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Stephens Makes Big Ear Visit

Phil Barnhart

Bob Stevens made a sweep into the Central Ohio region the week of March 6-10 for the purpose of exploring mutually beneficial equipment exchange. His whirlwind trip accomplished the testing of some local instruments and components.

As a result we now have about 250 feet of drive chain and accompanying sprocket gears for driving the horn cart with a system that does not require a friction coupling to the cable/drum system presently in place. This should simplify the horn cart motion and positioning project greatly.

Dixon reports Stephens returned to Algonquin with a trunk full of parts from the excess bin and a sly smile on his face. As is well known from coast to coast, Bob Stephens is rarely happier than when he is scrounging radio observatory back lots and telescope front ends.

NAAPO to continue distribution of Flag of Earth

Phil Barnhart

For some years Bob Dixon has served as a pipe-line for those wishing to obtain their own Flag of Earth, designed and manufactured by James W. Cadle of St. Joseph, Illinois. It has been decided that NAAPO headquarters will take over this task to relieve Bob of the paper work and mailing duties.

The radio observatory has not sought to make any profit from these sales since Mr. Cadle has manufactured and sold the flags at no profit to himself. We intend to continue this policy as part of our dedication to spreading the concept of the human endeavor of exploring the universe.

For those interested in the Flag of Earth product line the current price schedule and availability information follows. Anyone interested may order directly from James Cadle or send your requests through NAAPO.

Here and there in the universe a long time from now,
The Flag of Earth will whisper of a planet

Where you could stand naked under a warm sun.
Where you could swim in water that stretched as far as eyes could see,
And walk the very ground that grew your food.
A planet where it rained.
Home.

1980 James W. Cadle

Sewn Construction - Heavy Nylon - No Display Protocol
61x91 cm (2'x3') ... $22.00
91x132cm (3'x4 1/2') ... $41.00
122x183cm (4'x6') ... $65.00
2.5x3.7m (8'x12') ... $291.00 (Each is made to order and serialized.)
12.7cm (5") dia. vinyl decal ... @ $2.10
Please include payment with order to:
Flag of Earth Company International
St. Joseph, IL 61873

Signals Survey Not Complete

Phil Barnhart

The last issue of Signals contained a survey card for all recipients of the newsletter. It was our intent to use the return cards to update the mailing list and gain some feedback at the same time. So far, about 1/3 of our friends have replied.

If you misplaced, mutilated, folded, tore, or spindled your reply card, please send us the information anyway. We look for your current address, institutional affiliation and comments. We accept these on any medium, from ancient papyrus to cellular phone signals. Besides hearing that you arc still with us, it is a great help to clean up our mailing list.

Donations Surge Following Survey

Phil Barnhart

Many thanks to those who took the broad hint that we needed financial support for the projects of the next few months. We have increased the contents of the coffers by nearly $1700 which should get us to the end of the summer.

We wish to emphasize that all money donated goes to program operation. We do not have a large overhead category, and much of the casual costs, such as publications and clerical involvement is donated or volunteer oriented. With NAAPO you get more program per kilo buck than any other educational and research organization.

Lewis Gives Summer Internships a Shot in the Arm

Phil Barnhart

Internships to Honor Reber, Kraus and Jansky

Skip Lewis, a long time supporter and donor to the Radio Observatory, NAAPO and the cause of SETI, science education and astronomical research, has again stepped in with a donation and an idea to our organization.

His generous check was accompanied by the stipulation that it be used to support the internship program in the names of Grote Reber and John Kraus. Since we have applications for this summer from three potential interns, the decision was made to match Skip's donation and set up a third designated internship in the name of Karl Jansky.

Each intern will be provided housing while on site in Central Ohio, access to the radio observatory archives and facilities at Dreese Labs, the radio telescope, and will have a study room supplied in the library at Otterbein College. In addition, student interns will receive a modest stipend to prevent catastrophic events like starvation. After all, Madame Curie lived on less while in school. Transportation will be arranged as conveniently as possible during the summer. Transportation to and from the remote institutions will be arranged by the interns.

Announcement of the holders of each internship will be made in the next newsletter.

Coordinator's Corner

Phil Barnhart

When in the course of human events...How often when we hear these words do we forget that crises often arise, consume our efforts, and are handled as routinely as putting out the cat. Hospital emergency rooms come to mind as examples.

It is only when emergencies pile up, one upon another, that the need for some sort of triage becomes necessary for survival. I was responsible for the delay of this issue of Signals simply because in the list of crisis deadlines, it constituted the one most likely to survive a delay. The other crises required diligent and rapid attention and now lie pretty much at rest.

To assure our friends that it is not hopeless and that we are gaining some degree of control I will spell out the nature of the crisis calendar.

March 7-March 20 Final weeks of the winter term. Always a crisis time — procrastinating students, exams, final interviews, grades due. Tolerable when not complicated by...

March 8 Extraneous personnel problem requiring many hours of investigation over two week period.

March 14 Daughter enters maternity ward with impending grandchild. Long labor ensues.

March 17 Domestic problems erupt — grand-daughter and mother become ill. Decision to vacate domicile. I, who swore never to move again, moves furniture out of daughter's apartment till well past midnight... divorce lawyer engaged... new apartment engaged.

March 19-20 Finish grading exams 2:30am. Grades computed and submitted by deadline.

In the midst of all this the head gasket on my old reliable wheels goes out. They say

$800 to ransom it from the garage and that the 5 days without reliable transportation was a lucky break. I don't believe them.

In spite of all this I remain buoyed by the realization that NAAPO has a mission well served by a sturdy group of volunteers. Much has happened in the past month and we are getting our act together more effectively than we have for many months in the past. I will continue to recognize, and value the volunteer nature of our group. The badge of volunteer is one I will wear proudly and will encourage every one of our sturdy little group to honor and bear proudly. It is one of the best endowments any organization can have.

I apologize for the delay in this issue. Precedented as it is, I vow to make a better job of deadlines in the future.

Editor's Note:

You can add my apology to Phil's for the late appearance of this issue. My schedule did not permit me to finish putting it together promptly after receiving his material.

Working Session Notes
18 March 1989

Those Present: Childers, Dixon, Phillips, van Horne, Barnhart, Eberly, Hord, Joy, Jurgens, Janis, Vardag, Ferryman, Campanella

Recent requests to curtail the length of the business portion of the meeting and get on with tasks about the site led to an agenda involving only brief reports from active sections.

1. RFI (Phillips): A check with Delaware airport air traffic control yields 40,400 flights annually, few in our direction. No break down of time distribution.

Satellite information is next on agenda.

Materials from Ellingson will prove useful.

2. Observation/Data Analysis (van Horne): Continuum survey now off ground. Data on floppies will soon be available as Jurgens gets info from 11/23 hard disk. More

soon.

3. Software Group (Dixon): Ferryman nearly has SETI program running. Vardag still works on the A-D converter problem.

4. Site Engineer (Childers): Outline of use of link chain drive scheme for providing cart motion was presented. Advantages of fixed chain with DC motor mounted on cart were presented. The crew then retired to the ground plane to look over the situation.

Announcements:

We need a volunteer welder. There is acetylene and arc welding equipment on site. It will take someone to run it.

We need volunteers to handle the open house next meeting. There will be a 1pm public open house with parking, refreshments and direction giving guides. Contact Dixon or Barnhart for instructions.

NASA searching for Cosmic Feedback

$85M project seeks life out there

Paul Hoversten
USA TODAY (Mid Feb)

If E.T. is talking, NASA wants to listen

The goal: Clear up one of life's oldest mysteries — "whether we are alone as an intelligent species in the universe, or whether there are others," says Bernard Oliver, project chief at Ames Research Center, Mountain View, Calif.

"Modern astronomy and biology predict that life is very common," he says.

The 10-year, $85 million Search for Extraterrestrial Intelligence will tune in to cosmic microwave transmissions from 1992-98.

NASA managers on March 1 will ask Congress for $6.8 million this year to step up

work that began in 1987.

Says chief investigator Jill Tarter: "We can't proms [sic; "promise" should replace "proms"] that the search will find a signal."

That irks critics such as retired Sen. William Proxmire, who doubts E.T. exists outside the minds of film producers.

"There have been no breakthroughs to justify the millions NASA wants to spend," says the Wisconsin Democrat. "What we need is intelligent life in Washington."

Since 1960, radio astronomers around the world have searched various frequencies to no avail.

In 1983, the Planetary Society, headed by science guru Carl Sagan, launched Project Sentinel with a rented radio telescope from Harvard University. Scientists from the group, based in Pasadena, Calif., have since expanded the search from 131,000 to 8.4 million microwave channels.

NASA's attempt will be 10 billion times more intense. "We've got our nets cast very wide and the nets are very fine," says Oliver.

There are 200 billion to 400 billion stars in the Milky Way, which is just one of 100 billion galaxies in the universe. Sagan believes the universe may contain a billion civilizations.

NASA will use two methods: a high-intensity search of 800 stars — within 480 trillion miles of Earth — that resemble the sun and conceivably could support life; and a lower-intensity survey of the full sky.

Should a genuine signal come through, "I don't think there will be culture shock," says Oliver. "A lot of people are already prepared for it. They've watched so much fiction they'll probably be disappointed in what we find."

Meanwhile, Earth sends out unending signals

NASA will listen for signals from space – but every day Earth sends messages in radio and TV broadcasts.

"Folks out there are learning about Earth even as we speak," says Jim Sharp, Smithsonian National Air and Space Museum planetarium director.

A new planetarium show opening March 10 — "Calling All Stars" — takes viewers to distant stars where signals from Earth just now are arriving.

"Aliens could pick up our television," says Eugene Mallove, author of **The Quickening Universe**.

"They probably could tell it's coming from the direction of our sun."

N and the rise of cognitive intelligence on Earth

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from **The Quarterly Journal of the Royal Astronomical Society** (1988), 29, 503-509

Summary

Many papers dealing with extraterrestrial life assume that N is fairly large. If this is so, then the evolution of cognitive intelligence on Earth must have been a high-probability process. In this article, we argue from an evolutionary point of view that this assumption is unlikely to be true. The enthusiasm surrounding current discussions of interstellar communication by radio or physical means should be tempered with a sober reading of what actually appears to have happened on Earth.

1 Introduction

There is much interest today in the possible existence of extraterrestrial societies in our Galaxy. The well-known 'Drake equation' is often used to set limits on N, the number of galactic technological societies whose radio signals we could now detect, if we knew how and where to search. That search is beginning, with multi-channel

receivers at the state of the Art. In spite of enormous uncertainties about the value of N, most astronomers would probably favor a modest but persistent search; no other kind is likely to yield believable results, positive of negative. If the search were to succeed, then in the opinion of most (but not all) people, the implications would be far-reaching (Regis 1985). If the search 'fails' by finding no such civilizations, then it is important to understand why it failed, and what those implications might be.

2 Some Arguments About N

The range of estimates of N is greater than any other number that describes the Galaxy. For Shapley (1958) N was about 100 million, while Sagan (Sagan & Shklovskii 1966) weighs in at about 1 per cent of that value. From these 'optimistic' levels, estimates range to well below unity. Certainly, life is more exciting for the optimists: they can speculate freely about galactic cultures, Type II civilizations that rework their planetary systems, galactic 'zoos', the impact on us of exotic science and art, interstellar colonization, and even face-to-'?' encounters. 'Excitement', however, has never been a practical test for the validity of ideas, even though the Universe appears to be an exciting place, at least to astronomers and physicists. Nor, it must be added, is 'dullness' a better criterion.

Many discussions of intelligent life deal with the 'physical or engineering' aspects (e. g. Zuckerman 1985). Some writers have assumed that the case for a moderately large N is already made (Deardorff 1986). Others (e.g., Tipler 1982) have used the famous indirect argument which says that if N is large, 'where are they'? Such an approach, while perfectly valid, does not address what is truly the central issue: that of the actual evolution of cognitive intelligence, as judged by the one known example. Astronomers, having opened this biological door by exploring the issue of extraterrestrial life, should now confront those biological matters.

If one is an optimist about N, then intelligent galactic societies are common; further, the Galaxy crawls with primitive life. If one is a pessimist, then the evolution of cognitive intelligence is rare in a galaxy. To have produced one successful case probably implies that there were a huge number of 'failures', where evolution went astray of high intelligence. Therefore, the galaxy is (more or less) crawling with primitive life. (There is a third possibility: that while the origin of life is rare, when it does appear, some beneficent property of evolution assures the eventual

appearance of cognitive intelligence.) That critical evolutionary step that produced cognitive intelligence is truly at the heart of the issue. Before considering additional implications of a galaxy full of technological civilizations, we might first consider more carefully the evolution of cognitive intelligence on Earth. We attempt such a brief consideration here.

Suppose that eventually we do discover how such intelligence arose on Earth, and further that it was a high-probability process. Then it is likely to work elsewhere, in the course of the evolution of complex organisms. The case for a large N would be greatly strengthened, and radio search could proceed with optimism, and perhaps even funding. How have the optimists dealt with this question? One route has been a general appeal to the 'principle of mediocrity' (Sagan & Shklovskii 1966), which is a special case of the 'Copernican principle': that we are not privileged, and that what happened here could happen elsewhere. However, the Sun itself violates this principle with respect to luminosity, its most important property; instead of being near the mean luminosity of a nearby unbiased stellar sample, it is in the upper 5-10 per cent. This violation exists possibly because life cannot evolve far **except** around solar-type stars. But one is then in the uncomfortable position of using a principle that life itself tries to invalidate! Both Sagan, and Morrison (1981) have appealed to **evolutionary convergence** to argue that multiple paths lead to high intelligence, and that extraterrestrials could avail themselves of these many paths. Evolutionary convergence has been a dramatic process on Earth. It has produced flying reptiles (Pterodactyls), birds, and flying mammals (bats); it has seen multiple emergence of light sensors in many species; in the oceans it has led to strikingly similar streamlined forms of fish, reptile (Ichtyosaur) and mammal (e.g. dolphin). However, convergences are on rather basic levels: means of sight, hearing, locomotion, etc. Cognitive intelligence arose only within our line, so there is no evidence whatever for its convergent evolution.

This inquiry also bears on the survival value of intelligence. Intelligence clearly has such value. Will not natural selection therefore tend to produce more and more intelligent creatures, and will not this happen on any planet where life appears? Simply to deal with 'intelligence' over simplifies reality; moderate levels of intelligence are really not the issue. A high level of intelligence is the key. Such a high level carries with it enormous burdens. As Lovejoy (1981) has pointed out, certain mammals with large brain-to-body ratios have in fact survived poorly; these include Proboscids (Mammoth, elephant, etc.) and primates — with the single

exception of our own hominid line. Looking beyond broad generalities, it is in truth difficult to find much hard support for a high probability for the evolution of cognition.

3 Human Evolution

To see more clearly how cognition may have arisen, we must necessarily consider the one case about which we know something: ourselves. We cannot infer how the process would occur elsewhere. We can only assume, however, that if it did occur here with high (or low) probability, then it is also likely to do so on an alien planet. Thus, the rest of this discussion deals only with our terrestrial example.

About how cognitive intelligence arose on Earth, Gould (1977) has written: 'we simply do not know the answer to one of the most important questions we can ask'. We can glimpse in the fossil record evidence for bipedalism; for growth of the brain; for increasing and more skillful manufacture of stone tools; for maturation patterns in the growth of teeth; and for the use of fire. We cannot know much, except by very indirect deduction, of how hominids used other materials like wood, bone, and fibre; of social and sexual practices; of gathering, hunting, and sharing strategies; and of our ancestor's subtle and changing mental views of the outside world and of themselves. We can read opinions of various writers about presumed innovations that led toward a high order of intelligence. Stereoscopic vision, grasping prehensile hands, and upright posture may have begun the transformation. But these traits are shared with other animals. Some dinosaurs, and kangaroos, were/ are bipedal. Stereo vision is enjoyed by creatures like the domestic cat. Birds are bipedal and have prehensile grasp. These characteristics may be necessary, but by themselves are totally inadequate to insure cognitive intelligence. Few people believe any longer that hominids became bipedal in order to look over tall grass in search of animal prey (early hominids were vegetarians). Nor can we argue any longer that bipedalism led directly to the use of stone tools (they appear much later in the record). In the Freudian views of Lovejoy (Johanson & Edey 1981), bipedalism assured more consistent sexual attraction and mating, and thereby had high survival value. He writes that it was 'sheer luck' that standing upright and using hands later led to the manufacture of tools and the creation of a culture. Social interaction and cooperation in food gathering and infant care must also have been crucial tot he survival of those fragile creatures.

If stereo vision, prehensile grasp, and bipedalism were not unique to our hominid forebears, what was it that separated them from their primate relatives? Tool use was once considered the key, but we now know that some animals (chimps, some birds) actually use simple tools. Tool manufacture was next thought to be the key. But, again, some animals (e.g. chimps) are seen to make or improve simple tools, such as twigs, for probing termite mounds. One is left with the weak assertion that proto-humans were the only creatures who used tools to make tools; this line of argument seems bankrupt (Leakey & Lewin 1978).

Somehow, of course, social cooperation among hominids must have become important. Leakey and Lewin suggest that the existence of gatherer-hunter-sharer societies spurred the development of intelligence and of speech, the ultimate means of communication. That is, cooperation begat intelligence, which begat speech. We suggest that this sequence does not ring quite true. There is nothing new in the arguments we raise; only the emphasis and sequence of events has been changed the better to understand the outcome.

We start by returning to an old and nearly forgotten objection raised by Alfred Russell Wallace, the co-discoverer of natural selection, over 100 years ago. Wallace was willing to believe that only natural processes were involved in all of evolution, except for the rise of cognitive intelligence. About the human brain, he asked (Eiiseley 1957)[sic; "Eiiseley" should be spelled "Eiseley"]:

> ...how was an organ developed so far beyond the needs of its possessor? Natural selection could only have endowed the savage with a brain a little superior to that of the ape, whereas he actually possesses one but little inferior to that of the average member of our learned societies.

Like many embarrassing questions, this one seems to have been swept under the scientific rug; at least, it is seldom addressed in the popular literature (but see Gould 1982). The reason may be in part because Wallace invoked divine intervention to resolve the difficulty. However, it remains a problem, and one at the focus of our fundamental question. Leakey and Lewin have tried to explain that this 'unneeded' brain power actually was needed... for the kind of new, complex social interaction that must have appeared at some point. This assertion at first seems reasonable, until one realizes that, to be true, evolution would have foresight. It would have to be able to predict the future. Evolution lacks such foresight. It functions in the present;

it cannot anticipate the future by 'seeing a need for' something, and then by selecting in the present for that property. More soberly, we can perhaps conclude that the innovation that led to cognitive intelligence was unique and unprecedented in evolutionary history. The similarities between chimpanzee and human DNA only deepen the mystery of why such a gulf in intelligence has opened between our kind and our closest primate relatives.

4 A Computer Analogy

Historically, the human brain has been compared to many devices, from steam engines to modem computers. All such comparisons are inadequate, but surely a computer is a more apt analogy than a steam engine. It is illuminating to explore this analogy, following a line initiated by Lovejoy (1981). A computer may contain an enormous memory, but will be useless unless a means exist to access it, and to compile programs. An input is required. An output is also needed, to display results. Expanding on the Lovejoy argument, it is usually necessary, having examined the output of a particular run, to modify some of the input parameters for a subsequent, more satisfactory, run. This process would be needed if calculations were based on a theoretical model whose predictions were to be matched to observations. So, a very powerful feedback mechanism exists between output and future input. To put it differently, how useful would our computations be if we were allowed only one pass through the computer? We would know little about stellar evolution, for example, if we were so restricted.

Such use of a computer is a suggestive analogy to the operation of the animal brain. The animal brain/computer requires input via sensory organs. We could imagine an animal that is completely self-reliant and independent of others of his species (except of course for reproduction). Such an animal could survive with only its input channels; output, for interacting with others would be unnecessary. Nature has surely evolved an amazing range of input mechanisms/organs to supply the senses of touch, vision — particularly in color and stereo — hearing, taste, and smell. In many instances, these input senses far outstrip those of Homo sapiens, e.g. vision in raptors, the extraordinary sense of smell in dogs and insects, and infrared detectors in some nocturnal animals. In exotic cases electric or magnetic fields, or polarized light, can sense prey or guide annual migrations. We must conclude that the input channels of animals, compared to our own, are very sensitive indeed.

The same is overwhelmingly not so of output channels. Cooperative and social activity require output, communicating channels. Such communication is very widespread, if primitive, among animals other than man. Some kind of primitive communication must have guided single-celled organisms in the building of stromatolite colonies nearly 3000 million years ago. A form of recognition seems to exist among, for example, tadpoles. Instinctive communications occurs among social insects like ants and bees. Territorial marking by carnivores like wolves and cats is well-known, and frogs and crickets communicate via 'songs'. In a careful study of the common redpoll (Boswall 1987), 25 songs or calls with distinct meanings were recognized. By contrast, the Daurian redstart, a similar bird, survives on a repertoire of only nine, the difference probably being made up by 'signalling' with the latter's brilliant plumage. In cases like the Daurian redstart and other brightly colored birds, this type of visual communication must have a greater survival value than that provided by drab protective coloration. Among higher animals, signalling can take the form of chirps, grunts, body language, ritual dances, or 'grinning'. There has recently been speculation (Maranto 1986) that an increase in the efficiency of communication may even be an evolutionary divergence among ceropithecines (guenon monkeys).

What conclusion can be drawn from these facts? It seems inevitable that communication via output channels has great potential for survival value. In spite of this potential, the availability output channels are much cruder than the sophisticated sensory inputs found so widely in the animal kingdom. Perhaps we can use these simple clues to clarify the mystery of the rise of human and alien intelligence.

5 A Key to Cognitive Intelligence?

Years ago, the famous linguist Noam Chomsky (Leakey & Lewin 1978) suggested that only the human brain has the mental capacity for the 'deep grammatical structure' common to all languages. That is, this special mental ability is the uniquely human gift that makes complex speech possible. Chomsky, it now appears, was wrong. The rudiments of speech seem to have been mastered by some chimps and gorillas in various primate research laboratories — not by teaching them to utter words, but through the use of such output devices as sign language and computer keyboards. These results were first greeted with shock or disbelief, and are still to some extent debatable. But it does seem that yet another barrier, hypothesized to

separate man from other animals, has been breached. The search for the key to cognitive intelligence is again frustrated. It may seem that the great mystery has no solution, or that it will be found only after the fossil record becomes much. more, complete. But, even if such a record were now available, it might not unlock the secret. Many years ago, Eiseley (1957) warned:

> We have been so busy tracing the tangible aspects of evolution in the **forms of animals** that our heads, those little globes which hold the midnight sky and the shining, invisible universes of thought, have been taken about as much for granted as the growth of a yellow pumpkin in the fall.

Perhaps, then, we need not await future fossil finds. We return to a consideration of the communicative abilities of primates. Experiments trying to raise chimps from birth and to teach them to talk are well known; the only 'words' that ever emerge are 'mama', 'up', 'cup', and the like. The 'failure' to speak appears simply to be the lack of the physical means of articulate speech. Primate speech experiments suggest that, when some other output mechanism is provided, then a form of 'speech' follows quickly. Sagan (1977) pointed out that a human vocabulary of about 1000 words suffices for most everyday living, and that various chimps have achieved vocabularies between 100 and 200 words.

Is the elusive 'key' now in hand? Is it contained in the unique hominid ability to articulate complex sounds, that later became words? Other writers have reached this conclusion (e.g. von Hoerner 1986). That ability would have powerfully closed the feedback loop between brain output and input. It would have provided nearly instantaneous interaction time in social relations, constituting an enormous leap in ability and ease of communication. It would have become so important that other physical characteristics became of secondary import, perhaps helping to explain why humans are born in such a helpless, unprotected state. It could have explained, too, why some human senses are less keen than those of many animals. The stimulus to brain growth afforded by this unprecedented means of expression and information exchange might have become, relatively quickly, the primary impetus for rapid evolutionary change in hominids. The revolutionary nature of verbal communication may even answer that objection raised by Wallace so long ago.

The post-natal brain growth required by this innovation resulted in a slowing of

maturation and a delayed puberty — in creatures whose lifetimes could hardly have exceeded 25 years on the average. The accompanying loss of instinct had to be compensated by intensive learning through a protracted childhood. That childhood lasted for about the same fraction of a lifetime that today earns a person a PhD. If this argument is correct, then the Leakey-Lewin sequence of cooperation to intelligence to speech has it the wrong way around. Suppose that we accept this hypothesis about articulate speech — or, if not, at least we allow that speech did play some vital role in the emergence of cognition. How did the physical means of articulate speech evolve? According to Lovejoy (1981), the various anatomical structures that permit speech (details of nasal passages, larynx, tongue, lips, oral cavity, diaphragm, etc.) were restructurings that followed from bipedal posture and locomotion, and from a seasonal variation of food sources. They were initially completely unrelated to the capacity for speech. We are left with the conclusion that articulate speech is a consequence of a series of fortunate environmental changes and evolutionary responses; it was not prefigured into hominid evolution. It was, in other words, a matter of 'shear luck'.

One has to admit that solid evidence for a convergence of evolution to cognitive intelligence is simply lacking, at least in this reading of the record. Such a conclusion may not please those to whom high intelligence is the very touchstone of existence. Today, we still seek some lurking purpose in the rise of human consciousness. Sagan, at the end of his splendid book, **The Dragons of Eden** (1977), expressed this feeling by quoting Jacob Bronowski:

> We are a scientific civilization... that means a civilization in which knowledge and its integrity are crucial. Science is only a Latin word for knowledge... Knowledge is our destiny.

Such sentiments about the destiny of man sound oddly archaic. It is worthwhile recalling that, more than 150 years ago, scientists read evidence for design into the fossil record — evidence of a purpose and direction leading to man, the ultimate goal of the entire process. We no longer credit this interpretation; the animal kingdom is no longer thought to revolve around man. One needs to balance pronouncements about human destiny against the nearly incredible series of chance events that led to the emergence of man on Earth. In this same balance, the expectations of extraterrestrial intelligence must similarly be weighed.

I thank Ms. Karen Knox and Dr. Ben Zuckerman for their comments on an early draft of this paper.

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Radobs Notes

4 Feb 89
PHILLIPS-E
RFI

Dr. Barnhart, I am sending you the information that I have discovered so far in my search for possible RFI sources. Most of my discoveries have been ruling things out, i.e. police radar, which operates at a frequency of 10 MHz and 24 MHz. Also ruled out is CB radio transmissions, which operate in a freq. band of between 26.975 and 27.405 MHz. Air traffic Towers operate at a freq. of between 108 and 136 MHz, and therefore do not seem to be sources either. Possibilities include a very interesting signal I found on the freq. allocation chart, a copy of which I passed to you at this morning's meeting. This has the label "Aeronautical Mobile Satellite, Maritime Mobile Satellite, and Meteorological Satellites, " which operate at an assigned freq. range of between 1535 and 1710 MHz. As you can see, this is right smack in the SETI search area. Also included as possible RFI signals, are "Fixed and Mobile Telemetering, Land Mobile Telemetering &Tele-command", operating at an assigned freq. range of between 1350 and 1535 MHz, also smack in the SETI search area. Another is " Aeronautical Navigation", operating at 1300 to 1350 MHz, real close. All of these were identified using the freq. allocation chart which I gave you. If you have, or know of anyone who has info regarding these sources, I would like to take a look at it. At the meeting on 21 Jan., I was handed a diskette by someone who stated that it contained info regarding satellites. Thinking that it may pertain to the above mentioned possible RFI sources, I graciously accepted it and ran the info on a borrowed PC. I found that it contained tracking data, useful only if you wished to bounce signal off of it, or perhaps take a look at it through your scope on a clear night, knowing it's projected trajectory based on the tracking data provide on the floppy. If you happen to remember the original owner of the floppy, I would be happy to return it, as I have all the info I need on hard-copy. Other possible

sources are: A UHF television station, which operates at a freq. of 800 MHz, and whose harmonic may be a possible source, especially considering that my source says that this signal is "pretty strong". Another possible source is vehicle phones, who also operate at a freq. of 800 MHz, and who's harmonic may produce some of the RFI signal we pick up, especially considering the relative proximity of hwy. 23, and the fact that these devises are becoming more and more popular. All of these sources, however, fail to explain the spikes shown on the RFI charts. I am most interested in solving these spikes, so any info you may be able to disseminate regarding this, I would be most interested in.

5 Feb 89
CAMPANELLA-A
Sticky Brakes

An apt explanation of the stickyness of the flat-moving brakes is to be found on page 135 of John Kraus's BIG EAR: "To lock the flat reflector bays when they were not being moved with the hoisting winches, Bob Nash had designed massive brake arms which clamped against the sides of the ferris wheel assemblies. Aluminum does not slide easily when pressed hard against aluminum. Rather, it tends to grab and lock... Bob Nash took advantage of this property by equipping the brake arms with aluminum shoes and making them clamp against aluminum plates fastened to the ferris wheels."

In looking over this document, I conclude that Chapters 18 ("Big Ear") and 19 ("Busted Bolts") in their entirety (pp 131 - 151) should be read by every SETI volunteer in order that their orientation proceed as rapidly as possible. They really ought to read chapters 13 through 24, but that can come later.

7 Feb 89
DIXON-R
RFI Project Priorities

Now that Earl is getting into the RFI project, it is important to restate the priorities of this project. They are:

1. Restore the system to normal operation, as it was before. There is no reason we cannot be acquiring more data now. It is very important to record the long-term time

behavior of the spectrum.

2. Resurrect a data processing system to handle the acquired data. This was formerly done by Steve E. on the Vax at the Electroscience lab, which will not be available to us after he leaves. It is not useful to acquire data if you are not analyzing it continuously.

3. Modify the antenna to allow it to determine the azimuth of the signal sources under computer control.

4. Modify the antenna to allow elevation detennination under computer control.

After all that is done, then I think we will have the needed data to try and find out what the signal sources are, but that is not really a priority item at this stage.

8 Feb 89
CAMPANELLA-A
EAR RFI/Earl Phillips query.

Earl Phillips asked about RFI details & leads. My telecom with him included the following:

RFI Frequency candidates is a wildcard game. Some thoughts are:

a- A nice steady one is Mansfield's new TV Channel 68 runs @ 794-800MHz; I get it pretty good here in northwest Columbus. Expect the picture carrier (buzz-saw sound) @ 1.25 MHz above the bottom end, or 795.25 (giving a 1590.5 MHz 2nd harmonic RFI candidate. The sound carrier is .25 MHz below the top end, or 799.750 audio FM carrier (steady FM talking, etc), or 1599.500 MHz 2nd harmonic candidate. The carrier frequencies are probably not precisely this, but may be off +-.050 MHz or so.

b- One of the many candidates that may follow the daily variation noted in the NASTAR paper (that I call auto-traffic related) would be second harmonic residual radiation of cellular car phones; either directly from autos on RT23 or from one or more cellular network transmitters, which I understand claim continuous coverage from Cleveland through to Dayton and Cincinnati. You'll have to talk to the Cellular techies to find precise frequencies.

c-John Kraus refers on more than one occasion to the fact that nearby gasoline piston engine powered equipment cause spark RFI (remember that sparks emit radio energy from DC to light!). His comments always included negotiating with said equipment operators (farmers with tractors) to follow some non-interfering routine. (Happy was the day that they changed to diesel power.)

The "directional" RFI antenna — one step up from the Discone — can be a Yagi like on the Canadian's signal spritzer, or a Corner Reflector cut for 1500 MHz, or one of them good old Kraus Helix's, dealer's choice (advantage is that it's circularly polarized). There might even be an old helix like that laying around the focus shack somewhere. NOTE: Kraus helix's are 150 ohms impedance. I once designed a two-step 1/4,1/4 wave coaxial transformer that pretty well matched it to a 50-ohm coax line over a 2:1 frequency range (1-2 GHz). Needs some machine shop work to do it right. But even when only hard-wired to RG-8U center conductor and using a small ground plane, they still make a nice receiver antenna.

The "Big Ear" book by Kraus is published by Cygnus-Quasar Books of Powell, OH, printed by Beaver Press, USA (1) and bears a Library of Congress Catalog Card number of 76-24396. Chapters 18 & 19 are primers for moving the flat and Chapters 15 to 24 constitute a SETI primer.

8 Feb 89
HUCK-R
power supply

I have completed the construction of a 3 stage regulated power supply identical to the one I built for the spare LNA. It is being used with a 2 stage amp that was the predecessor to the new 3 stage LNAs currently being used. The intended use of the 2 stage amp is on the spectrum analyzer which has a low sensitivity and is worthless without some boost to the input signal. The 2 stage amp could also be used in the RFI Survey system if necessary. The new power supply could be used as a spare for the 3 stage LNA although it would have to be adjusted. For future reference, the 2 stage amp takes a drain voltage of 1.5 volts and a drain current of 5 - 8 mA, it has about 19 db of gain. The regulated power supply fits nicely in the weatherproof boxes. We could have bought the supply already built and tested on a PC board for over $500.00. Mine is the same exact circuit and cost about $45 in parts.

13 Feb 89
HUCK-R
East upper brake on bay 5

I have investigated the East upper brake on bay 5. As Jim said in the flat moving video, it has been hot wired to be activated when the cord is plugged in. It appears though that the solenoid coil or some other contact inside of the air valve has opened up. The air valve is still operable in the manual mode, for this reason I did not remove the valve. If we are not going to be moving the flat for a while the valve should be removed and fixed. This is not so simple of a job because the bolts and hose fittings are somewhat rusted. The last time a valve was removed a hose fitting broke. I have put some Liquid Wrench (penetrant) on all the fittings and bolts which would help a little should we decide to remove the valve.

15 Feb 89
DIXON-R
News Flashes

1. I now know that the RFI data passed from Steve Ellingson to Ron Koch is in Dreese. I plan to look thru it and then pass it on to Earl Phillips.

2. We have been offered a Tektronix storage tube scope, which could be very useful. It is from Riverside hospital, where we got a PDP11 before. I will pass on the info to Steve J to make the transfer arrangements.

3. The possibility of getting a VAX 11/780 thru Tom Hain has again arisen. This is a large, fast VAX, but fairly old.

4. We have been offered another PDP11/70. We may take a few parts.

5. Another order for overlay maps is in the mail. That will add a little to our coffers.

6. I have the 2400 baud modem today and will take it to Dreese at noon, for Rodney to take whenever he wishes. Steve J please record this transfer. It includes the power supply and phone cord, but no manuals. Ron Huck has all the manuals and you can get them from him.

17 Feb
DIXON-R
New Staff Member

Russ Childers has been hired as a student electronics technician. He has a B.S. in Electrical Engineering from OSU, has been working in industry for several years, and will be entering grad school in the summer. His specialty is control systems, so he will be concentrating on automation of the telescope. He will want to talk with everyone else who has been working on various aspects of this. He needs a copy of the famous RO videotape, so I would appreciate it if someone could get him one. His first priority will be getting the cart motion under better control. He will soon be here on MM and will be at the meeting Saturday. His work with the telescope does not replace anyone else's efforts, but adds to them. So nobody should think that their efforts are no longer needed.

20 Feb 89
DIXON-R
What the chart recorder does

This is a description of what the present chart recorder at the observatory does, for the benefit of those working on alternative arrangements. This is not a statement of what should be done.

The recorder has 6 pens. 4 of them are used for data, and each pen can cover the entire page (the pens are slightly offset, so they can cross one another without hitting). We put different colored ink in each pen to distinguish the different plots. The other 2 pens are called "marker" pens. There is one at each edge of the paper, and they can only have 2 values, on and off. They are used to record status signals, time marks, etc. All pens are controllable from the 11/23, or can be connected to external voltages. All pens have electrical lifters controllable from the 11/23, so they can be lifted off the paper when not wanted.

The speed of the chart drive is electrically controllable from the 11/23, in about 12 discrete steps. The speed is very accurate and consistent. The drive motor runs at sidereal rate, as it is powered by a special 60hz/sidereal second power source.

The chart paper is specially designed for the purpose. In the time direction, it has 6

small divisions to a major one, to show time-like divisions. It is cross-perfed to enable easy fan folding to standard page size later.

At the moment, one pen records the continuum analog, another the continuum digital, and a third the 10 minute sidereal time marks. These marks are generated by a separate digital clock that runs on sidereal rate and puts out both the 60 Hz and the 10 minute pulses on every even 10 minute mark. There is at present no computer-readable clock putting out sidereal time, although this could be done. The subject of time and clocks is beyond the scope of this note.

The SETI software is programmed to speed up the recorder and activate more pens when a signal is detected, but that aspect is manually disabled at present until the program works better in other aspects.

All of the ways in which recorders are used are subject to change, depending on observational experience.

The chart paper is viewed in the orientation that up is stronger signal and left is later time, contrary to most other plots. That is because the sky is arranged that way. When we make contour maps of the sky, they must look like the sky and not be backwards. We make the charts and maps to the same scale and orientation, so that it is possible to hold a chart against a map and see one line cut thru the map.

22 Feb 89
DIXON-R
Satellite RFI

The Geostar navigational satellite system is expanding. Private users on the ground transmit in the 1610-1626.5 MHz band, and the satellites reply in the 2500 MHz band. The number of private users is now being increased from 10,000 to 50,000 and their power is being increased. This is not going to help us any!

22 Feb 89
DIXON-R
Natural Line Frequencies.

For general interest, here are the natural line frequencies in our band of interest:

Hydrogen (H) 1420.406
Hydroxal Radical (OH) 1612.231, 1665.402, 1667.359, and 1720.530

22 Feb 89
DIXON-R
Pollution Problems

The January Issue of the International Astronomical Union Information Bulletin has some sobering reports about pollution of various kinds that affect Astronomy and the Space Program.

1. The amount of light energy that is now wasted by shining upwards into the sky costs about 1 billion dollars a year for electricity, in the US alone. This is far greater than the total expenditures for Astronomy.

2. The RFI from satellites is getting so serious that it is estimated that Radio Astronomy only has another 10 years before it will be impossible to do high-sensitivity work from the surface of the Earth.

3. There are about 1000 people now employed full time in the US to track space debris (satellites, boosters, junk, etc). That is approximately equal to the number of optical astronomers in the US.

4. The number of man-made objects orbiting the Earth is doubling every 10 years. At the present time, most of the objects are relatively large. But as their number increases, they are beginning to collide with one another, making lots of small objects. This increases the rate of collisions and an exponential runaway has started. When the number of objects reaches somewhere between 10 and 100 times its current level, the runaway is irreversible and cannot be stopped even by never launching another rocket again. This means that ALL space operations out to at least synchronous orbit distance will become impossibly dangerous due to high probability of collision with debris. No more communications satellites. No more space flight. It is speculated that the Space Age may only last a few more generations before Earth is surrounded by a man-made asteroid shell. It is also speculated that the debris will reflect the sunlight such that night will never be dark again, only dimmer than day.

It seems we (man) had better start developing space "vacuum cleaners" now to keep the situation under control. Might this not be a new reason for why space travel is not popular in the Galaxy?

23 Feb
DIXON-R
Quiet Places

The SETI people are actively working to preserve the back side of the moon as a radio-quiet zone. It is the last chance we have. But the battle is not going well. There are commercial interests who already want to start orbiting satellites around the moon, and do mining on the back side. Any Lunar satellite will destroy the radio-quiet environment. But suppose we do have bases on the back side; how can they communicate with Earth if not by satellite? One plan is to lay fiber-optic cables around to the front side, and use them to carry the communications. This seems doable.

24 Feb 89
HORNE-T
radio interference

Bob, you have been writing about the contamination of our radio skies and how radio astronomy from earth has only 10 years at best. I know we have briefly discussed this on several occasions, but isn't Argus technology a reasonable solution to this situation. It would seem to me that when using Argus to resolve a specific object, every other sky source is RFI as far as the system is concerned. If it would be able to resolve a source sufficiently to form an image of it without being confused by other sky sources then surely it doesn't care what else is in the sky or whether it is artificial or natural. I imagine I am over simplifying, but could you explain what I'm leaving out of this scenario. Is Argus capable of being overwhelmed to the point that it cannot resolve faint sources when its elements are receiving high levels of energy from very intense sources?

24 Feb
DIXON-R
Argus vs RFI

This is a complex issue.

On one hand, Argus is potentially poorer than a conventional dish. That is in the area of receiver overload. A receiver in a typical dish is protected somewhat in all directions except where it is pointed. RFI comes in thru the side lobes. An Argus receiver is subjected to the sum of all signals in the sky all the time. Thus the Argus receivers must be capable of handling very strong signals without overload. There is a compromise between overload resistance and weak signal sensitivity. On the other hand, assuming the above problem is overcome, Argus has a great advantage. Signals in the side lobes of a dish are generally not well known or controllable and fluctuate with time as the dish moves. But Argus can know exactly where all such signals come from and can ignore them, even adaptively. Argus could put nulls in the directions of troublesome RFI sources. Of course Argus also has side lobes, but they are completely knowable and controllable and can be varied instantaneously as desired to deal with RFI sources. This will require considerable intelligence in the control computer, but is doable in principle.

24 Feb
DIXON-R
Argus Side lobe Switching

I believe it may be possible to generate two kinds of beams with Argus. They would have the same main beam, but orthogonal side lobes. This means the nulls of one set of side lobes would coincide with the peaks of the other. Then one could multiply the two outputs together, obtaining a large reduction in the net side lobes. This may have been thought of elsewhere before, but would be worth looking into for Argus. All we need is an antenna engineer to design all this.

2 Mar
CAMPANELLA-A
Aircraft Transponder Freqs

Finally found a printed reference to the omnipresent aircraft transponder frequencies which are to wit: air traffic control radars (ground-based like Port Columbus & other "Remote" sites all over the US) ..... 1030 MHz.

All participating aircraft (mostly all in air these days around here) ..... 1090 MHz.

OK, folks; who'll be the first to figure out where this belongs on Big Ear's RFI chart? I'll bring a FREE 5-1/2" 360 KB floppy (UGH!) to the Saturday meeting for that lucky soul!

2 Mar 89
PHILLIPS-E
reply re: sat. sigs

One of the freqs you eluded to in your message, 1090 MHz, is a frequently occurring signal picked up as RFI, according to the charts. The one at 1030 does not seem to be on the charts. I have enlarged the charts from the survey, copied them on to transparencies, then tried to pick out all the recurring signals. I then read as best I could, (the survey charts don't enlarge well), the freqs on the chart and wrote them all down. As I said, the 1090 MHz is a recurring signal. As far as I can see, the lowest signal picked up as RFI is around 1080 MHz, so I cannot find the 1030 freq. By the way, where did you get this info, and would you be willing to share a copy of it?

3 Mar 89
ELLINGSON-S
AC's recent findings

Good going! This is the kind of info we need. As I recall, we had a lot of hits near 1100 MHz, tantalizingly close to the 1090 MHz transponder frequency. I also seem to remember finding that this band was a big-time contributor to the rush-hour phenomenon.

We may not have good data for 1030 MHz, however. This is because the ICOM's 1 + GHz band only tunes down to 1025 MHz, which I believe corresponds to one of its LO frequencies. I can't recall whether we had problems down there or not. If we did, then I would have instructed the system not to remember hits near that band.

In any event, the data printouts in Ron K's possession are the best way to check this out. We can go over it Tuesday, if you all care to.

6 Mar 89
CAMPANELLA-A

RFI through Images: Chart.

RADOBS: Having surveyed the "red book" on the Big Ear operating circuit frequencies, I point out the following:

1/ The "RF front-end" is a 30 MHz band width(*) preselector-filter, whose band pass centre is tunable from 1,000 MHz to 2,000 MHz.

2/ The mixer band pass(*) is 1,300 MHz to 1,800 MHz.

3/ The IF is centered at 150 MHz and is 5 MHz wide(*).

4/ The local oscillator frequency is quadrupled from a nominal 300 MHz variable frequency oscillator. The first doubler is followed by a 700 MHz band pass filter 300 MHz wide(*). The second doubler is followed by a 1,350 band pass filter 500 MHz wide(*).

5/ Second IF is 30 MHz(*), which feeds the 100 kHz and 10 kHz detectors(*).

6/ Second local oscillator is 120 MHz crystal-controlled.

* (I don't know its attenuation beyond the quoted limits, but let's continue).

On the basis of the above information, I surmise the following "Image" RFI vulnerability frequencies.

RFI LIKELIHOOD CHART

BAND OF CANDIDATE FREQS. (Range where RFI emitters presently exist)	**PASSAGE MODE**	**APPEAR AS FALSE BIG EAR SIGNALS AT:**
1,000-1500 MHz Example: Acft Transponders @ 1,090	Primary Lower Image (Fo-300) "	1,300-1,800 MHz >>>" 1,390 MHz "<<<

1,600-2,100 MHz	Primary Upper Image (Fo+300)	1,300-1,800 MHz
940-1440 Example: Acft Transponder @ 1,090 Also "DME"**	Secondary LowerLower Image (Fo-300-60) "	1,300-1,800 MHz >>>" 1,430 MHz "<<<
1060-1,560 Example: Acft Transponder @1,090	Secondary UpperLower Image (Fo-300+60) "	1,300-1,800 MHz >>>" 1,310 MHz "<<<

** DME RFI is similar to Transponders in that it emits from the bottom of an aircraft at frequencies in the 900-1000 MHz range. I don't know the exact frequency. The most likely frequency for aircraft flying locally is associated with the local VOR called "Appleton" (near Johnstown, OH). [It gets a little confusing, but here goes: "Appleton" is a VHF Omni-Range Beacon transmitting at 116.7 MHz. However, a UHF distance-measuring transceiver is also located on that site. It emits response pulses in the 900 MHz region to aircraft which interrogate it for the purpose of determining their own distance from it. The aircraft's interrogation pulse RF frequency is also in the 900 MHz region, spaced a few MHz away.

Other VOR's that would be used by aircraft overflying Big Ear are located at Rosewood (117.5 MHz, near Sidney, OH), Findlay (108.2), Mansfield (108.8) and Riverton (116.5 MHz, east of Mt. Vernon).

The general time pattern of DME radiation from an aircraft is that it pulses only a few times a second or minute, getting updates of distance from the associated VOR to calculate ground speed. When first tuned into the VOR DME it pulses rapidly for acquisition purposes.

Not all aircraft carry DME, though it's getting more common, and it's always carried on larger aircraft.

12 Mar 89
DIXON-R

Horn Cart Proposal

Bob S and Russ C came up with this plan for driving the horn cart.

1. Abandon the current system completely and start over.

2. Use a DC motor and gear train mounted on the cart, as the power to move the cart. (We have previously resisted such plans, due to the possibility of a motor on the cart causing RFI, and there may be a problem getting lots of power thru the scissors).

3. Use the new chain, and apply force to it at two separate points, one at each end of the cart. A claimed advantage of this is that the cart will move only along the desired path, and not try to drive off to the side. Use a chain on the cart to drive the two drive gears from the motor, and allow it to droop so that there is mechanical flex between the 2 drive points.

4. The motor Bob says he has would be capable of doing this, and could also speed up to enable a retrace in about 5 minutes.

5. Take all unneeded debris out of the horn shed to lighten the load.

6. Fix the dewar support immediately as he says you should never support anything like that on the wave guide as we now are.

7. Attach a turns counter to the drive gear axle and use that to sense the position of the cart. Since the chain cannot slip, this is basically acceptable so long as the turns are counted mechanically. Bob says he has an optical turns counter he may be able to send us for this. Of course we can still use the existing big pot at the same time.

We will have to look into all this.

13 Mar 89
PHILLIPS-E
reply

After a lot of phone calls, and a bit of legwork, I think I have come up with what I feel are the principal sources of RFI. First, it should be pointed out that, with the

exception of a very few bands, there is relatively little actual RFI to worry about. The signals that are possible RFI sources, are:

Air traffic, which plays a heavy role in RFI, namely deflection signals, radar, transponders, and some military voice radio nearing the UHF area of the spectrum. All the signals related to air traffic are limited to fundamental and second, and in one case, third harmonics.

Mobile phones, and associated towers. This is perhaps one of the larger sources of RFI, I think. I obtained the traffic data from the Delaware DOT, whose patterns match ours almost exactly. There are a lot of these vehicles that have mobile phones, verified by engineers at both companies operating in Central Ohio. Their signals are received by us as either fundamental or as a harmonic thereof, from both the individual phones in the cars, and from the towers, many of which cross our line of site [sight].

UHF television. There are a few UHF signals operating at high signal strength which are being picked up by our system as a second and third harmonic.

There are also many possible sources that I have effectively ruled out as being either too low on the spectrum, or too weak in strength to have any effect on us as a harmonic. At this point, it is necessary that I restate my plea to reactivate an active RFI system, in order to verify the sources and signals as much as possible. There will be some that will remain unverifiable of course.

15 Mar 89
DIXON-R
Tasks needing Doers

Please publicize and keep this list handy for willing doers. It is not in any special order, just things I can think of now. More later.

1. Scrub outside walls of office building.

2. Paint outdoor things such as buildings as needed, crane, truck, electrical boxes, doors, telescope. Derust first. Choose bright colors.

3. Need donations of deruster, paint, brushes, etc.

4. Clean out office building, pod, trailer. The biggest problem is for someone to haul the junk away from the site. Just moving it around does not help.

5. Make pod and trailer useable for storage, if possible. Now they allow rain, snakes, etc to enter freely. Requires repairs and paint.

6. Paint Flag of Earth on the ground plane. Need the right special paint, cleaner for gp, etc. Big project, but would gather lots of publicity. People would see it from airplanes everywhere. Would look great on new photos we could take.

7. Derust and paint the horn cart.

8. Put new small wheels on the horn cart. Need wheels and know how.

9. Clean junk out of horn cart house.

10. Clean out drains in antenna wells. Need rooter-rooter-type tools ["roto-rooter"] and know how. Willingness to get wet.

11. Clear brush away from antenna. Good to do now before it gets another strangle hold on the telescope in Spring. Kill the brush permanently.

12. Organize monthly tours. Need coordinator and helpers.

I have the details for all these projects.

Schedule of Working Sessions at Telescope Site

15 April
06 May
20 May
03 June
17 June
01 July
15 July

Plus regular meetings in 805 Dreese each Tuesday at 5:00

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E-mail Webmaster

Designed by Jerry Ehman
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