaps hardly surprising in the light of Tarter's comments on using the media for profile-raising that the Institute does not use the media as the main vehicle for encouraging public understanding of science. This is in line with comments made by the *Societal Implications of Detecting an Extraterrestrial Civilisation* workshop team. The authors say, '…the final practical effects of any strategy to use media as a mode of public information are questionable. Summaries of the effects of mass communication of scientific work via news media are very few' (Billingham et al,1994, p 5-14). These comments concur with the R2 Group, which notes that considering science demands data it is surprising that little or no evaluative work has been done to determine what impact any message via the media has on the public. 'For a data-driven enterprise, science demands very few data from communicators of science, whether to craft and frame appropriate messages and message content or to evaluate the impact of messages on scientific knowledge or behaviour,' the panel noted (Borchelt, 2001, p 196).

Impact of messages

Determining the impact of a specific message is difficult in science says Borchelt (ibid) unless it is in the medical area where a change in behaviour is clearly identifiable. An example is the collection of campaigns to reduce the number of smokers, though one obvious conclusion is that such campaigns make media only a part of a communications strategy that includes advertisements, pamphlets, posters and advice from doctors directly to patients. However, there have been some science related news stories that have indeed had a marked and lasting effect on society or a specific society. A clear example (and one whose influence reached even the birth of SETI) was the impact on US society of the launch of the Soviet satellite Sputnik 1 on October 4, 1957. A survey six months prior to Sputnik 1 and another six months after the launch revealed a dramatic jump in the understanding of the potential of satellites (Hillier et al, 1968). Such big news often invokes societal changes and Sputnik proved to be a pivotal event as reported by Billingham et al (1994). It influenced US law, policy and in particular science education. NASA, formed in response to the Sputnik launched, was charged with disseminating science information to the public. Today any researcher awarded NASA funding has to pledge a minimum of 5% of that to public outreach. Other big story events have had an effect too – for example the sinking of the Titanic resulted in all passenger ships having enough lifeboats for all and the Shuttle Challenger disaster in 1986 was supposed to have led to greater safety standards (Nelkin, 1987) - though questionable with the loss of yet another Shuttle, Columbia, in February 2003.

In spite of this evidence, the SETI workshop report authors argue conveying science information to the public via the media alone would probably work no better or worse than other methods via informal and formal education. The *Societal Implications of Detecting and Extraterrestrial Civilisation* workshops' report counsels inclusion of a wide range of strategies to publicise SETI, which are followed by the SETI Institute today. These include reaching the public via science fiction on television and in the cinema – counsel that was to be somewhat predictive with the production of the film *Contact*, based on a book by Carl Sagan of the same name. The film grossed $100,870,675 at the box office (Steinke, 1999, p 113) and the effect was measurable to a certain extent, contributing to an increase in use of the SETI Institute's web site and television crews interested in news or documentary pieces (Shostak, personal interview, 2003).

Role of science fiction

Science fiction appears to play a role in the societal response to science. *Contact*, for example, provides the first silver-screen representation of a female scientist in a position of power as a young woman with a passion for science. Ellie Arroway's quest is the scientific answer to a long-asked societal question, Are we alone? Jodie Foster, who played Arroway, spent some time with Jill Tarter, Director of the SETI Institute's Centre for SETI Research. Even today Tarter encounters media curiosity about how fiction and fact parallel for her (Tarter, 2003, private communication).

Billingham's team recognised before *Contact* that such books and films with some scientific integrity had laid the way so that '… most cultures now possess a body of speculation on possible encounters between human beings and intelligent extraterrestrial life, much of it imaginatively and aesthetically motivated' (1994, p 5-20). These books include *The Black Cloud* (Hoyle, 1957), *The Listeners* (Gunn, 1972), and *Contact* (Sagan, 1985). Other influential popular culture mediums might be the television shows, *Star Trek* and the *X-Files* and the movies *E.T.* and *Close Encounters of the Third Kind*. SETI is not alone in experiencing a cultural setting created by science fiction. In fact it has prompted at least one serious science documentary to use the cultural setting to put into context some fairly heavy science. Priest (1999, p 106) describes how *Jurassic Park* seemed preposterous to scientists but a *Nova* television program drew together experts to find out just how possible it might be to make a dinosaur from very ancient DNA, if indeed the DNA was viable at all.

While SETI embraces science fiction and its place in creating a societal worldview, it finds a nemesis in Unidentified Flying Objects (UFOs), of which more than half the US public believes are visiting the Earth on an almost daily basis (National Science Foundation, 2002). A smaller percentage thinks US citizens are being abducted for reproductive experiments, which Shostak points out in *Sharing the Universe* (1998) would not work anyway. A species is defined by its ability to breed, and we can't do that with other species in spite of the fact more than 95% of our genes (in one case 99.99%) are in common, he says. The late Carl Sagan (1996) was deeply concerned about the inability of the public to divide science from pseudoscience. As mentioned in the introduction to this thesis, he believed a lack of knowledge of the scientific method left the public without a means of critically analysing what they were being told. This view is supported by the SETI Institute's Deputy Chief Executive Officer and Director of Educational Programs, Edna DeVore,

> 'The pseudoscience accounts are carefully filmed and professionally narrated for television as 'documentaries' about mysteries, or unexplained events. All aim to convince the public that aliens have been here or nearby on the Moon or Mars, and that all of the 'evidence' is being covered up by a grand conspiracy of seriously un-fun people in the government, universities and research organisations'

http://www.space.com/searchforlife/seti_devore_face_020425.html.

DeVore says denial or offering alternative explanations fuels the conspiracy or cover-up theory. However, teachers have the opportunity to encourage their students to critically analyse a situation – to become scientists. The Face on Mars pictures, for example, provide the 'teachable moment' – the point at which students can be encouraged to uncover the evidence for themselves.

Director of the Knight Science Journalism Fellowships at MIT, Boyce Rensberger, agrees with Sagan and DeVore.

> 'Many scientists think this is a zero-sum situation: if you believe in pseudoscience, you surely can't believe in real science. But the fact is, a large share of the public does believe in both. Why? They can't tell the difference' (private communication, 2003).

He says many people lack the ability to understand the nature of evidence,

> '… what it is, how it is obtained and why some forms are worth more than others. And why sincerity and passion are irrelevant to deciding what might be true. That, in my opinion, is what we

> need to be communicating to our readers, viewers and listeners.'

Given the views of Sagan, DeVore and Rensberger, a conclusion could be drawn that scientific literacy is much like literacy itself. Norris et al (2002) argue scientific literacy is not a collection of facts but more akin to literacy in the ability to read and write. '… the comprehension, interpretive, analytical, and critical capacities required to deal with science text are largely, if not entirely, the same as those required for texts with different substantive contents.' If this is correct then measuring scientific literacy among the public by asking a set of questions about some basic concepts in science such as how long it takes for the Earth to go around the sun is a measure of scientific knowledge, not literacy.

Weigold (2001) also suggests the dichotomy between high levels of scientific illiteracy and high levels of interest in science raises questions about the methodology in determining 'science illiteracy'. These include basic scientific concepts such as the time it takes for the Earth to orbit the Sun once or that humans and dinosaurs did not co-exist. What is it then, Weigold asks, that the public **should** understand – should it be these kind of basic concepts, or knowledge of science developments now or should they exhibit an understanding of the scientific method? Moreover, is it important for the public to understand all of these aspects or just some of them?

Cultural context

Cultural context may also play a part in what the public knows about science. For example Augustine (1998) reports in the magazine *Science* that the latest National Science Foundation survey on the public understanding of science (1998 figures) show only 21% of the American public could define DNA. This is dramatically at odds with the UK where great concern has centred on genetics. A Royal Society survey showed a jump in UK public knowledge of what DNA was from 43% of adults in 1988 to 81% in 1996.

In India, Raza et al note there is 'cultural distance' at work in the understanding of science according to how many years are spent in schooling,

> '… in developing countries, the formal system of modern education operates as a strong determinant in shaping cultural structure of thought prevalent among the citizens. It influences the worldview of even those who have never received any formal schooling and are categorised as 'illiterate' (Raza, 2002, p 303).

One aspect of science communication characterised by Miller (1986), the R2 Group and the UK Office of Science and Technology, among others, is that the public is not one group but many, each group requiring a different communication strategy. Miller, who was part of the R2 Group, proposes that the public can be divided into a pyramid like structure with the non-attentive public taking up about a third of the base. On top of this are the interested and attentive publics and at the apex the policy leaders and decision makers (in Friedman et al, 1986). The UK Office of Science and Technology, on the other hand, divides the public into six attitudinal groups. 'The group discussions showed that attitudes to science are defined, to some extent at least, by general attitudes to life' http://www.wellcome.ac.uk/en/1/mismiscnepubpat.html. *Sky and Telescope* magazine reports on another view of science illiteracy (June, 1989). A film made with National Science Foundation funding to probe how the public perceives knowledge opens with a primary school level description by a new Harvard graduate of why the seasons happen. The student perception of the truth is coloured by preconceived notions. 'Only when misconceptions are confronted directly and shown to be wrong can correct ideas replace them' (*Sky and Telescope*,1989, p 586).

Communicating with the media

Perhaps one of the biggest mistakes of scientists, their institutions and sometimes public relations offices is to think a general press release sent to everyone is somehow an effective means of science communication and that the more that are produced the better it is. It is clear that, in particular, these groups have no idea that they are competing for, at most, ten seconds of a science journalist's time. Nor are many of these groups aware that the messages of science are best targeted at specific audiences and the specific science journalists serving those audiences unless it is a major news story in which a wide range of audiences would have an interest.

Figure 1 (opposite page) shows the result of a decision between a general press release and targeted media for a plan I devised and ran for NASA in Australia in June, 2003. The latter was chosen by NASA and *The Australian* was, successfully, encouraged to send a science journalist and features photographer from Sydney to the remote Pilbara region of Western Australia for almost a week. The article above is the forerunner of a full feature, which is scheduled to appear in *The Australian's* weekend colour magazine later in the year. A number of research organisations are involved in the drilling program, and as it happened, a press release was sent out too, prior to the story in *The Australian*. This enables a comparison to be made, that otherwise would not have been available. The press release achieved a small mention on ABC Science Online and a short article in the *Port Hedland News,* a weekly paper produced in a township on the edge of the Pilbara. The mass media targeted technique to allow NASA to explore the concept of audience selection for specific items of news.

Figure 1: An example of targeted media in The Australian – personal contact, not press release organised on behalf of the NASA Astrobiology Institute

NASA seeks the rock of ages for clues to life

Leigh Dayton
• Science writer, in Marble Bar

AS NASA launched a spacecraft towards Mars last Wednesday, another NASA team began drilling into Western Australia in search of the same thing — clues to the origin of life.

While the spacecraft will travel for seven months before it can begin collecting data, the Earth-bound team, at Marble Bar in the Pilbara, will have its first results within days.

The rock of the Pilbara is among the oldest on Earth. Much of it is 3.5 billion years old — just a geological blink from the planet's birth roughly 4.5 billion years ago. By studying it, the team hopes to glean important clues about when, where and how life formed.

They will be looking for deep red stripes, or banded iron formations, in rock cores from at least 50m down.

Team leader Bruce Runnegar, of the University of California at Los Angeles, said such stripes would show oxygen had been present, suggesting life might have started 3.5 billion years ago.

"We'll be very disappointed if we don't find evidence of banded iron formations," the incoming director of NASA's Astrobiology Institute in California said.

The team had to drill deep because "we want to end up with rocks that are more or less in the condition they've been in for billions of years, rather than being messed around by surface processes".

Professor Runnegar and his colleagues have been racing against time to be ready for today's opening ceremony of the Archaean Biosphere Drilling Project.

Partners in the NASA-managed project include the University of Western Australia, the Geological Survey of Western Australia, Kagoshima University, near Tokyo, and Pennsylvania State University.

The team will drill three 300m cores this year: the one at Marble Bar and another two in the Pilbara. More will be drilled over the next two years.

The cores will be split among the participating insitutions for study. For example, project initiator Hiroshi Ohmoto, of Pennsylvania State University, will look for geochemical signatures of life.

Other scientists will look for details of the magnetic field, the presence of tiny organisms and mounded structures called stromatolites formed by the earliest single-celled life forms

They can dig it: Professor Ohmoto and Professor Runnegal with a core sample at Marble Bar in the Pilbara

Picture: Glenn Campbell

(Source: The Australian, June 15, 2003, p 8)

CONCLUSIONS

This chapter has explored a number of issues surrounding science communication, and discussed how SETI has dealt with those issues. It has shown that societal attitudes set the framework for science communication and while many think of the mass media as an educational vehicle in the area of science news, it is actually not an instrument of mass remedial science education or even a vehicle for a science communication strategy. Furthermore, there is no evidence that more science communication will result in sustained or greater public support for the funding of science. It has also discussed the aspect of the public being not one audience, but many. Major groups identified are the science attentive, the science interested, and the science inattentive. Messages aimed at all three at once are likely to fail. Overlaying that is scientific literacy, which may actually relate to understanding how science works, much as reading and writing literacy requires an understanding and comprehension of language. Public audiences have difficulty in separating science from pseudoscience and this may be due to widespread lack of understanding of the scientific method, which it is argued may be a better measure of scientific literacy. Specific questions, even about basic science concepts, may be flawed.

CHAPTER 3

Communicating uncertainty under the media spotlight

SETI has yet to hear from ETI. There have been two notable false alarms at the National Radio Astronomy Observatory in Green Bank, West Virginia – one in 1960 (Drake, 1998) and the other in 1997 (Shostak, 1998 and 1999). In October the following year there was an outright hoax that claimed a detection had been made using a small ten-metre satellite dish in the UK (Oliver, Shostak and Sim, 1999, Shostak and Oliver, 1999). Only the latter precipitated unwanted media coverage, but it also provided an opportunity for the SETI community to test its readiness for a real detection together with the experiences at Green Bank. These experiences, together with other related examples, expose some of the issues that surround communication of risk and uncertainty to multiple public audiences during periods of intense global media attention - in the case of SETI, the potential detection of an extraterrestrial civilisation. These examples, which I will explore briefly for their relevance to the SETI experience, include the Viking mission in 1976 (Billingham et al, 1994), the NASA Mars rock team's announcement of putative Martian fossils in 1996

(Jakosky, 1998), a potential SETI signal in 1997 (Shostak and Oliver, 1999) and the above mentioned SETI hoax perpetrated in October, 1998. The underlying question is whether it is possible to impart scientific understanding to public audiences in high news focus events relating to a particular area of science research.

In the Hollywood blockbuster *Contact* the Very Large Array radio telescope in Socorro, New Mexico receives a signal from the vicinity of the star Vega some 25 light years away. It is thundering out the prime numbers 1 to 101 like a jack-hammer and it is on a repeating loop. Both the signal and its deep space origin are confirmed by the Parkes radio telescope in Australia. There is no doubt. Booming across the control room at Socorro is proof that we are not alone. Ellie Arroway, the project leader, is asked by a member of her SETI team, 'What now?' She replies: 'Tell everyone'. They do, and the media, the government and the public descend on the telescope array.

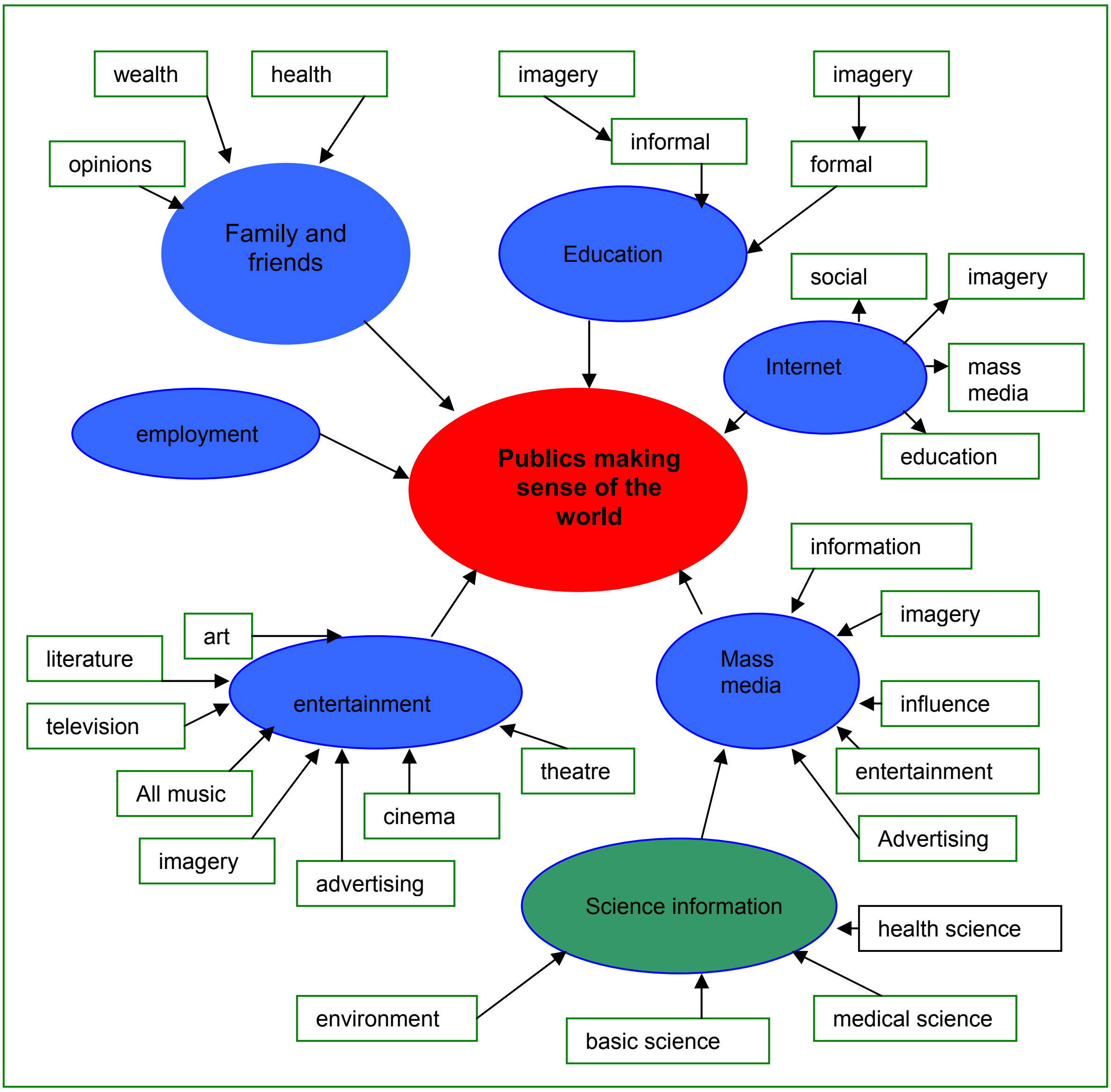
No long-term study has been undertaken on how the global media or public audiences would react to a real detection. Drake, who carried out the first SETI experiment in April 1960, searching for artificial signals from two nearby sunlike systems, found a very strong signal apparently from one of them. Later the 'signal' from Epsilon Eridani proved to be from Earth - a high-flying airplane. 'To this day many people believe falsely that we received signals from another world, and that some fiendish government agency has required us to keep this a deep dark secret,' said Drake (1979, http://www.bigear.org/vol1no1/ozma.htm). For Drake the initial experience – before resolving what the source was – highlighted a problem, 'Suddenly I realised there had been a flaw in our planning. We had thought a detection so unlikely that we had never planned what to do if a clear signal was actually received. Almost simultaneously, everyone in the room asked, 'What do we do now?'

Indeed, a formidable task may lie ahead for SETI – or any other science with such global potential for a possible event that would attract the intense focus of media and public attention. Priest, Director of the Centre for Science and Technology Policy and Ethics at Texas A&M University notes,

> 'Journalism is not written on a blank slate but inscribed as one component in a complex information environment. At the same time, the people who compose journalism's audiences are hardly blank slates to begin with themselves. Were there no mass media, in other words, there would still be folk beliefs about science. Neither science journalism nor education, let alone a movie, book, or a television show, is interpreted independently of the context of preexisting belief' (in Friedman et al, 1999, p 107).

For example, attitudes to genetics seem to be based more on personal sources of information rather than media. The public sees risk and uncertainty differently from scientists. In focus groups run by Rogers, an overriding theme in understanding science was the lack of context in the media within the societal framework – what does it mean to me or my family?... how much does it cost?... why do scientists think this? (Friedman et al, 1999, pp 189-191). Rogers notes that in spite of hundreds of studies over 40 or 50 years very little is known about how audiences make sense of information about complex science issues. Figure 1 on the opposite page is my attempt to consider what aspects may be influencing the reception and processing of the information.

Figure 1: An indication of the complex reception environment of multiple audience (Source: Carol Oliver, 2003)



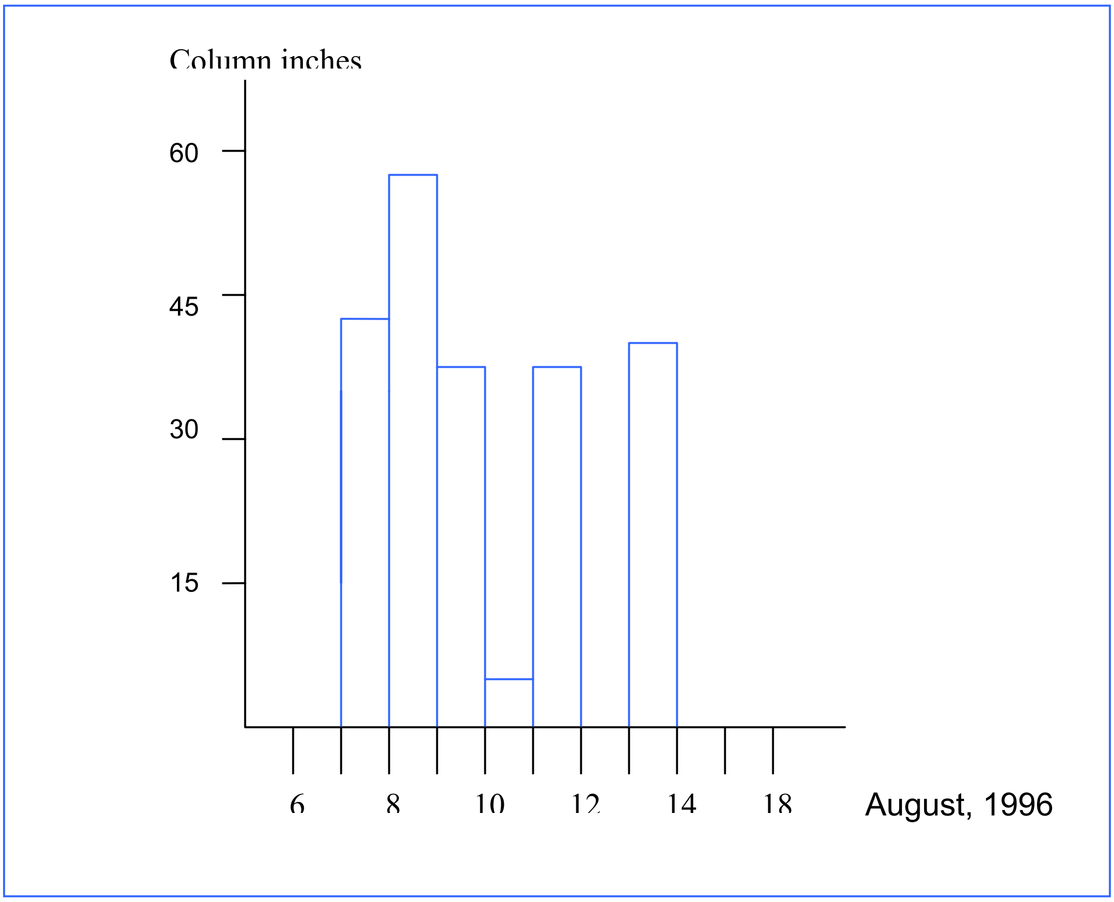
Vakoch, SETI's only paid social scientist, urges survey instruments be developed and tested in preparation for detection. 'Carefully planned studies may help anticipate sources of skepticism about, or opposition to, bona fide reports of the existence of extraterrestrial intelligence,' he said (Vakoch, 1999, p 29). Vakoch believes such surveys would provide the foundation for a coherent public outreach program aimed at identifying resistance to, and support for, astrobiology that would help 'develop intelligent policies' (ibid). Similar recommendations were made by those researchers attending a series of NASA SETI workshops in 1991 and 1992 (Billingham et al, 1994) who also noted the lack of data about how audiences react to science information, concurring with Rogers' findings.

Analogies of public response

In the absence of substantive data on media and public reaction to a detection some broad analogies exist. One was the 1996 announcement by a team of NASA scientists that they had found what appeared to be fossilised microfossils inside a meteorite that had unquestionably come from Mars. It attracted the attention of the world's media. NASA lost some control in the preceding days with a leak strong enough for media to speculate before the press conference. The night before the press conference astronomer Professor Richard Berendzen from MIT was talking to Ted Koppel on US national television about possible life on Mars and astronomer Dr Seth Shostak from the SETI Institute was talking with the news network CNN (Shostak, 1998).

Figure 2 shows the amount of news coverage of the story in the *New York Times*, beginning with the day of the press conference because of the leak 24 hours earlier. The data is taken from Shostak, 1997, but I have excluded opinion pieces and letters from the original data for clarity in comparision with the Viking news coverage data later on in this Chapter.

Figure 2: News coverage of ALH84001 in the New York Times



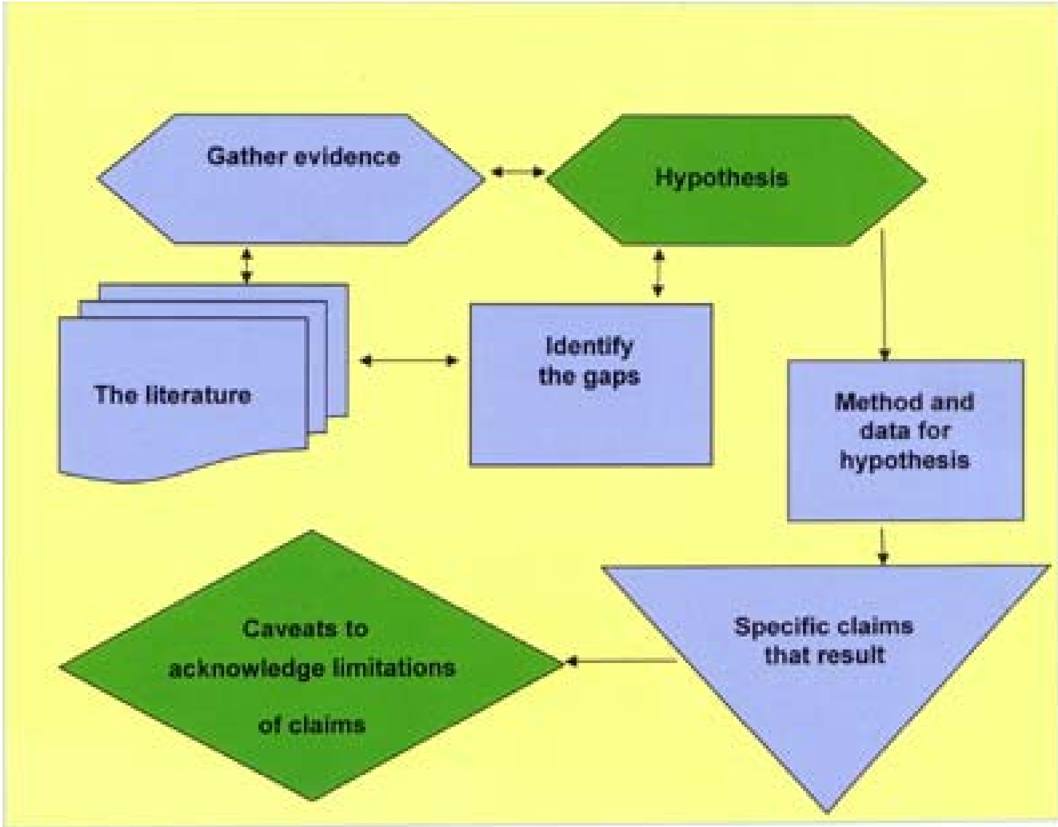
(Source of data, Shostak, 1997, with letters to the editor and opinion pieces removed to allow comparison to Viking data in figure 4)

The speculation may have increased media attendance at the official press conference in Washington DC the following day. It attracted around 500 media representatives, with the start delayed because so much electronic equipment overloaded the audio system, causing a high-pitched whine (Schopf, 1999). It was follow by a White House lawn statement from US President Bill Clinton amid world headlines 'Life on Mars'. NASA's handling included inviting possible opponents as well as proponents to the press conference. NASA offered a skeptic at the press conference - palaeobiologist Professor Bill Schopf, who had been critical of the evidence from an early stage of the research. However, he blamed the press for making the uncertainty certain, not the research team.

> 'The published account (of the Mars rock ALH84001) was meant as a preliminary report, not the final word, and the claim was of evidence 'compatible' with past life on Mars, not that they had proved it present. But 'compatible …possible … perhaps … maybe' make mushy sound bites and don't sell newspapers. The research team was done in by an over-zealous press corps,' he said (ibid).

Schopf's issue with the press may partly stem from the scientist-science journalist relationship where the management of uncertainty means different things. To a scientist, uncertainty is not uncontrolled but a device that invites discourse on new claims or organises the knowledge (Zehr, 1999). This is shown in figure 3.

Figure 3: How a scientist manages uncertainty



Source: Carol Oliver, 2003

The media have difficulty in picking their way through scientific uncertainty (Stocking, 1999), and so did Rogers' focus groups mentioned earlier in this thesis. They found the uncertainty confusing.

An interesting moment of exasperation on the different ways uncertainty is perceived and understood occurred during the week of publicity on ALH84001 during a television broadcast on PBS in the US. A member of the research team, Richard Zare, Professor of Chemistry at Stanford, drew out the difference between how a scientist views uncertainty and how the media and public views it when challenged on why he and members of the team thought ALH84001 may contain evidence of past life on Mars. He noted during the program,

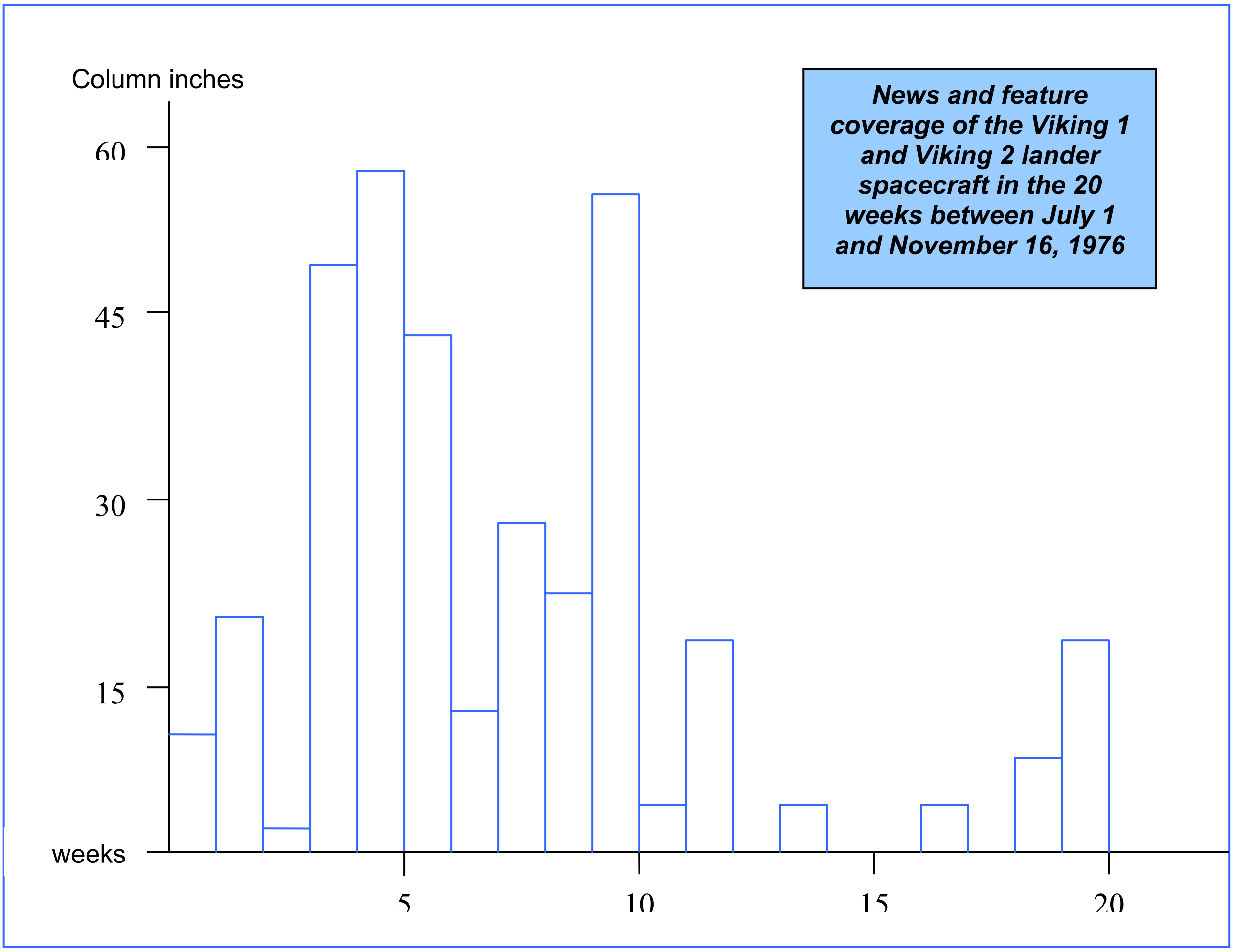
> 'There are various levels of confidence in science, and I'm generally not sure of much, sometimes not even of my own name….What am I sure of? It (the rock) has gases in it that look just like what the Viking Lander found, and there are orders of magnitudes, powers of ten different than what you'd find on Earth. It has a ratio of heavy hydrogen, which we call deuterium to hydrogen in the water, just like is found again on Mars but not on Earth. It's found in an ice field. You don't find a rock in an ice field in the snow unless it generally comes in there, so it's a meteorite. I'm now with a situation that you see it waddles like a duck and it quacks like a duck, so I say it's a duck, but maybe it's not a duck. If it's not from Mars, it's from somewhere else, and it's still exciting' http://www.pbs.org/newshour/bb/science/mars_jim_8-7.html.

Viking lands on Mars

The Mars rock story still surfaces every now and then on some argument about the validity of evidence of past life on Mars. At the time of the announcement in 1996, it gripped intensive media interest for only seven days. This was a similar period for media reaction for each of the two Viking spacecraft landing on Mars in 1976. The latter provides perhaps a closer analogous event in that it mimicked more closely the kind of uncertainty that SETI might face over a similar period in the event of a successful detection of extraterrestrial intelligence.

For this analysis I searched a newly computerised archive database, which allows story, page and edition searching of the London *Times* from the mid-19th Century to 1985. I used all three search parameters for the period July 1 to December 31, 1976. This database was chosen because of the comprehensive record of this time and chosing a non-American national quality newspaper lends a global view of the kind SETI will experience. Viking 1 landed in Chryse Planitia on July 20, 1976, and Viking 2 at Utopia Planitia on September 3, 1976 (US dates).

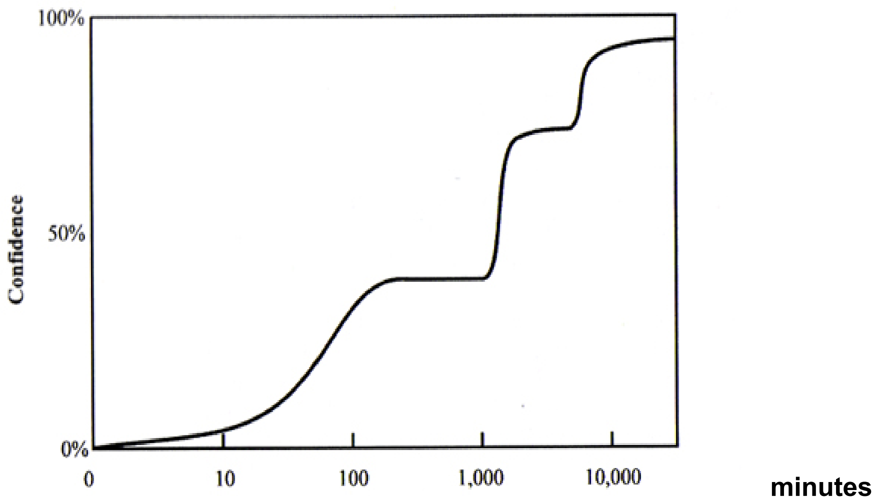
Figure 4: Viking coverage in the London Times



(Source: Carol Oliver, 2003)

The measure of column inches in figure 4 is used to maintain consistency with the data in figure 2. Column inches are taken as the exact number of words per article divided by 50, a measure typically used by UK journalists (personal experience of UK newspapers) to obtain column inches. The timeline is a total of 21 weeks from July 1 to Nov 25, although the actual life of Viking 1 from landing to switch off before Mars moved into conjunction (behind the Sun, so out of radio contact until late December) was 16 weeks, Viking 2 life span before conjunction was just under 10 weeks. According to the hypothetical prediction of building confidence in a putative SETI signal shown in figure 4, the time might be in the one-week period similar to the ALH84001 announcement on August 7, 1996. However it does not reach the 100% confidence level – this may take a similar time scale to the Viking landers – 10 to 16 weeks or perhaps longer. I discuss the implications more fully later in this Chapter.

Figure 5: A typical track of confidence in a SETI signal?



(Source: Shostak, 1999)

Although figure 5 shows a progressive building of confidence, it is reasonable to assume that the signal will come under scrutiny from the science community. Alternative explanations (especially if only the carrier signal can be detected) will undoubtedly be sought (Shostak, personal interview, 2003) and in the glare of publicity.

This has already occurred to a degree in radio astronomy when rapid pulsed signals were detected in 1967. Researchers initially (but privately) entertained the idea that it might be coming from intelligence elsewhere in the universe, but later found the source to be natural. Jocelyn Bell, a student of astronomer Anthony Hewish, had noted 'scruff' that appeared in the same area of sky repeatedly on recordings made from a new radio telescope near Cambridge in the UK and essentially made of wire and poles and spread over a number of acres. She called Hewish who came to observe one of the transits of the 'scruff' one afternoon after deciding it was not man-made interference. Bell described her feelings in an after-dinner speech some decades later at the 8th Texas Symposium on Relativistic Astrophysics, 'It is an interesting problem … if one thinks one may have detected life elsewhere … how does one announce the results responsibly? Who does one tell first?' http://bigear.org/vol1no1/burnell.htm. Bell and Hewish did not resolve the question that afternoon. Bell recalls wryly, 'I went home that evening very cross. Here was I trying to get a PhD out of a new technique and some silly lot of little green men had to choose my aerial and my frequency to communicate with us' (ibid). Bell, Hewish and colleagues had dubbed the signal as LGM (Little Green Men), but found a natural explanation – a rapidly rotating remnant of a star that emitted the characteristic pulse.

If radio SETI succeeds, it will pick up a tone not a radio message. Unlike the movies, no SETI equipment is capable of detecting more than the pure tone of a carrier wave, which may or may not be information rich in itself. To pick up any information being carried along like a radio or TV signal on Earth would require the building of a larger instrument should such a signal be received (Shostak, personal interview, 2003). This means that in the event of success SETI faces two lines of uncertainty. Firstly determining whether the signal is from an artificial or natural source (it took months for Hewish and his team to eliminate the LGM hypothesis in the discovery of pulsars). Secondly the lack of information opens SETI to a great deal of speculation – researchers will know much about the signal, but nothing about the senders. This may heavily influence reporting.

Influence of uncertainty in story selection

There was an ebb and flow of uncertainty on whether the Viking experiments had determined life existed on Mars – and hence the attractiveness of the story to media, which can be clearly seen in the media representation of the Viking experience. Vikings 1 and 2 experienced a similar amount of column inches in *The Times* (58 and 56 column inches) on arrival on the surface of Mars. However the concentration of coverage around Viking 1 is markedly more than for Viking 2. Prior to arrival of the second lander, the soil experiment on Viking 2 was proving suggestive of organic matter. Then there is a drop in coverage with a story in *The Times* entitled *'Hopes fade for life on Mars'* on August 20, 1976. The following week this swings back to another story by the same correspondent, Michael Binyon, on August 27 with the headline *'Experiment points to life in Mars soil'.* Viking 2 landed a week later, renewing interest in the question of whether the red planet had extant life. After that stories talk of the ambivalence of the soil tests, even with soil taken from under a rock. Media interest waned; the landers, which had already exceeded their own life expectations, were shut down for most of the rest of 1976 on November 8. A 283-word story, appearing on page 8 the following day, notes the event. Binyon wrapped up coverage for *The Times* on November 11 – 841 words under the headline *'Life on Mars neither proved nor disproved by Vikings'.* The Vikings were eventually terminated in May, 1977.

Uncertainty was constantly at hand during the Viking 1 and 2 missions. Scientists were in totally new and remote territory (though very much closer to home than any putative signal from intelligence elsewhere in the universe). It could be years before a SETI signal could gain 100 percent confidence and for it to be generally accepted by the scientific community (Shostak and Oliver, 1999). Given public audiences may demand information within a 'what does it mean to me' reception environment as shown in figure 1 of this chapter, perhaps the media will intermittently seek out other 'experts' to pontificate on what the extraterrestrial civilisation might be like (or 'experts' will seek out the media) as verification of the signal continues.

Some attention has been given to managing at least the immediate uncertainty in the form of the Declaration of Principles. This is a voluntary protocol worked out over a number of years by the former SETI Committee, now the SETI Permanent Study Group, under the auspices of the International Academy of Astronautics. Its nine points are:

1. Verification of the signal before making any public announcement.
2. Inform parties to the protocol and continue monitoring the signal.
3. If the signal is credible send an International Astronomical Telegram to observatories and other researchers.
4. Disseminate the information to the public.
5. Make data available to all.
6. Continue monitoring.
7. Seek international agreement to protect the relevant frequencies.
8. No response to a signal before international consultations.
9. Set up an international committee of scientists as a focal point of continued observations.

The protocol also commits signatories to inform the Secretary General of the United Nations.

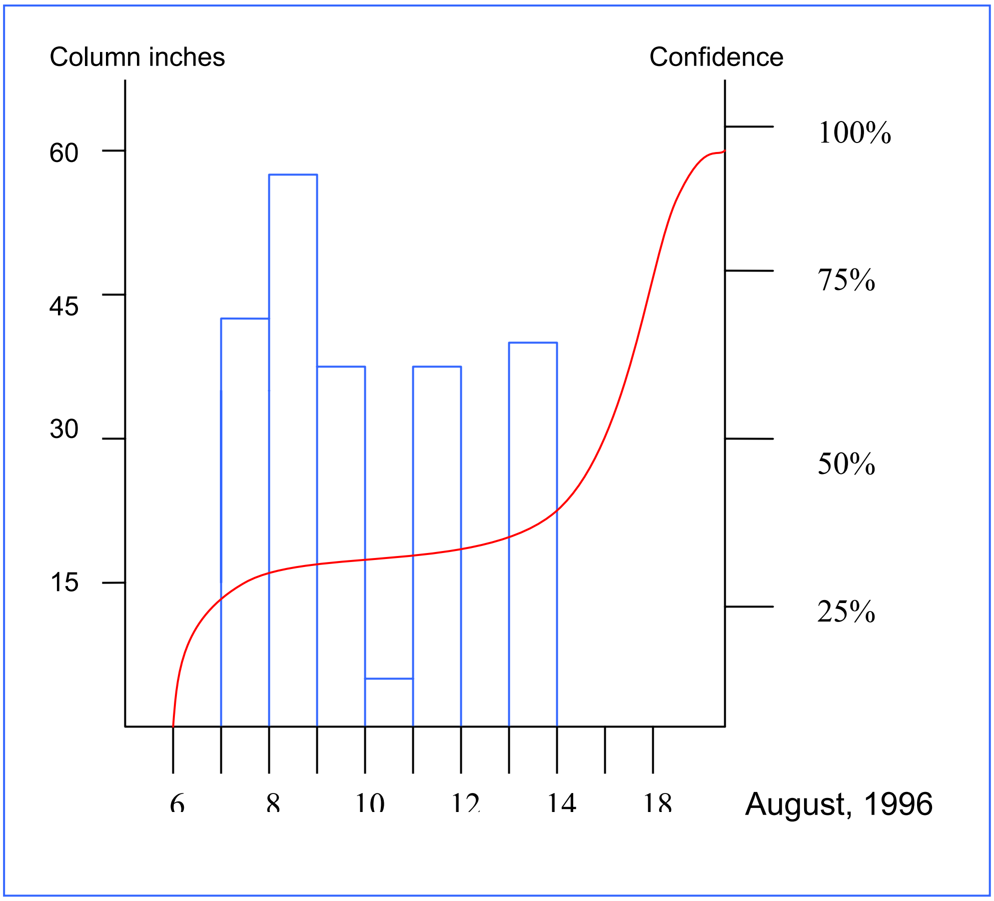
In reality things are not going to happen in this order. Billingham, one of the chief architects of the protocol, said that there had never been any intention to make this the order – it was just a list of the activities researchers should be considering in the event of a promising detection (personal communication, 1999). However, as Shostak points out (1998), 'The story won't break cleanly. This is an unavoidable consequence of our policy of 'no secrecy' (1998).

Shostak describes in *Acta Astronautica* how in June of 1997, Project Phoenix, the SETI experiment run by the SETI Institute, was observing with the 140 foot telescope at the National Radio Astronomy Observatory in Green Bank, West Virginia. This was the same observatory as Drake had used to undertake the first SETI experiment in 1960 but on a different telescope (he used the 85 foot Tatel telescope). The Project Phoenix team was tracking a signal that had all the characteristics expected in a real SETI signal. However, they were cautious because of a temporary failure of a second radio telescope normally used for checking possible candidate signals. About half a day into the full day it took to discover the origin of the signal, a science writer from the *New York Times* called to find out about the 'interesting signal.' 'It is our speculation that Mr Broad learned of the signal through a chain of events beginning with an innocuous phone conversation to a third party involving SETI Institute personnel,' notes Shostak (1997, p 624). The writer was put off with a promise of a call back within six hours if the signal proved positive, but it turned out to be a sun-seeking research satellite known as SOHO.

However, as Shostak points out, had the signal proved positive it would put the SETI community immediately in a dilemma – either researchers lie to observe the protocol or tell the truth that they are trying to verify a signal, at which point the media will inevitably publish. ‘The Institute would be immediately flooded with calls from the media and the public. So would every other SETI organisation’ (ibid). As Shostak points out in his paper it is interesting to note how other researchers were approached to comment on the leaked story of the Mars meteorite when the NASA scientists on the Mars rock research team were gagged by NASA until the press conference. It would follow that if SETI researchers were faced with observing the same gag orders, then others outside of the SETI community would be approached to comment.

Another aspect to the SOHO observation is that had it proved to be a signal from another civilisation the chances are that the public might lose interest long before full confirmation could be made if the reaction to the Mars rock story is a reasonable analogue. figure 6 is taken from figure 5, but is overlaid with data taken from a schematic representation of an expected time it would take to reach increasing levels of confidence in a claimed discovery of an extraterrestrial signal.

Figure 6: New York Times coverage of ALH84001 against progressive confidence in a SETI signal

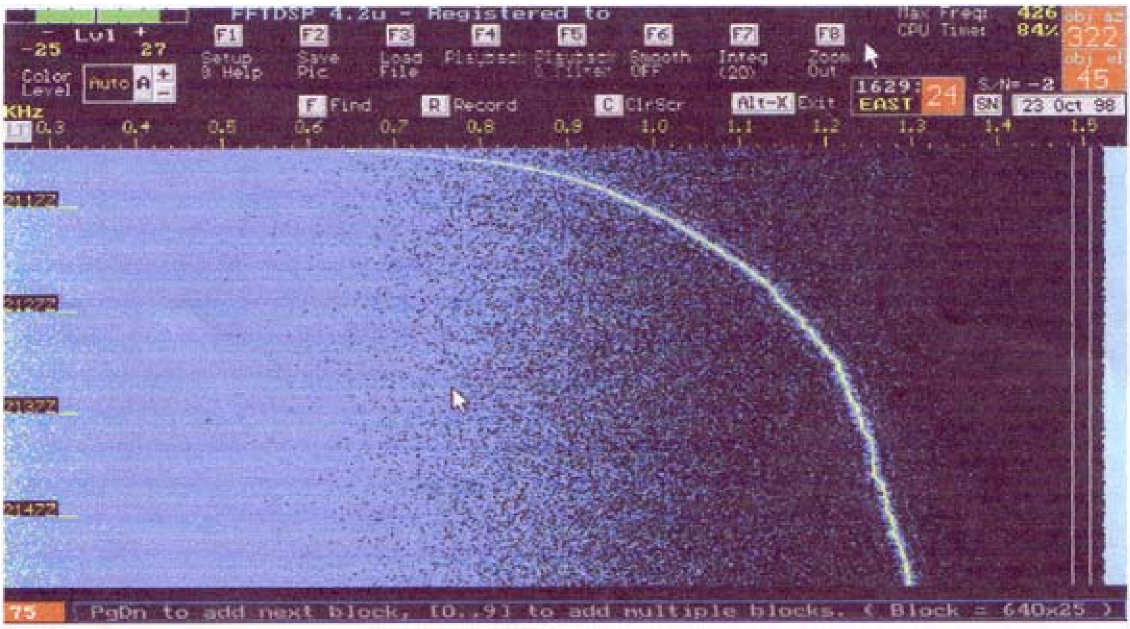


(Source: Combined data of Shostak, 1998, and Oliver, 2003)

While this graph indicates the need for a media plan for the entire SETI community in addition to the Declaration of Principles in a real detection, it might also apply to a hoax. One such hoax was experienced by the SETI community in October of 1998. In this case it made a media story because SETI scientists used to dealing with SETI data had already dismissed it as an obvious fake and, probably as a result of that, stayed on the sidelines even when it did become a *BBC* Science Online story (Oliver, Shostak and Sim, 1999). The hoax also revealed a failing in relation to the

Declaration – not all signatories to the declaration had been directly informed of the unfolding events as required and some researchers were dependent on information from the media and the Internet. A number of vital questions were raised applicable to future responses from the SETI community in the event of hoaxes, genuine mistakes and perhaps one day the real thing. These centered on whether the public really understood the explanations being given even on SETI web sites. Figure 6 shows a picture (now not available on the Internet) that was being used by the hoaxer to claim a detection and recognised by SETI scientists as the obvious fake it was. No press release debunking the claim was issued by any part of the SETI community in the initial stages although later in the piece some SETI web sites included a page explaining why the purported signal was a hoax.

Figure 7: the hoaxer's purported SETI signal



(Source: from now defunct web site

***http://members.aol.com/ufoseek/CapeCanaveralHall7193*)**

As Friedman et al noted in 1986 in relation to the Three Mile Island nuclear accident in 1979, a lack of provision of information to the public via the media leads to confusion, misinformation and sometimes unnecessary sensationalising.

While the hoax left SETI with a memorable example of how to do things better in the future it left an indelible mark on the relationship between the journalist who ‘broke’ the story and some SETI researchers. The accuracy of Dr David Whitehouse’s story was hotly debated between US researchers and Australian researchers. Whitehouse maintained he could not get in touch with key SETI personnel before his deadline and wrote it in a way that acknowledged it as a probable hoax. The real issue was probably in the opening paragraph as shown in Figure 8 (full piece in Appendix 2) with the words ‘the scientific world is buzzing … ’ and the headline *‘Puzzle over alien ‘discovery.’*

Figure 8: From the BBC Online report of EQ Peg (named after the stellar location of the purported signal)

BBC ONLINE NETWORK

BBC NEWS

News in Audio | News in Video

Front Page
World
UK
UK Politics
Business
Sci/Tech
Health
Education
Sport
Entertainment
Talking Point

On Air
Feedback
Low Graphics
Help

Thursday, October 29, 1998 Published at 18:42 GMT

Sci/Tech

Puzzle over alien 'discovery'

Is there intelligent life in this star system?

By our Science Editor David Whitehouse

The scientific world is buzzing with the suggestion that signals from aliens living in another star system may have been picked up by a part-time astronomer.

Other astronomers are scrambling to confirm or deny them.

Sci/Tech Contents

Relevant Stories

13 Nov 98 | Sci/Tech
Is anybody out there?

13 Nov 98 | Sci/Tech
Anyone out there?

Internet Links

Seti Institute

British UFO Research Association

Ufology Society International

The BBC is not responsible for the content of external internet sites.

In this section

World's smallest transistor

Scientists join forces to study Arctic ozone

(Source: http://news.bbc.co.uk/1/hi/sci/tech/203133.htm)

The EQ Peg hoax ran from Oct 23 to November 5, 1998 with media appearing in the US and UK but not Australia. In spite of observations made by Professor Ray Norris of EQ Peg using the large array at Narrabri in New South Wales showing that the signal was non-existent, a story on the hoax appeared in the *Boston Globe* on November 4 based on a press release sent out by Chip Cohen debunking the claim. The 'non' story had its last run on November 5 on the US's Laura Lee television show with two SETI experts and a SETI researcher.

One specific outcome from the EQ Peg debacle was the suggested development of an Immediate Reaction Plan by Shostak and Oliver presented at the International Bioastronomy Conference in Hawaii in 1999. This has still not been implemented. No international media reaction plan exists, though efforts continue through the same International Academy of Astronautics group that generated the Declaration of Principles, in particular through its post-detection sub-committee led by Professor Ray Norris.

In addition to the Declaration, Dr Ivan Almar and Dr Jill Tarter, members of the IAA SETI Permanent Study Group have worked out a scale to be used in contact with the public on measuring how much confidence there is in any claim, false or real. It is called the Rio Scale and is similar to the Torino Scale used for measuring the likelihood of an asteroid or comet hitting the Earth. Tarter hopes that it will provide an easy method for the media to get an idea of the response of SETI scientists to any particular signal claim (Tarter, personal communication, 2002). The website for this is at http://www.setileague.org/iaaseti/rioscale.htm.

CONCLUSIONS

It is suggested that not enough is known about public audiences to understand how science information – including information about a SETI detection of extraterrestrial intelligence – is or would be received by the wide variety of audiences embedded within the word ‘public’. Although much is known about science interest levels and the outcomes of various health campaigns (smoking, for example) the best that has been achieved in the past 40 or 50 years in knowing precisely how audiences react to science news and information are some sporadic focus group studies by researchers like Rogers. Vakoch urges survey instruments to be developed and tested to learn about reaction of audiences to a SETI detection. This approach would appear to be of importance broadly to the understanding, and improvement, of science communication in general.

The communication of uncertainty is a complex issue with main players such as scientists and science journalists seeing uncertainty in different ways. This particularly comes into play during a period of intense attention from the media and the public.

Lastly, discussion across all of the examples suggests risk communication, which is well-developed in the corporate world, is still in its infancy in science communication.

CHAPTER 4

Education, information and the media

SETI has provided a case study of a small group of researchers in a specific area of an emerging science – astrobiology. I have shown how the SETI Institute has considered science communication as an integrated and vital part of its enterprise, driven in part by the kind of factors that are becoming, or may become, more relevant to other areas of science. These include the societal implications of science, science education and, more crucially, funding to continue the research. The Institute makes deliberate use of the media primarily to raise the profile of the organisation and understands that is the key objective in imparting information about SETI via this medium. As mentioned in Chapter One, the blue ribbon science communication G2 group identified this as generally not well understood by researchers and science institution managers in undertaking communication with public audiences via the media. The SETI Institute's efforts to increase the public understanding of science instead utilise other channels – namely its formal and informal education activities. These in turn increase the credibility of the Institute across a broad range of audiences. A good example of an effort to improve science literacy among the adult population in the US (and to anywhere else in the world via the Internet) is its one-hour weekly radio show *Are we alone?* on Radio America. It offers the potential to go beyond information to the kind of informal education that encourages and develops the public understanding of science by posing the kind of questions Bill Bryson and other would ask. Such steps may be key in preparing for the challenges ahead in the rapidly changing arena of science communication and, as mentioned in the Introduction, in addressing an increasing interest in science among public audiences as reported by surveys in the US and Europe. In addition to exploring the approach of the SETI Institute to science communication, I have also examined relevant aspects of the practical nature of science and the relationship with science journalists. In Chapter One and Two I discussed how governments and other institutions focus on more and better science coverage in the media as part of an effort to improve the public understanding of science and that this approach may be basically flawed in its expectations of improving the public understanding of science. In this final Chapter, I intend to draw the preceding Chapters together through discussion and a qualitative analysis of the above and why the SETI experience points to the need for re-evaluation of the actual role of the media discussed in Chapter Three rather than the perceived role discussed in Chapter Two. The SETI Institute's apparently successful approach points to an obvious conclusion - that it has already recognised, perhaps by default, that the mass media is a poor science educator for at least the adult population in the West. It is counter to the hopes that are pinned on the media by governments and other research institutions in relation to science literacy, as shown in Chapters One and Two.

In general, science research is undertaken in isolation from science communication in all its forms: formal and informal education and the mass media. As mentioned above, SETI provides a rare exception to the rule. This is true even in universities and other institutions where science journalists or public relations experts are employed as a bridge to communicate the often-complex results of research to the media and the public. However, communication professionals tend to have responsibilities relating to promotion of the institution rather than encouraging the public understanding of a specific area of science. Few public information officers are actually involved in the process of the research or in offering public outreach expertise as an integrated part of promoting public understanding of science although the capability is available. This has happened in the team environment of the SETI Institute, albeit sometimes imperfectly and with a learning curve on doing things better in the public arena. Examples of the resulting poor risk communication abound in science. Among the most outstanding instances of such media mismanagement, perhaps partly through the general failure to understand the subtle difference between information and education, are Mad Cow Disease (BSE) and Genetically Modified (GM) foods – or ‘frankenfoods’ as they have become known in Europe. The results of such failure to address public concern has been noted in UK http://www.parliament.the-stationery-office.co.uk/pa/1d199900/1dselect/1dsctech/38/3801.htm. This includes the mounting distrust among the UK public of science in general and government policy-makers.

One critical aspect appears to have been overlooked – no-one really knows how the public absorbs and integrates science information, as was pointed out in Chapter Three (Friedman et al, 1999). Much is known about the public interest in science thanks to the regular public surveys in the US (NSF, 2000) and Europe (Eurobarometer 55.2, 2002), but nothing is known about how the public actually receives and uses science information. As shown in figure 1 in Chapter Three the influences and context in which an individual receives information is coloured by a large number of factors. Little is known beyond that there is a correlation between education and gender (Friedman et al, 1986) on the reception of science information and the level of understanding, and there is a high level of interest in science across all audiences but also a high level of science illiteracy.

Some have questioned this dichotomy of interested but largely scientifically illiterate audiences, such as Wynne (1991) and Hargreaves (2000). At issue is the ‘deficit model’ used to determine science literacy by all major surveys on the public understanding of science. The model assumes that to be scientifically literate it is necessary to understand some basic concepts such as the Earth goes around the sun and antibiotics do not kill viruses. Hargreaves (2000) in particular argues that such an approach tells us nothing about how the public audiences can operate in public debates on major scientific issues. Norris et al (2002) maintain scientific literacy is no different to literacy itself – it is the ability to use the tool to understand the content and, in this case, the tool is the scientific method not the concepts. Sagan (1996) and others go further saying knowledge of the kind of critical thinking that is necessarily part of the scientific method is essential to democracy as stated in Chapter One, and key to understanding science stories. Journalists though, do not see themselves as educators. US freelance science journalist Charles Petit notes,

> ‘Education is a welcome side effect of good reporting, but as an independent goal it would interfere with getting the news out. We shouldn't worry about the public's general science knowledge in any pedagogical sense. My goodness, we'd work so hard getting people ready to understand something fully that we'd never get around to the new stuff. Just provide enough to the layman to understand a specific story’ (private communication, 2003).

The desire to know

This subtle but important difference between the education and information aspects surfaces in Rogers' focus groups. Participants were critical about such things as vagueness in media reports, not enough evidence or background and, more crucially, where the meaning was (in Friedman et al, 1999). More recently, travel writer Bill Bryson took three years out of writing to produce his popular science tome *A Short History of Nearly Everything* in which he investigates the facts, hypotheses and theories of basic science. He begins from the position of no knowledge – just the childhood desire to know how science knows. He recalls taking home a science text book with a cutaway diagram of the Earth through to the core. The text told him nothing except about 'anticlines, synclines, axial faults and the like' (2003, p 5) and other things incomprehensible to a fifth grader. His questions remained unanswered: 'How did we end up with a Sun in the middle of our planet and how do they know how hot it is? And if it is burning away down there, why isn't the ground under our feet hot to the touch? And why isn't the rest of the interior melting – or is it?' (ibid). These might well be questions representative of an interested public – and answered in different ways, such as through museum exhibits. The SETI Institute has included participation in museum exhibits as well as public talks in its informal education program linked to its science research. It has also done this in its formal education programs, most recently *Voyages Through Time* that takes students on a journey of inquiry-based learning within the context of the evolution of the universe, the solar system, the Earth, life and technology. Perhaps this education link to research underscores the concept that, in general, the default in other areas of science may be to expect too much of the mass media. If this is so, then there may be little understanding among the majority of scientists of how limited media is as a communications medium when it comes to the public understanding of science. The main advantage of the media is in provision of information on latest developments, and on a much shorter timescale than is possible via normal formal and informal education methods.

Even if it is accepted that the mass media have a more limited role than is generally considered, there is still the question of the influences at work in both the sending of the messages to the public and in their reception. For SETI this has meant persistence in sending the same message: SETI is the scientific search for extraterrestrial intelligence and has nothing to do with UFOs (Unidentified Flying Objects) and unwelcome little grey men (Shostak, 1998). While, as Tarter has said, the sole objective is to make SETI a household name (Tarter, 2003) it is with the necessary undertone of building and maintaining credibility. It is often difficult because of the lack of dramatic images, so everything from Spielberg's benign *E.T.* to malevolent aliens in

Independence Day have been used instead. Increasingly, the SETI Institute has built an image library, part of it available on its website devoted to mass media use and at various qualities for Internet and print use. Short clips of video have been made too, and other visuals are available http://www.seti.org.

Such attention to imagery may be a lesson in itself, particularly in making the normally invisible or unreachable aspects of research visible in some way to public audiences. Boyce Rensberger, former *Washington Post* science writer and now Director of the Knight Science Journalism Fellowships at MIT, held a conference entitled *Image and Meaning* at MIT in June 2001. He said, 'Because there is insufficient collaboration among scientists, journalists, and imaging experts, including photographers and illustrators, the remarkable new images coming out of science are rarely used to best advantage.' Conversations among the exhibition of scientific images included 'a microscopist chatting with an architect about structural relationships inside cells' and 'a science editor talking with an astronomer about ways to link spectacular images on the Web to newspaper articles' (Rensberger, 2002, p 343). However, one delegate, writer and social critic Susan Sontag criticised the images for being so powerful they detracted from the subject matter. 'We remember through images,' she said, 'but we understand through words' (ibid).

If it is the words, not the image that counts how is it possible for the messages of science to reach the receiver as the sender intended as faithfully as the image? Perlman (1997) has hinted of the layers that science stories traverse between the scientist and the science journalist. He points out there is no other way to view science information other than in a very human way with all the values and prejudices that being human entails no matter how objective a reporter tries to be – and it applies to scientists too in their pursuit of knowledge. This is similar to the reception environment of audiences as shown in figure 1 in Chapter Three. SETI researchers have been aware for more than a decade that the audiences they address are many and complex. Doyle highlights the kind of factors that influence human behaviour, such as image repertoires, belief systems and education. In his paper *Social implications of NASA's high resolution microwave survey* he noted, 'The social scientists advised that the use of language, even of particular words, can easily colour and contour the perceptions of an audience' (1998, p 724).

Plurality of audiences

The plurality of audiences appears to have been noted first by Miller in 1986 when he pointed out audiences ranged from very disinterested to decision-makers, as noted in Chapter One. More recently UK researchers have suggested there may be as many as six attitudinal groups in the same kind of range. The panel of highly experienced science communication experts brought together over several years at NASA's George C Marshall Flight Centre mentioned in Chapter Two went further – that any message sent to the broad general public would always fail since there was no such thing as a single public audience. Messages have to be targeted at specific audiences. One of the UK's top science journalists, Roger Highfield of the *Daily Telegraph*, notes scientists could learn from the knowledge a journalist has of his or her audience (2000). However even that seems faulty in understanding audiences. The Newseum lists the top 100 stories of the 20th Century as voted by journalists and the public http://www.newseum.org. Science appears in six of the top ten for the public, but only half that number for the journalists' top ten. There was agreement the top story was the 1945 dropping of the atomic bomb, and in fourth place with the Wright Brothers first flight. There was similarity on the Moon Walk too (public put it as the third most major story, while journalists ranked it second. Not making the top ten for journalists, but making it for the public were: Penicillin (journalists ranked it 11th, public 6th); Polio vaccine works (journalists ranked it 21st, public 9th) and the discovery of the structure of DNA (journalists ranked it 12th and public 10th). Further down the list the difference becomes more apparent. The Shuttle Challenger crash in 1986 was ranked 83rd by journalists, but 43rd by the public; Dolly, the cloned sheep made 79th on the journalists' list, but 47th on the public list. Though it is difficult to draw specific conclusions a general observation might be that this survey is a reflection of surveys carried out in sports-oriented Australia and the level of interest in science recorded by the most recent National Science Foundation survey of the public understanding of science (2002). As noted in the Introduction, the Australians appear to prefer a science story to sport. In the US nine out of ten American profess to be interested in science. Although neither constitutes evidence, it suggests that there is reason to look at this more carefully to see if public audiences really would like to see more science in the media and what kind of science that may be.

For SETI it is critical to understand these audiences, not only for science communication but to understand how publics might respond to the idea that other intelligent civilisations exist in the galaxy, should SETI succeed. For the latter aspect Dick (1995) suggests parallels can be found in periods of history where new ideas prompted a major shift in worldview for specific societies or groups of societies over time. For example, the Copernican theory of a sun-centric planetary system prompted a scientific revolution, with impact on 'all areas of human thought' (1995, p 525). How audiences digest science information is unknown, but some health campaigns have prompted a paradigm shift in societal attitude – for example the hazards of smoking cigarettes. While this single paradigm shift took not much more than one or two decades in the West compared to the half century or more in Dick's examples, it also took place in an increasingly information rich culture with much faster communication technologies even without the Internet. We have yet to see the full footprint on society of the latter. Events in the 20th and 21st centuries have taken a shorter time to change societal attitude. They include the launch of Sputnik 1, which prompted a large number of changes in US society such as the formation of NASA – a space agency with at least one of its imperatives from the beginning of its existence being in science education and communication. Nevertheless, the change in attitude never happens overnight. The SETI Institute made a deliberate policy from the outset to be a science and education research organisation. The latter includes public outreach in a number of different ways and mass media. The objective throughout has been the one Tarter characterised in Chapter One and mentioned earlier in this Chapter: to make SETI a household name. Billingham et al (1994) pointed the way in the NASA sponsored SETI workshops on the *Societal Implications of the Detection of an Extraterrestrial Civilisations* in 1991 and 1992 with a laundry list for regular news releases on aspects of SETI. While it is impossible to measure the effect of a single media interaction or public event, it may be the SETI Institute would uncover effects if media coverage was measured over a longer period. One correlation is known to a certain extent: television and cinema science fiction makes a difference, as Shostak pointed out in Chapter One. The growing popularity of *X-Files* and *Contact* was concurrent with an increase in the number of visits to the Institute's website and an increase in the number of visiting television crews (Shostak, personal interview, 2003). In particular reporters link the lead role in *Contact* with the real life version of the head of a SETI research project – Dr Jill Tarter – indicating Shostak's conclusions were reasonable, but also underscoring the influences on audiences in being attentive (or not) to the messages of science.

Risk communication

If a single – or a short-term collection – of media interaction(s) or a public event(s) cannot be measured for effect on public audiences, what happens in a risk communication type event via the mass media where science is concerned? Does change in attitude take place? Or does it leave an idea that supercedes previous ideas until it is removed by a successive idea? Is it important to be aware of this idea in planning mass media science communication?

According to the official NASA history of 'Sputnik Night'

> '… reverberated through the American public in the days that followed … a collective mental turmoil and soul-searching followed, as American society thrashed around for answers ...'
> http://www.hq.nasa.gov/office/pao/History/sputnik/sputorig.html .

Perhaps even more memorable was the landing of humans on the Moon in July, 1969. According to the Newseum in Washington DC the biggest question on editors' minds was how big they could run the headline on page one http://www.newseum.org/datelinemoon/essays/front_pages.htm.

Both Sputnik 1 and the first human footprints on the Moon were societal mood changing moments. Undoubtedly news of a signal picked up from another intelligent civilisation would be another. While news of the signal will probably span no more than the seven days experienced by the 'life on Mars' story in 1996 (see Chapter Three) and the Viking lander spacecraft in 1976 (also Chapter Three), perhaps the societal ramifications may not be appreciated or fully understood for months or even years afterwards. Shostak notes in an interview with the newspaper *Florida Today*, 'If the headline tomorrow says, 'Scientists Prove Existence of Extraterrestrial Intelligence', Joe Six Pack will say, 'Look Marge, they've finally come clean. I knew the aliens were out there. Could you hand me the sports section?' http://www.floridatoday.com/space/explore/special/contact/panic.htm.

However, the US also has a high level of belief in UFOs – more than half the US public according to the 2002 National Science Foundation's survey on the public understanding of science.

Globally, it might make a difference as suggested above by Dick (1995). Planning for a promising detection is currently being studied by the Post Detection sub-committee of the SETI Permanent Study Group under the auspices of the International Academy of Astronautics. It includes two media specialists as well as scientists and other experts.

SETI and NASA

As I complete this thesis in late June, 2003, the new lead teams for the NASA Astrobiology Institute have been announced. Four lead teams have been retained from 14 teams for the years 1998 to 2003. There are 12 other lead teams, either re-formed or newly formed, for the years 2003 to 2008. Among the latter is the SETI Institute.

Undoubtedly the long and careful journey to the status of a highly respected research and education institution came from its substance in these two areas. The science research as an NAI lead team includes:

- high-altitude terrestrial lakes as analogs to early Mars.
- the surface geology and ocean chemistry of Jupiter's moon. Europa, and the survivability of bio-markers on its surface.
- the habitability of planets orbiting cool M stars, which may enlarge the list of stars targeted for SETI searches.

- the biotic and abiotic mechanisms behind the "oxygen transition" on early Earth.
- the prebiotic and biotic nitrogen cycle on Earth and in laboratory simulations of Mars.
- the role of iron in protecting anoxic life on early Earth against UV radiation.

The SETI Institute has actively explored science communication in an integrated way through its education, public outreach and mass media interactions for more than a decade – the latter being the focus of this thesis. The education and public outreach activities associated with the NAI proposal include a typical SETI Institute approach:

- fund teacher training and professional development workshops.
- collaborate with the California Academy of Science on new astrobiology exhibits.
- further engage the public, including underserved audiences, with the science that underlies the funded NAI research.

(SETI Institute press release, http://www.seti.org/seti_nai/media_release.php)

This emphasises the SETI Institute’s preference to use informal education methods to offer science education to the public rather than the mass media.

It underscores the actual, and best, use of the media is not to educate an apparently scientific illiterate public, but to address institutional profile-raising and impart information without the expectation of improving science literacy. The aim is public support, particularly in relation to funding.

Measuring science literacy

It might be useful for science literacy to be measured in some other way than the 'deficit model' – for example, having a demonstrated idea of how science works or the ability to evaluate such science news. The latter is not addressed by one of the two key science communication surveys – the National Science Foundation's Science and Engineering Indicators (2002) – and is only briefly attempted by the Eurobarometer 55.2 survey (2001). With a shift in paradigm about what the mass media does do, researchers may more clearly understand the objectives in this kind of science communication. It may help scientists and science communicator intermediaries to tailor research news to a variety of audiences rather than try to educate via the mass media. It may lead to less disappointment or misunderstanding in the scientist-science journalist relationship I explored in Chapter One. Inevitably, most newsworthy science, as demonstrated by the examples provided in this thesis, is of the type that invites societal and cultural questions rather than about the science itself.

There is a compelling alternative arising from the discussion throughout this thesis. Science researchers, educators and communicators have the potential to interlace seamlessly science and societal research, education *and* mass media. Over time the messages of science may make a great deal more sense to public audiences trying to make sense of the world - and to the decision-makers too - in an increasingly complex point-and-click environment of mass communication. There are few, if any, science research institutions yet capable of undertaking such an endeavour, with Education and Public Outreach (known colloquially as EPO) – where it exists – mostly carried out separately from the science research. While this is still occurring, the increasing role of the Internet with more than half a billion people now connected to the web, some of whom are using it as the primary source of information, is forcing an alternative science communication model for the future. Even a cursory glance through a good science website such as *Powers of Ten* http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/ provides science information and education in combination, and often through news sites that include links to this background information. In Chapter One I cited Hargreaves' (2000) view that the public are not an empty vessel to be filled. Unfortunately the deficit model persists, and the expectation is members of the public are crippled by scientific illiteracy. Somehow though, public audiences appear to be easily able to respond in debates concerning science, particularly in the kind of science that has context and meaning – for example, the environment, GM foods and SARS. These same audiences may also be the kind that participate in debate should an intelligent extraterrestrial civilisation be found. Perhaps by then it will be easy for audiences to access an understanding of the scientific information simply by plugging into a range of highly visual and educational websites.

CONCLUSIONS

Throughout this thesis I have explored the relationship between science research, formal and informal education and mass media using SETI, and mostly the SETI Institute as a case study. The intention has been that from this viewpoint it might be possible to see science communication from an unusual angle with the aim of suggesting possible improvements to a process that few question but which is important in an increasingly science-based world.

Perhaps the single most important conclusion is the expectations of governments and research institutions that the mass media is a conduit for science education. The Royal Society's view typifies the education perception, 'We recognise that the media play a crucial role in communicating an understanding of science to the public' (Royal Society, 1999). Education may sometimes be a by-product, but it is usually only incidental. A prime SETI example of this incidental education is where an article may impart an understanding of the size of the cosmos when explaining why SETI is a difficult experiment. The mass media, even in the science section, informs; it does not educate. Nor is that an intention of science journalists as pointed out by Rensberger in Chapter Two or even science researchers as Shostak notes in Chapter One. Governments and institutions who think otherwise are simply wrong and this is drawn out clearly in the SETI community's interactions with the mass media over many years.

From this conclusion, a number of other conclusions emerge. One is that while the science mass media does not seek to educate it is a part of a science communication education web along with formal and informal education, stemming from the science research itself. A study is recommended on how these parts can be drawn together more tightly to ensure formal and informal education is not limited largely to the young. Perhaps the expectation should be that a good education encourages life-long learning, and the critical thinking required to evaluate information. In the case of science, Sagan (1996) encouraged the idea that everyone be taught the scientific method as a tool for critical thinking. Undoubtedly an understanding of this bestows the ability to distinguish between science and pseudoscience. As Rensberger pointed out, this distinction is often not appreciated by viewers and readers because of lack of knowledge of the scientific method.

With a more scientifically literate public, the mass media then has a vital role in providing science news that then prompts audiences to discover more about the things that matter to themselves and their families and to take a role in the democratic processes as envisaged by Sagan. One immediate method of redirecting enquiring public audiences might be to encourage more news organisations to include a web site address for the institutions of the researcher they have interviewed. This is most likely to get a reasonable reception in print feature pieces.

Another conclusion is that the Internet is rapidly changing the face of science communication. With more than half a billion connected to the web within ten years of its public inception, where does it go in the next decade? It promises to have, eventually, the same audience penetration as television media with the speed and ability to convey much information dynamically and very succinctly with links to other relevant information to suit multi-users. This rapid change should alert science institutions to the importance of having a web site that addresses the range of audiences highlighted by Miller and others not only to provide information but formal and informal education too.

Lastly, SETI – and the SETI Institute in particular - is well in advance of most science research in considering the social implications of the success of the experiment. While there is still no international plan to cope with the flood of demands on a relatively small research group or team by the mass media in the event of success, this will undoubtedly eventuate. Any plan will of course be subjected to sabotage by events unthought of – even minor ones. However, a plan may be better than no plan, even if it is as basic as those worked out by the Viking team in speaking to the mass media with one clear voice and no jargon or unintentional language confusion (Billingham et al, 1994) and being considered for an eventual Mars sample return mission. The events of the Three Mile Island nuclear accident are salutary enough. Twenty years after the event, the biggest casualty was anxiety among those living near the reactor and a concept among a global audience that nuclear power was something to be concerned about (Raso, 1999). It would not be difficult to see how similar mismanagement of a SETI detection could lead to the same result. The effect would not be limited to a community or even a society but would touch the whole of humanity. The discovery of extraterrestrial intelligence would have an implication for everyone whatever the background, culture or societal beliefs. The key aspect is that public education is unlikely to happen during such an event in SETI, as with any other area of science where there is the potential to have a very large impact on society. The mass media is not an education medium and this will not change in the heat of the media spotlight during a period of intense media scrutiny.

In summary, to expect the science media to improve the public understanding of science and to reduce what appears to be a very high scientific illiteracy rate among the adult population is like expecting the daily newspaper to contain lessons on how to read.

This thesis has necessarily been largely qualitative through the experiences of a specific area of scientific endeavour. The conclusions suggest it warrants further study to quantify the issues in the quest to improve scientific literacy among the adult population, particularly in the US and Europe where there are already very detailed surveys and reports on the public understanding of science.

APPENDICES

APPENDIX 1

DECLARATION OF PRINCIPLES CONCERNING ACTIVITIES FOLLOWING THE DETECTION OF EXTRATERRESTRIAL INTELLIGENCE

We, the institutions and individuals participating in the search for extraterrestrial intelligence,

Recognising that the search for extraterrestrial intelligence is an integral part of space exploration and is being undertaken for peaceful purposes and for the common interest of all mankind,

Inspired by the profound significance for mankind of detecting evidence of extraterrestrial intelligence, even though the probability of detection may be low,

Recalling the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, which commits States Parties to that Treaty "to inform the Secretary General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results" of their space exploration activities (Article XI),

Recognising that any initial detection may be incomplete or ambiguous and thus require careful examination as well as confirmation, and that it is essential to maintain the highest standards of scientific responsibility and credibility,

Agree to observe the following principles for disseminating information about the detection of extraterrestrial intelligence:

1. Any individual, public or private research institution, or governmental agency that believes it has detected a signal from or other evidence of extraterrestrial intelligence (the discoverer) should seek to verify that the most plausible explanation for the evidence is the existence of extraterrestrial intelligence rather than some other natural phenomenon or anthropogenic phenomenon before making any public announcement. If the evidence cannot be confirmed as indicating the existence of extraterrestrial intelligence, the discoverer may disseminate the information as appropriate to the discovery of any unknown phenomenon.

2. Prior to making a public announcement that evidence of extraterrestrial intelligence has been detected, the discoverer should promptly inform all other observers or research

organizations that are parties to this declaration, so that those other parties may seek to confirm the discovery by independent observations at other sites and so that a network can be established to enable continuous monitoring of the signal or phenomenon. Parties to this declaration should not make any public announcement of this information until it is determined whether this information is or is not credible evidence of the existence of extraterrestrial intelligence. The discoverer should inform his/her or its relevant national authorities.

3. After concluding that the discovery appears to be credible evidence of extraterrestrial intelligence, and after informing other parties to this declaration, the discoverer should inform observers throughout the world through the Central Bureau for Astronomical Telegrams of the International Astronomical Union, and should inform the Secretary General of the United Nations in accordance with Article XI of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Bodies. Because of their demonstrated interest in and expertise concerning the question of the existence of extraterrestrial intelligence, the discoverer should simultaneously inform the following international institutions of the discovery and should provide them with all pertinent data and recorded information concerning the evidence: the International Telecommunication

Union, the Committee on Space Research, of the International Council of Scientific Unions, the International Astronautical Federation, the International Academy of Astronautics, the International Institute of Space Law, Commission 51 of the International Astronomical Union and Commission J of the International Radio Science Union.

4. A confirmed detection of extraterrestrial intelligence should be disseminated promptly, openly, and widely through scientific channels and public media, observing the procedures in this declaration. The discoverer should have the privilege of making the first public announcement.

5. All data necessary for confirmation of detection should be made available to the international scientific community through publications, meetings, conferences, and other appropriate means.

6. The discovery should be confirmed and monitored and any data bearing on the evidence of extraterrestrial intelligence should be recorded and stored permanently to the greatest extent feasible and practicable, in a form that will make it available for further analysis and interpretation. These recordings should be made available to the international institutions listed above and to members of the scientific community for further objective analysis and interpretation.

7. If the evidence of detection is in the form of electromagnetic signals, the parties to this declaration should seek international agreement to protect the appropriate frequencies by exercising procedures available through the International Telecommunication Union. Immediate notice should be sent to the Secretary General of the ITU in Geneva, who may include a request to minimize transmissions on the relevant frequencies in the Weekly Circular. The Secretariat, in conjunction with advice of the Union's Administrative Council, should explore the feasibility and utility of convening an Extraordinary Administrative Radio Conference to deal with the matter, subject to the opinions of the member Administrations of the ITU.

8. No response to a signal or other evidence of extraterrestrial intelligence should be sent until appropriate international consultations have taken place. The procedures for such consultations will be the subject of a separate agreement, declaration or arrangement.

9. The SETI Committee of the International Academy of Astronautics, in coordination with Commission 51 of the International Astronomical Union, will conduct a continuing review of procedures for the detection of extraterrestrial

intelligence and the subsequent handling of the data. Should credible evidence of extraterrestrial intelligence be discovered, an international committee of scientists and other experts should be established to serve as a focal point for continuing analysis of all observational evidence collected in the aftermath of the discovery, and also to provide advice on the release of information to the public. This committee should be constituted from representatives of each of the international institutions listed above and such other members as the committee may deem necessary. To facilitate the convocation of such a committee at some unknown time in the future, the SETI Committee of the International Academy of Astronautics should initiate and maintain a current list of willing representatives from each of the international institutions listed above, as well as other individuals with relevant skills, and should make that list continuously available through the Secretariat of the International Academy of Astronautics. The International Academy of Astronautics will act as the Depository for this declaration and will annually provide a current list of parties to all the parties to this declaration.

APPENDIX 2

BBC ONLINE NETWORK

HOMEPAGE | SITEMAP | SCHEDULES | BBC INFORMATION | BBC EDUCATION | BBC WORLD SERVICE

BBC NEWS

News in Audio | News in Video | Newyddion | Новости | Noticias | أخبار | 国际新闻 | 粤語廣播

Front Page
World
UK
UK Politics
Business
Sci/Tech
Health
Education
Sport
Entertainment
Talking Point

On Air
Feedback
Low Graphics
Help

Thursday, October 29, 1998 Published at 18:42 GMT

Sci/Tech

Puzzle over alien 'discovery'

Is there intelligent life in this star system?

By our Science Editor David Whitehouse

The scientific world is buzzing with the suggestion that signals from aliens living in another star system may have been picked up by a part-time astronomer.

Other astronomers are scrambling to confirm or deny them.

It could either be the most important discovery ever made, or more likely, a case of mistaken identity or an elaborate hoax.

The part-time astronomer who discovered the signals posted the data on the internet but would not reveal his identity.

He has been using a small radio telescope belonging to his firm to scan the sky for intelligent signals.

On October 22 and on the following night, he reported

Sci/Tech Contents

Relevant Stories

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Is anybody out there?

13 Nov 98 | Sci/Tech
Anyone out there?

Internet Links

Seti Institute

British UFO Research Association

Ufology Society International

The BBC is not responsible for the content of external internet sites.

In this section

World's smallest transistor

detecting signals from the EQ Pegasi star system which is 22 light years away.

The signals were not the type that occurs naturally. The data has been distributed to several astronomers and observatories.

However astronomers at the Jodrell Bank Observatory in England say it is all a case of mistaken identity. Astronomer Ian Morrison told BBC News Online: "I think he has detected signals from a satellite."

The truth is out there

The same search for extra-terrestrial life is being carried out by professional astronomers using the world's largest radio telescopes such as the one in Arecibo, Puerto Rico.

They call it Seti, the Search for Extra-Terrestrial Intelligence.

With the development of radio astronomy in the 1950s, astronomers realised that they had telescopes that could send and receive radio signals between the stars.

The first search for radio signals from space was in 1960. Two nearby stars were observed but no signals were detected.

Since then about 40 searches have been made. Many unusual signals have been detected but astronomers think that none of them were from intelligent life.

Last month astronomers at the giant Arecibo radio telescope conducting 'project Phoenix,' a detailed search for radio signals from intelligent life in space, detected a signal from EQ Peg but concluded that it was man-made interference.

The EQ Peg star system is unlike our own. It consists of two dim red dwarf stars orbiting each other. From time to time explosions, so-called stellar flares, occur on both stars.

Detecting signals from some form of intelligence living in a nearby star system would be the most important scientific discovery ever made.

At the moment it seems likely that the 'alien' radio signals are just man-made interference.

Terrestrial signals can easily fool astronomers into thinking that they have detected ET.

The searchers of project Phoenix recently tracked a signal for many hours before they realised it was a scientific satellite.

Scientists join forces to study Arctic ozone

Mathematicians crack big puzzle

From Business
The growing threat of internet fraud

Who watches the pilots?

From Health
Cold 'cure' comes one step closer

Many astronomers involved in searching for life in space have expressed regret that the EQ Peg observations were released without going through the procedure agreed to tell the public about possible ET signals.

Because of this they say they are suspicious that it is all a hoax.

Even if it is it will have caused many scientists to think again about how they would release the news of a real discovery.

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Search

Advanced options | Search tips

APPENDIX 3

I hereby give my permission for Carol Oliver to include in this thesis the content of our conversations related to the subject, "SETI and the Media: Improving Science Communication".

Ethics Committee approval has been sought and granted for the interview with me, Dr Jill Tarter, and inclusion of this in the aforementioned thesis.

Dr Jill Tarter

SETI Institute

July 19, 2003

APPENDIX 4

I hereby give my permission for Carol Oliver to include in this thesis the content of our conversations related to the subject, "SETI and the Media: Improving Science Communication".

Ethics Committee approval has been sought and granted for the interview with me, Dr Seth Shostak, and inclusion of this in the aforementioned thesis.

Dr Seth Shostak

SETI Institute

July 19, 2003

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