CIVILIZED LIFE IN THE UNIVERSE

SCIENTISTS ON INTELLIGENT EXTRATERRESTRIALS

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CHAPTER TEN

Mirror Worlds

> The future of science won't be like the comforting picture painted in *Star Trek:* a universe populated by many humanoid races, with an advanced but essentially static science and technology. Instead, I think we will be on our own, but rapidly developing in biological and electronic complexity.
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> -Steven Hawking, *The Universe* in *a Nutshell, 2001*

Universal Science?

As early as the sixth century B.C., Xenophanes criticized the Greeks for modeling their gods and goddesses after human beings. He satirically declared that if cows and horses had hands and could draw, they would mode! the bodies of their gods after themselves. And in the middle of the eighteenth century, the British philosopher David Hume observed there was a universal tendency among humans to conceive all beings like themselves, "and to transfer to every object, those qualities, with which they are familiarly acquainted."

These sources recall the long history of anthropomorphic thought and its continuing influence in mode~n times. Despite the efforts of SET I scientists to avoid the pitfalls of anthropomorphism, they duplicate terrestrial life and civilization on distant planets, creating a succession of alien worlds that mirror their own.

SETI investigators tend to transfer terrestrial life and culture to the rest of the universe because they operate beyond the limits of their knowledge and competence when they discuss the universality of science and mathematics, biological and cultural evolution, the idea of progress, the nature of technology, and the meaning of civilization. Astronomers and physicists first meet these complex areas of knowledge when they venture into history, philosophy, and the biological and social sciences. Not surprisingly, they use concepts drawn from the physical sciences to determine the nature of alien cultures.

Searchers for extraterrestrial intelligence suppose that alien mathematics and science are essentially like ours. When physicist Edward Purcell wrote about communication with extraterrestrials in the 1960s, he asked rhetorically: "What can we talk about with our remote friends?" His immediate answer was: "We have a lot in common. We have mathematics in common, and physics, and astronomy. . . . We have chemistry in common, inorganic chemistry, that is."[2]

Purcell not only assumed that the physical sciences are practiced throughout the universe but that alien science is bound to harmonize with terrestrial science. These premises, crucial to the belief that we can communicate with advanced extraterrestrial civilizations, are riddled with philosophical difficulties.

In a speech on the nature of science delivered in 1989, Nobel laureate physicist Sheldon Glashow noted that the recently discovered rings of Neptune were evident to American, Russian, Japanese, and Ugandan astronomers alike. The existence of the rings did not depend upon the gender of the observers nor upon their ethnic, national, or cultural backgrounds.

The universal nature of science practiced on Earth led Glashow to extend human knowledge of the physical sciences to the rest of the universe. He maintained that intelligent aliens would eventually develop "the same logical system as we have to explain the structure of protons and the nature of supernovae."[3]

Glashow's attempt to establish a cosmic physical science is not well founded. American, Russian, Japanese, and Ugandan scientists are *Homo sapiens* trained within the confines and traditions of modern science. On the other hand, virtually all scientific commentators on the subject agree that intelligent aliens are not like humans. They are not replicas of *Homo sapiens* who happen to live on an extrasolar planet.

Glashow makes no distinction between science practiced by different human groups and science practiced by intelligent creatures living on other worlds. However, human and alien science differ because there are enormous discrepancies in the biological constitution, intellect, and sociocultural lives of the two sets of practitioners.

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1996, Weinberg argued that if we translate the scientific works of intelligent aliens into our terms, we will learn "that we and they have discovered the same laws."[4] The difficulty here is translation, an act studied by modern philosophers. If we meet aliens, how can we determine if they have a language and practice science? To simplify matters, suppose we overcome these initial problems. We will then transform alien science into something we recognize as our kind of science. The result of this transformation process does not produce universal science. It produces a form of knowledge cast in the image of terrestrial science.

Barry Allen, who criticized Weinberg's views on extraterrestrial science, commented: "Weinberg knows no more about how aliens think than you or I do."[5] Weinberg agreed with Allen's comment but added that he never intended to depict the true nature of alien science. He merely presented an "illustrative prediction." Weinberg's illustrative prediction is based on the way physicists of different national origins on Earth accept the validity of the same set of physical laws. Thus, Weinberg resorts to the same analogy of a multicultural human science that Glashow offered earlier.

Shortly after NASA launched its ambitious new search for intelligent life in 1992, an editor of *Scientific American* asked Frank Drake how it was possible to communicate with advanced life in the universe. Intelligent aliens, Drake said, developed systems of mathematics, physics, and astronomy similar to those found on Earth. He believed that general relativity, quantum-field theory, and superstrings were already part of alien physics. An innate curiosity about nature and the need to better their lives, Drake continued, compel extraterrestrials to explain physical phenomena as we do.

When philosopher Nicholas Rescher was asked to comment on Drake's notion of alien science, he dismissed it as infinitely parochial. It was like saying that extraterrestrials share our legal or political system. Rescher was well qualified to examine Drake's claims. He had recently studied the anthropomorphic character of human science and how it related to alien science.

Rescher struck at the heart of the popular conception of alien science when he challenged the widely held view that there is only one natural world and a single science to explain it. He called this the one world, one science argument.

The physical universe is singular, Rescher agreed, but its interpreters are many and diverse. What we know about physical reality stems from our special biological and cognitive make-up and our unique cultural and social heritage and experiences. We have no reason to suppose that extraterrestrials share our peculiar biological attributes, social outlook, or cultural traditions. Human science, therefore, is incommensurable with extraterrestrial science. If extraterrestrials cultivate science, it will be their kind of science, not our kind. Alien science is a wholly different form of knowledge. It is not human science raised to a higher degree.

Rescher offered a compelling illustration of how human biology and our situation on Earth shaped our science. Astronomy as practiced by humans has been molded by the fact that we live on the surface of the Earth (not underwater), that we have eyes, and that the development of agriculture is linked to the seasonal positions of celestial objects.

Intelligent alien creatures living in an oceanic abyss might develop sophisticated hydrodynamics but fail to study the motion of heavenly bodies, investigate electromagnetic radiation, or build radio telescopes. Even if extraterrestrials are surface dwellers, their biological endowment will determine what they are able to sense, their ecological niche, what aspects of nature they exploit to satisfy their needs, their cultural heritage, which questions about nature they find interesting to ask.

Rescher acknowledges the existence of intelligent extraterrestrials who possess the ability to develop science and technology. He does not dispute the scientists' repeated claims (1) that there is a single scientifically knowable physical reality and (2) that aliens are not simply other humans inhabiting a different planet. After adopting these claims, he demolishes the idea of a universal science that serves as a common language in the universe.

Rescher maintains that wherever science exists in the universe, it will be localized. It will be the science of the creatures who have fashioned it. They will act according to their special physical constitution, environment, history, and needs. Hence, science diverges in the universe. It does not converge on the theories, concepts, and topics that happen to interest terrestrial researchers at this point in the history of the human intellect.

Rescher accepts the real world of the scientist and believes that science yields unique knowledge about the inherent structure of reality. Nevertheless, he refuses to equate human science with the science created by beings who are biologically distinct and who inhabit radically different physical, social, and cultural milieus.

Searchers for extraterrestrial intelligence overlook the fact that modern science is a mere four or five centuries old. It was not available throughout the more than 5-million-year history of hominids. Our early ancestors survived, multiplied, and spread over the Earth without the help of science. Modern science is a notable human achievement, but it is not an absolute necessity for the survival of our species. Since science has not powered the long history of humanity, why should we assume it is a form of knowledge found everywhere in the universe?

The Evolutionists on SETI

Three well-known evolutionary biologists—Theodosius Dobzhansky, George Gaylord Simpson, and Ernst Mayr—mounted strong attacks on notions of

the origin and development of intelligent extraterrestrial life held by SETI investigators. Their criticism focused on four issues: first, the deterministic thinking of scientists who portray evolution as a fixed process with preprogrammed goals; second, the contingent nature of organic evolution—mutations and unpredictable ecological changes make the evolutionary process dependent upon a chain of random circumstances; third, the role of intelligence in the adaptation of organisms (scientists in the SETI circle take the emergence of high intelligence for granted; most evolutionists see high intelligence as a rare event in the history of life); fourth, the anthropomorphism that typifies thinking in physics and astronomy about alien life—despite protestations to the contrary, the physical scientist's view of advanced life retains key human characteristics.

In 1964 George Gaylord Simpson published an essay in *Science* entitled "The Nonprevalance of Humanoids." He was inspired to write about humanoids (human-like creatures) because of the various research programs on alien life sponsored by NASA, and encouraged by the National Academy of Sciences, in the 1960s. The study of exobiology, Simpson argues, might have official sanction, but it is a science without any evidence to support it. Exobiologists may think of themselves as biologists, but they tend to know more about physics, chemistry, and biochemistry than they do about evolutionary biology.

Simpson doubts that humans would recognize life forms not based on the carbon chemistry that fostered terrestrial life. Organisms with some other chemical and structural basis would not fit classificatory systems devised by Earth-biased observers. Although he raises these and other objections, Simpson thinks it reasonable to suppose that life defined by terrestrial criteria may exist beyond Earth. However, Simpson reminds his readers that this is pure speculation on his part. It is not a fact.

Simpson criticizes scientists who envision an evolutionary path that culminates in intelligent creatures similar to humans. Evolutionary history, he counters, is opportunistic and unpredictable. It does not move deterministically toward preestablished goals. Instead, evolution makes do with what happens to be available at a particular time and under a given set of circumstances.

Humans beings are no exception to this rule. *Homo sapiens* are the result of a 3-billion-year-old causal chain of events. That chain cannot be repeated on some other planet unless the planet has a history identical in every detail, including every moment of time, to the history of the Earth.

Simpson writes that it is extremely unlikely that anything remotely like humans inhabits the universe. If such creatures do exist, it is impossible for humans to communicate with them. The fundamental differences between terrestrial and extraterrestrial organisms prevent the exchange of information between them.

Extremely unlikely does not mean impossible, and Simpson admits that others have the right to dream that they are not alone in the universe. Dreams of alien intelligence, however, remain dreams. They may inspire science fiction or poetic reflection but not scientific research.

Simpson understands that his rational arguments will not persuade those who search for signs of intelligent extraterrestrial life. Their emotional commitment and self-interest, he says, hinder his chance of success. Nevertheless, if astronomers persist in searching for extraterrestrial intelligence, they should know that their hunt is a gamble with the worst odds in history. That is why the search for alien intelligence resembles a wild spree more than a sober scientific program.

Dobzhansky's appraisal of the problem of extraterrestrial life appeared a decade after the appearance of Simpson's essay. Dobzhansky begins his article by clarifying the distinction between the origins of life and its subsequent evolution. He notes that most biologists avoid commenting on extraterrestrial evolution. By contrast, cosmologists and exobiologists assume that the development of extraterrestrial life recapitulates the appearance of intelligent life on Earth. Hence, they conclude that creatures similar to humans have established flourishing technological civilizations throughout the universe.

Simpson and Dobzhansky presented their ideas of alien life during the early decades of the space age. Ernst Mayr, writing in several scientific periodicals in the 1990s, confronted NASA's SETI program and the conception of intelligence adopted by its researchers. He based his criticisms on a lifetime study of the science, history, and philosophy of organic evolution.

Mayr argues that the $100 million allotted to NASA for its decade-long SETI project is a waste of federal funds. Astronomers, physicists, and engineers, ignorant of the crucial biological and social components of their venture, advise the space agency on SETI projects. Therefore, NASA's search for messages from advanced civilizations is a flawed if not futile effort.

Mayr accepts the *probability* that life originated independently on extrasolar planets resembling the Earth. He says that it is *improbable* that extrasolar planets nurture intelligent life and that it is *highly improbable* that alien life has evolved advanced intelligence. Given his reservations, Mayr all but ruled out the possibility of extraterrestrial civilizations contacting Earth via radio signals. He considered the possibility of extraterrestrial organisms receiving human-generated radio signals directly through special sensory organs but rejected it.

Mayr dismisses the argument that intelligence ensures the successful adaptation of an organism to its surroundings. Nor does he believe that human-level intelligence is a premium property for any creature. Of the billions of species that have inhabited the Earth, only one developed civilized life, and only one

civilization mastered electronic communication. Perhaps civilizations are rare because high levels of intelligence do not benefit organisms. Many so-called higher creatures have levels of intelligence lower than humans. These include apes, monkeys, dogs, cats, whales, dolphins, and birds. None of the above developed civilized life or established electronic communication. Nevertheless, they have succeeded in surviving and reproducing themselves.

Evolutionary biologists claim that each species confronts peculiar environmental conditions and that there is no single property, including intelligence, that insures a species' survival. Millions of species have used other strategies to adapt, survive, and reproduce. According to Mayr, physical scientists are driven by a single-minded determinism. They erroneously believe that intelligence was a necessity early in the history of life and that its adaptive value increased thereafter. He has a ready explanation for this kind of thinking. Human beings are dependent on, and proud of, their superior intelligence. Consequently, they assume that other creatures cannot get along without it. An anthropomorphic impulse drives their discussions of evolution and intelligence.

Mayr notes that human intelligence comes at a steep biological price. It requires a large brain and complex central nervous system plus the metabolism to maintain them. It also demands a long infancy with extended parental care. That is why large-brained *Homo sapiens* appeared less than 300,000 years ago even though the hominid line branched away from the apes five to seven million years earlier.

The billions of species that have lived on Earth without intelligence, or with a low level of intelligence, were not at a disadvantage. They evolved other adaptations to cope with their ongoing struggle for existence. These alternative adaptations evolved more readily and more widely than the high intelligence we admire in humans and confer upon extraterrestrial organisms.

Mayr concludes that intelligence is a fluke of history. It is not an inevitable or necessary consequence of the development of life. Intelligence is one of many ways organisms deal with their environment. It is not a special property driving evolution along a progressive path. Or, as evolutionary psychologist Steven Pinker said, "Evolution is about ends, not means; becoming smart is just one option."[6]

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Not every evolutionary biologist is as critical of the search for extraterrestrial life as Dobzhansky, Simpson, and Mayr. Some evolutionists have offered SETI their qualified support. Four distinguished evolutionists signed Carl Sagan's 1982

petition endorsing increased funding for SETI research. One of the signers, David Raup, reacted to criticism of SETI by proposing an organismic source for extraterrestrial signals.

Raup reviewed the arguments made by SETI enthusiasts, including claims that intelligent extraterrestrial creatures practice advanced science and technology and that they build and deploy electronic communications instruments. Raup agrees that evolutionary biologists have good reason to question such claims.

SETI investigators assume that intelligent extraterrestrial organisms build radio transmitters. Raup asks if creatures with nonconscious intelligence might transmit radio waves in some other fashion. We know that certain terrestrial organisms can detect magnetic fields and generate strong electrical currents. Electric eels and fishes, for instance, generate electrical fields that they use for seeking food and communicating with other members of their species. They generate electricity biologically, not technologically with dynamos. Likewise, some alien creatures might generate electromagnetic waves biologically, not technologically with radio transmitters.

Raup states that as late as 1991, biologists have found no living thing that transmits electromagnetic waves. Researchers in the future, however, might discover such a creature on Earth. A terrestrial organism able to generate radio signals could serve as a model for extraterrestrial organisms who have neither the conscious intelligence nor the manipulative ability to construct electronic devices.

Raup supports NASA's SETI projects because he believes if they succeed, humans will gain enormous benefits. He has difficulty, however, explaining how radio signals of biological origin will benefit us because the transmitting organisms are not necessarily intelligent. They have simply evolved the ability to send radio signals. And, how can radio astronomers located on Earth know where to search for electronic signals generated organically? SETI investigators claim that intelligent alien communicators deliberately choose radio frequencies based on their knowledge of the physical sciences. The same does not hold true for low-intelligence, biological transmitters.

Raup asks that we search for signs of incoming radio signals from organisms that have a minimum level of intelligence. Two-way communication is unlikely to take place under these circumstances. The alien signalers may accidentally reveal their existence, but they are not able to send coded messages or extensive information to Earth.

Another evolutionary biologist, Stephen Jay Gould, rose to defend SETI in 1982. Gould, a well-known popularizer of biology and evolution, approached

the issue of intelligent extraterrestrial life cautiously. He ultimately endorsed SETI research because it was relatively cheap, promised great changes in human thought if successful, and did not contradict the theory of organic evolution. In supporting his third reason, he closely analyzed the response of evolutionary biologists to the idea of intelligent life in the universe.

Gould drew a distinction between the *specific* and *general* claims made by SETI practitioners. The specific claim, which most evolutionary biologists including Gould discount, calls for the near-exact repeatability of long sequences of evolutionary events. In this case, it means that evolution operating on a distant planet will produce creatures resembling humans. Gould argued that if the evolution of life on Earth were started anew, it would not necessarily end with the appearance of *Homo sapiens*. Using an analogy taken from magnetic tape recording, he said that if the tape of life were run through once again, the results would not be the same.

Most evolutionists reject the specific interpretation of organic evolution because they believe that evolution is a complex process filled with historical accidents along the way. Gould listed two major objections to the specific argument. The first is the mass extinction of organisms in the past. An asteroid happened to strike the Earth 65 million years ago. Dinosaurs, who lived on Earth for 140 million years, became extinct and opened the way for the evolutionary development of mammals. This cataclysmic event, which eliminated a dominant form of life, underscored the random nature of evolution.

Gould's second argument emphasized the contingent nature of the evolutionary process. The evolutionary chain of any species extends into a past filled with chance interactions between species and species, and environment and species. Evolutionary paths shift in one direction and then another again and again. According to Gould, any species is the result of a series of unique happenings. Its history is not repeatable on Earth nor on another habitable planet.

Gould could not defend the specific claims made by SETI scientists. However, he accepted the looser claim that intelligence in some unspecified or unimaginable form might exist elsewhere in the universe.

Gould thought it was possible for exotic alien life forms to converge on intelligence. On the Earth, convergence was evident in the separate evolution of flight in insects, birds, and bats. If convergence resulted in flight appearing in species belonging to different lineages, perhaps convergence might lead to the emergence of intelligence in extraterrestrial life forms. Gould was satisfied with this argument for extraterrestrial intelligence and believed it acceptable to other evolutionists.

Despite his use of convergence to bolster the existence of alien intelligence, Gould had low expectations for SETI's chances of success. He said that the probability of alien contact is much lower than that calculated by optimistic physical scientists. Nevertheless, the whole venture is worth a try. The curiosity that drives humans may also drive intelligent beings inhabiting other parts of the universe.

Gould's endorsement of the general claim for extraterrestrial intelligence rests upon his belief that these creatures are not similar to humans. Intelligence can appear in alien life forms with different anatomical structures. They might be blobs, films, spheres, masses of pulsating energy, or even more diffuse and unimagined shapes.

Gould and other evolutionists might settle for the general claim that intelligent life in some unspecified form may inhabit the universe. Living blobs, spheres, and films, however, are not suitable candidates for constructing and operating radio transmitters. Technology, as we know it, probably resulted from a combination of a big brain capable of comprehending the physical world and manual dexterity enabling an organism to manipulate it. In short, advanced terrestrial technology is a unique product of humans.

A small number of biologists believe that there is a limit to the number of evolutionary possibilities. One of this group wrote in 1964: if we succeed in communicating with extraterrestrials "they won't be spheres, pyramids, cubes, or pancakes," "they will look an awful lot like us."[7]

The British paleobiologist Simon Conway Morris revived this argument in a book he published in 2003. Specifically, Conway Morris disputed Gould's claim that evolution was the result of a series of random events. If the tape of life were rerun, said Gould, it would yield a different set of life forms that did not include humans. In criticizing Gould's contingent evolution, Conway Morris presented his views on the constraints limiting the direction of evolution, the nature of intelligence, and the existence of extraterrestrial beings.

At the heart of Conway Morris's argument is convergence and the repeated emergence of complex biological systems. All evolutionary biologists acknowledge that convergence plays a role in the evolution of life. They agree that different species, living under similar environmental conditions, can independently evolve similar characteristics. Eyes, for example, have evolved in unrelated species a number of times.

Conway Morris uses examples of convergence drawn from a wide variety of sources to expand the role of convergence in shaping evolution. In his world, evolution is confined to a limited number of paths because species tend to converge on the same solutions to produce similar body plans and biological mechanisms. Therefore, when Conway Morris reruns Gould's tape of life, he expects

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Likewise, evolution operating on another planet will produce extraterrestrial beings that resemble humans. And, since Conway Morris is willing to extend his thesis beyond biology, extraterrestrial cultures will converge upon agriculture and tool use as practiced on Earth.

At first glance, Conway Morris appears to support the views of life and culture held by SETI researchers for years. However, he makes it clear that although extraterrestrial life and culture would reflect its terrestrial counterparts, life does not exist beyond the Earth. Hence, he argues, "Life may be a universal principle, but we can still be alone."[8] Conway Morris is not impressed by attempts to create life in the laboratory. He is convinced that the initial appearance of life was due to a set of extraordinary circumstances not easily repeated on Earth or elsewhere in the universe.

Conway Morris's conclusions on these matters are probably influenced by his personal religious beliefs. Remarks supporting a religious outlook and critical of materialistic interpretations of life run throughout his book. The last part of his work is entitled "Towards a theology of evolution." There he announces his belief that Darwinism and religion are compatible. Given Conway Morris's search for a common ground between science and religion, he believes that the teleological approach has a rightful place in the search for scientific truths.

According to Conway Morris, the many convergences guide evolution along a progressive path that leads to intelligent, human-like creatures. Living things are not products of a helter-skelter process. Instead, long-term trends constrain evolution to a goal of complex human-like creatures. If humans recklessly destroy themselves, there are other intelligent species waiting in the wings to follow the converging paths that end in high intelligence, culture, and tool use.

All of the above takes place on Earth, not in the heavens. Conway Morris's final message is summarized in the subtitle of his book, *Inevitable Humans in a Lonely Universe*. The universe, as he sees it, is not without purpose or plan. Nor does it lack a creator who is the lord of all creation.

Progress

Unlike many evolutionists, Conway Morris finds evidence of progress in the evolution of life. The emergence of complex animals with larger brains with the ability to communicate with one another, live in advanced social systems, and create culture is proof enough that progress has occurred. His claim that life converged upon agriculture and tool use goes beyond biology into the realm of

culture, where it raises questions that have long troubled historians, philosophers, and anthropologists. The idea of progress, the meaning of technology, and the nature of civilization are often mixed together in discussions of progressive technological civilizations. These complex subjects deserve special attention. They cannot be understood by lifting concepts and theories from the biological or physical sciences.

Scientists searching for extraterrestrial intelligence often cite goal-oriented progress as proof that human evolution is progressive. The goal of organic evolution becomes the production of intelligent creatures able to produce sophisticated technologies. It is possible, however, to choose other goals with different results. For example, we can define the aim of evolution as the domination of the terrestrial biomass, the total mass of all living things on Earth. By many measures—species longevity, total biomass, ability to cope with widespread catastrophes—bacteria easily win the contest.

Forests, often considered the largest component of the biomass, contribute far less to the total biomass than bacteria. One scientist estimates that bacteria living beneath the Earth's surface account for 2×10^{14} tons of the biomass. This figure exceeds the mass of all flora and fauna living on the face of the Earth.

The lineage of bacteria extends back more than 3.5 billion years while our earliest human ancestors first appeared 5 to 8 million years ago. And the germ theory of disease demonstrates that bacteria can cause humans to sicken and even die. This does not prove that bacteria rule the Earth or that they are superior to humans. It does raise questions about how to define progress and direction in the evolution of life on Earth or elsewhere in the universe.

The idea of progress, a creation of early modern Europe, has few roots in antiquity or the Middle Ages. Its origins are evident in its strong Eurocentric bias. Western civilization is the standard by which the progressive achievements of all other cultures are judged. The idea of progress reached its high point in the early twentieth century. Since then it has come under attack from critics who point to a variety of persistent problems that undermine a simple faith in human progress. How can we celebrate progress, the critics ask, in an age threatened by overpopulation, intractable diseases, environmental pollution, wars, terrorism, religious conflicts, and the widening gap between the rich and poor?

Throughout its history, progress has carried at least two meanings. It can mean forward movement toward a stated goal, or more broadly, the betterment of the human condition. In practice the two meanings are often merged, and the goal of progress becomes the advancement of humanity. Modern writers tend to stress human advancement in scientific or technological terms rather than in moral or cultural ones. Thus, technological innovations and scientific discoveries

serve as convenient markers for the progress achieved by a particular civilization, nation, ethnic group, race, and so on.

Technology

Seekers of extraterrestrial intelligence have adopted some mistaken notions about the nature of technology. They assume that technology moves progressively toward goals predetermined by the universal laws of science. The pathway of technological development culminates in interstellar communication by space ships, probes, or radio waves.

The Project Cyclops report of 1971 argued that despite differences in intelligent life forms, their technologies converge. At some point in the history of extraterrestrial technology, the report announced, "microscopes, telescopes, communication systems, and power plants" must be similar to ours because they are based on the same physical principles. The report claims that technological systems are products of the laws of optics, thermodynamics, and theories of electromagnetism and atomic reaction and not the peculiar attributes of the creatures who happen to design them. Because of the universality of science, mathematics, and technology, communication with extraterrestrial beings is assured.

The Cyclops report does not consider the influence of cultural factors on the development of technology. Given our knowledge of the history and philosophy of technology, we know that our technology could have developed in many different directions. Science is a necessary, but not sufficient, condition for the production of technology. Granted, modern technology owes much to the growth of scientific knowledge. However, there are important technologies that are not dependent upon modern science. The making of a wide array of tools and weapons from stone and plant material persisted without the help of science for several million years. The controlled use of fire appears long before the rise of science.

Technology produced by the application of modern terrestrial science is constrained by the nature of that science. Modern technology is shaped by the ways humans have constructed their view of the physical universe. The physical universe limits that construction, but it does not absolutely define it. Just as there is no universal science, there is no universal technology.

Popular accounts of the history of technology claim that the stage of interstellar communication is reached through a well-defined sequence of technological events. They include the use of stone tools by our early human ancestors, origination of language, discovery of fire, emergence of ceramics and metallurgy, development of agriculture and sedentary living, invention of writing, cultivation of early mathematics and astronomy, rise of modern science founded on

observation and experimentation, and creation of mechanically based industries. All of this reached its high point in the establishment of electronic technology, a technology dependent on the application of modern science to communication technology.

Historians have no proof that technology follows this or any other predictable sequence of stages. If a technological tradition begins with stone hand tools, it need not end in electronic communications. The history of technology is filled with technological paths never followed. Once a particular technology is developed, and social, cultural, and economic commitments made to it, then other technological possibilities are closed. The opening of a door to one technological solution closes off outlets to its alternatives.

So the history of technology does not follow a single path that leads from stone tools to radio telescopes, or any other technological process or artifact. A more fruitful analogy is a many-branched bush with some technological branches fully developed while other branches are left unexplored, or partially explored and abandoned. The historical record demonstrates that humans have lived in radically different technological settings. There is no single technological way of living as a human being. Over time, different societies, using different technologies, have survived and flourished. We tend to overstate the influence of technology on human survival. Even controlled fire arrived late on the scene, perhaps 250,000 years ago or earlier.

John Ball, who originated the zoo hypothesis to explain the absence of alien visitors to Earth, also offered an analysis of the overall evolution of a technological civilization. There were, he claimed, three possibilities. First, a civilization could be destroyed by technology externally or internally. Second, a technological civilization could stagnate, showing no signs of progressive development. Civilizations with a low level of technology, he continued, "would eventually be engulfed and destroyed, tamed, or perhaps assimilated."[9] Thus, we are left with the third possibility, a civilization that shows quasi-technological progress, where progress is defined as control over the environment. These progressive, advanced civilizations have mastered the universe and are the only ones of interest. Aliens who control the universe may act as the zookeepers of other intelligent creatures who have not reached the technological prowess of their overseers.

Kardashev's three tiers of alien civilization is yet another way of thinking about alien technology in terms of evolutionary progress. The Soviet astronomer accepts the idea that as a culture uses more energy, it progresses to a higher level of civilization. A Type III galactic super-civilization has access to far more energy than a terrestrial industrial civilization; hence, it is superior to it. This is not a new idea. In 1928 author Aldous Huxley poked fun at thinkers who claimed

that because humans now use 110 times more coal than their ancestors, they are 110 times more civilized.

The viewpoint Huxley satirized in the 1920s was at least a century old. It first appeared in the early days of the Industrial Revolution when steam engines were equated with the progress of British civilization. A number of nineteenth-century writers believed that excess energy made available by steam engines advanced the level of civilized life in Great Britain.

The equation of energy and civilization was periodically revived thereafter. In the early twentieth century, it was used by physical scientists to promise a paradise on Earth based on free energy from reactions at the atomic level. This promise was renewed after World War II when scientists and laypersons alike imagined a utopian world filled with automobiles, airplanes, and ocean-going ships powered by nuclear reactors.

The weakness of the energy-civilization equation is evident when we ask how the surplus energy delivered by steam engines or nuclear power plants is used by society. The additional energy can serve socially constructive purposes or be wasted on the production of trivial goods or warfare. Were the Soviets and Americans more civilized than other nations when they stockpiled enormous quantities of nuclear energy in missiles aimed at each other's cities? Measured in the quantity of energy per capita, they controlled more energy than any other people on Earth. The coupling of high energy use with civilization illustrates the defects in the notion that advanced technology acts as a civilizing force throughout the universe.

The idea of a progressive technological civilization is one of the weakest links in the chain of arguments used by searchers for extraterrestrial intelligence. Civilization, like progress, is a latecomer to Western thought. And civilization, like progress, is a vague term burdened with value judgments.

Civilization

"Civilization" became a popular term in the eighteenth century when it defined a polished and refined state of society. Civilization was contrasted with barbarism or savagery, which possessed much lower levels of social organization, moral behavior, artistic sensibility, and knowledge. Many nineteenth-century anthropologists mistakenly believed that all human societies pass through a savage and barbaric stage before they reach the heights of civilized societies exemplified in Western Europe.

By the nineteenth century, science and technology became important parts of the definition of civilized life. The existence of science and industry in

5. Jill Tarter, "HRMS, Where We've Been, and Where We're Going," *Progress in the Search for Extraterrestrial Life*, ASP Conference Series, vol. 74. ed. G. Seth Shostak (San Francisco: Astronomical Society of the Pacific, 1995), 457.

6. John N. Wilford, "Astronomers Start Search for Life Beyond Earth," *New York Times*, Oct. 13, 1992, C2.

7. Ibid., C2.

8. John D. Boudreau, "Cosmic Endeavor or Black Hole," *Washington Post*, Feb. 15, 1994, E, 1.

9. John N. Wilford, "Ear to the Universe Is Plugged by Budget Cutters," *New York Times*, Oct. 7, 1993, 12.

CHAPTER 10

1. David Hume, *Dialogues Concerning Natural Religion and the Natural History of Religion*, ed. J. C. A. Gaskin (Oxford: Oxford University Press, 1993), 141.

2. Edward Purcell, "Radioastronomy and Communication through Space," *The Quest for Extraterrestrial Life,* ed. Donald Goldsmith (Mill Valley, Calif.: University Science Books, 1980), 195.

3. Sheldon Lee Glashow, "The Death of Science!?," *The End of Science?,* ed. Richard Q. Elvee (Lanham, Md.: University Press of America, 1992), 28.

4. Steven Weinberg, "Illustrative Prediction," *Science* 285 (Aug. 1999): 1013.

5. Barry Allen, "What It's All About," *Science* 285 (July 1999): 205.

6. Steven Pinker, *How the Mind Works* (New York: Norton, 1997), 153.

7. Robert Bieri, "Huminoids on Other Planets," *American Scientist* 52 (Dec. 1964): 457.

8. Simon Conway Morris, *Life's Solution: Inevitable Humans in a Lonely Universe* (Cambridge: Cambridge University Press, 2003), 32.

9. John A. Ball, "The Zoo Hypothesis," *Icarus* 19 (Mar. 1973), 348.

10. I. S. Shklovskii and Carl Sagan, *Intelligent Life in the Universe*, trans. Paula Fern (New York: Dell, 1966), 375.

CHAPTER 11

1. Carl Sagan, "Unidentified Flying Object," *The Encyclopedia Americana* (1982), vol. 27, 369.

2. Cynthia Ozick, "If You Can Read This, You Are Too Far Out," *Esquire* 79 (Jan. 1973), 74.

3. David W. Swift, *SETI Pioneers* (Tucson: University of Arizona Press, 1990) 83.

4. Joel Achenbach, *Captured by Aliens* (New York: Simon & Schuster, 1999), 283.

5. Dennis Overbye, "Where Are Those Aliens?" *New York Times*, Nov. 11, 2003, F15.

Bibliographic Note: Th
on the topics I discus
are listed according t

At this point I w
reference work: Dav
to All Life in the Uni
articles, and conferen

Steven J. Dick, *Plura*
to Kant (Cambridge:
restrial Life Debate, 1
Guthke, *The Last F*
1990).

Milton K. Munitz,
1951): 231–255; Cyr
Press, 1928); David
of Chicago Press, 19
(Chicago: Universit
Theories of Space an
Cambridge Univers
1687 (Cambridge: