Remarks as Delivered by
Vice President Al Gore

Commencement Exercises
Massachusetts Institute of Technology
Cambridge, MA
June 7, 1996

Dr. Gray, President Vest, members of the MIT Board and faculty, Mayor Sheila Russell, parents and families, alumni and alumnae, students, and especially those of you who are graduating seniors:

Thank you for inviting me this morning. It is truly an honor to be MIT's Commencement speaker. It's a pleasure to return to this city where I myself graduated 27 years ago, from a school just up the river.

That school, Harvard, and MIT have had a long and sometimes tumultuous relationship. In the early days, beginning in the 1860s, Harvard tried to absorb MIT. But this school's founder and very first President, William Barton Rogers, fought back. He was adamant that an institution devoted to fostering scientific knowledge **and** a liberal education must remain independent.

Many things have changed since those days. For example, tuition for first-year students in 1866 was $100.

President Barton, incidentally, literally gave his life for this institution. When he returned after his retirement to deliver the commencement speech in 1882, right in the middle of his speech, he died. As a result, I have the rare comfort of knowing that whatever your reaction today, I will not be remembered as the stiffest speaker in your school's history. I am fully prepared, however, to be remembered as the second stiffest.

In preparing for this speech, I engaged in a dialogue with the graduating class by way of the Internet and your university's computer network, the Athena system. More than 100 of you responded in some detail, and I thank you very much. For those of you who didn't respond, I know who you are. I read every response thoroughly -- on the World Wide Web -- and I learned a great deal. Among other things, several of you emphasized the fact that MIT not only educates scientists and engineers but also architects, linguists, designers, economists, even poets.

Nevertheless, because this is MIT, I want to share some thoughts today about the relationship between science and technology on the one hand and humankind and society on the other.

When Winston Churchill spoke here in 1949, he spoke about the relationship of science and society. Ten years later, in a celebrated lecture in England, scientist and writer C.P. Snow introduced the concept of the "two cultures." In his subsequent book, entitled *Two Cultures*, he wrote that the culture of science and the culture of society's literary arts "had almost ceased to communicate at all." He noted that the popular culture in England and America spoke the same cultural language. But both "had about as much communication with MIT as though the scientists spoke nothing but Tibetan."

Why is there such a gulf between science and society?

This schism between science and the rest of society -- which began at least as early as Galileo's trial in 1633 and continued with the trial of John Scopes in 1925 in my home state of Tennessee -- has not narrowed since the publication of Snow's famous book.

Indeed, eighteen months ago, Sheila Tobias examined this schism and concluded that it has grown worse. "Science illiteracy has entered a second, more pernicious stage, fueling widespread opposition to science," she said, noting that physicist and science historian Gerald Holton has written that this new opposition to science "threatens to topple the Enlightenment-based tradition on which scientific discourse and democratic politics are based."

Two cultures separated by a great divide.

One of the consequences of the widening of this divide is that the metaphors of science are no longer migrating into our popular culture at the rate they once did. In the early decades of the scientific revolution, during the 17th century, there was an explosion of new metaphors that crossed the permeable boundary between science and culture. It was more common in that era for individuals to be fully conversant in both science and the rest of culture. And there was less to master before the scientific revolution speeded up. John Stuart Mill was described as "the last man to know everything." In that age, people generally acquired an intuitive sense of Newtonian physics, and spoke of the universe as an apparatus that ran like clockwork. They spoke of social organizations resembling machines. Later on, Charles Darwin's theory of natural selection supplied metaphors for competition in economics and life, and still later supplied the language for a social movement that misused his theory and borrowed his name.

But now, in the second half of the 20th century, while the number of new discoveries flowing out of the still accelerating scientific revolution is at least a thousand-fold greater, the flow of these metaphors into the rest of society has slowed to a trickle.

I believe it is time for a new effort to build bridges between these two cultures. I agree with my late friend Jerry Weisner, who said in his inaugural address as President of MIT in 1971, that it is our responsibility "to understand what our learning and discoveries may do to man and society, and to transmit that knowledge to new generations -- to . . . leaders who may be wiser than we in applying it, or wiser in judging how slowly or rapidly these technologies may be absorbed."

I am convinced that a more robust discourse between science and society could empower us to fruitfully apply some powerful new metaphors from science in an effort to better understand society and better understand the relationship between science and technology and our society.

Let me illustrate what I mean with an example. I have a friend who's an MIT graduate, named Danny Hillis. A few years ago, he patiently explained to me the workings of a massively parallel supercomputer by pointing out that the first computers relied on a central processing unit surrounded by a field of memory. To find the answer to a particular problem, the CPU would send out to the memory to retrieve data, then bring it to the center for processing. The result would then be placed back in the memory. Three trips, back and forth, consuming precious time and generating unwanted heat.

The architectural breakthrough associated with massive parallelism was to break up the power of the CPU and distribute it throughout the memory field in the form of smaller, simpler processors, each co-located with the memory it processes. When a task has to be performed, all of the processors begin to work simultaneously and process a small quantity of information. Then all of the separate parts of the answer are sent simultaneously to the center where they assembled. One trip. Less time and heat.

When you think about it, the metaphor of massive parallelism, or "distributed intelligence," offers a nice explanation for why our representative democracy is superior to a governmental system run by a dictator or a king. Where totalitarian regimes rely on a central processor to dictate all commands, representative democracies depend on the power and insight of people spread throughout the society, each located adjacent to the part of society in which he or she is most interested.

Or take capitalism. The Soviet Union's economy collapsed because it relied on a central processor to make all economic decisions. It didn't work very well. Innovation withered and corruption took root. The North Korean economy continues to rely on a central processor, and today its people are starving. But capitalist economies distribute the power to those located outside the center -- entrepreneurs and consumers, who make their own decisions independent of each other, and those accumulated activities create a stable system that marries supply and demand and keeps prices stable.

To take a third example, many of the latest techniques from the world of management -- as graduates of the Sloan School know very well -- rely on the same principles of distributed intelligence, even if they don't call it that. By distributing intelligence and information and responsibility to workers on the front lines, organizations are transforming themselves, serving customers better, and producing greater value.

Each of these examples relies for its success on the same basic architecture. Instead of insisting that all decisions be made in a single place, the power is widely distributed throughout the organization. Each individual's portion of the answer is then assembled as part of a collective conclusion. In capitalism, it's called supply and demand. In representative democracy it's called self-determination. In each case it is essential that all the individuals involved share some basic characteristics: for example, the freedom to obtain information that flows unimpeded throughout the system.

In organizations that are based on this design, it is crucial that all the individuals who are part of the organization feel a sense of cohesion that is based on a common understanding of the organization's guiding vision. It is crucial that they all understand the organization's basic goals, and that they all share the same basic values upon which a decision can be based, whether it is made by the CEO or a clerk behind a word processor.

Some organizations find this cohesion deceptively easy to establish, simply because they're new, and everyone involved has been present at the creation and is eager to accomplish the goals easily kept in mind until the initial burst of enthusiasm wanes. For example, NASA put a man on the moon and returned him safely in less than 10 years. It was an inspiring sprint. But once that goal was achieved, the organization's culture began to quickly erode and has had recently to be painstakingly rebuilt.

Likewise, some of the institutions of government created in the burst of enthusiasm we call the New Deal were remarkably successful until the first generation of managers passed from the scene, and then we began to see bureaucratic rigor mortis set in.

The challenge for any organization is not simply to establish these conditions and gain the advantages of distributed intelligence, but to nurture and sustain this creative state. There's no better example of how to do that than the U.S. Constitution, with its checks and balances and careful design intended to sustain the creativity of self-government, even after more than 200 years. Our Constitution is, in a sense, the software guiding the operations of a massively parallel system for processing political decisions.

Our Founders rejected the idea of a pure democracy, not as some suppose because the information technologies of the 18th century simply couldn't accommodate a plebiscite on every question. Rather, as the Federalist Papers make clear, they insisted upon the importance of a reflective process, with an intermediate institution placed between the people and the exercise of power -- an institution capable of reasoned debate and deliberation, which would cool passions and distill judgment and look beyond the present moment to the future consequences of the decisions made.

Many people feel that valuable processes like these in our society are threatened by the still accelerating scientific and technological revolution. They wonder in this case, for example, about the impact of television and 30-second commercials on our ability to be deliberative and reflective in our political decisions as a nation. Passionate beliefs held by a temporary majority, when powered by the extra force of new technology, may not be cooled or slowed down at all by the institutions of our self-government.

This concern that science and technology now regularly unleash forces that threaten to seriously damage some delicate balances important to the fabric of society is one of the principal issues our society must resolve in order to establish a healthier relationship between the two cultures.

Until recently, this dialogue was difficult to even begin because of a philosophical preference in the scientific method for narrow specialization, which often resulted in the splitting of large questions into smaller and smaller component parts, each of which was then analyzed by expert specialists -- independent of those studying the other component parts. Not only was communication difficult between scientists and generalists. It was difficult between specialists in one field and specialists in another field. The often frustrating result was a tendency to ignore important relationships between the different parts that made up a whole.

As Goethe said in anger and frustration, "How often do they strive to divide that which, despite everything, would always remain single and whole."

In more recent decades, there has been a new appreciation within science for the study of whole systems. Here at MIT in the early 1960s, for example, the System Dynamics Group was founded by Jay Forrester, a professor of electrical engineering. And the new emphasis on systems creates new possibilities for a fruitful dialogue between the two cultures.

For example, both cultures can describe how the invention of nuclear weapons radically transformed the age-old habit of war. The destructive consequences of all-out war between superpowers became unthinkable, and a "cold war" emerged in its place. In the same way, a large cluster of new technologies that enhance our capacity to exploit the earth for sustenance has radically transformed the relationship between humankind and the global environment. For example, the air we are breathing in this great court contains six times as many chlorine atoms in each lungful than it did when these buildings were constructed. The same is true of the air at the North Pole and the South Pole and the Equator and everywhere on earth.

The concentration of chlorine in the entire atmosphere of the earth has increased sixfold in only a few decades because of a single new family of chemicals invented in the 1930s and used in large quantities only since World War II -- chlorofluorocarbons. There are, so far as we know, no direct health consequences of breathing six times as many chlorine atoms. But the impact on the earth's environmental system is quite harmful. The hole in the stratospheric ozone layer and the increased irradiation of the earth's surface by ultraviolet rays is a direct consequence of this new technology.

Similarly, the burning of fossil fuels by five and a half billion people and the destruction of forest land at an unprecedented rate worldwide is now leading to the rapid accumulation of carbon dioxide and other greenhouse gases in the atmosphere of the earth. The resulting global climate change is increasing global temperatures, threatening the disruption of the climate balance we are used to that has remained relatively stable for thousands of years. It is also causing the rise of sea level at six millimeters per year, the retreat of nearly every mountain glacier in the world, the rapid disintegration of important ice shelves in Antarctica, and the disruption of important ecosystems upon which much of the diversity of life on earth depends.

A third potentially destabilizing set of new technologies is what is commonly called genetic engineering. One graduating MIT senior wrote that recombinant DNA technology represents "a powerful tool for countless therapies. However it could also be very harmful in the wrong hands."

In all these examples, there is a clear sense that what is needed and what is at risk is <u>balance</u>. The new capacities conferred by new discoveries in science and technology clearly have a promising potential for good and beneficial effects, but simultaneously provoke widespread and deep concern that the use of these new powers can be disruptive and harmful. Another graduating senior expressed his concerns in these words: "I believe that technology in any form is a new power that can potentially disrupt society. With the current pace of advances, our society is undergoing a destabilizing revolution constantly. Maintaining the delicate balance that we have achieved between individual liberty and societal needs requires diligence and a watchful eye. Failure to do this will lead to either chaos (Lord of the Flies), or tyranny (1984)."

How can we create a richer, more productive dialogue about these possibilities that is

accessible to men and women who inhabit both of "the two cultures?"

Let me suggest a second metaphor that is based on a new discovery in science, which I believe has explanatory power directly relevant to the society's need for a discussion of this problem: "Complexity Theory" is a new science useful for describing what are called non-linear systems that exist "at the edge of chaos." By that definition, our society certainly qualifies as a complex system.

Here is how the author Mitchell Waldrop describes the phenomenon: "Complex systems have somehow acquired the ability to bring order and chaos into a special kind of balance. This balance point -- the edge of chaos -- is where the components never quite lock into place, and yet never dissolve into turbulence either. The edge of chaos is where life has enough stability to sustain itself and enough creativity to deserve the name of life.

"The edge of chaos is where centuries of slavery and segregation suddenly give way to the civil rights movement of the 1950s and 1960s; where seventy years of Soviet communism suddenly give way to political turmoil and ferment; the edge of chaos is the constantly shifting battle zone between stagnation and anarchy, the one place where a complex system can be spontaneous, adaptive, and alive."

There are a number of societies in our modern world which appear to be in a state of equilibrium and balance, but move suddenly toward chaos or totalitarian stagnation.

Consider, for example, Somalia. The clans which organized traditional Somali society often engaged in confrontation at the boundaries of their respective territories, in clashes which consisted largely of symbolic conflict with few casualties.

The introduction of automatic weapons in large numbers and then the mounting of machine guns on light pickup trucks -- a combination that became known as "technicals" -- tragically transformed the consequences of these once symbolic conflicts, and the entire system slipped out of equilibrium and into utter chaos.

To take a second example, in Sarajevo, the stadium that was the centerpiece of the world's celebration of peaceful competition at the 1984 Winter Olympics became a cemetery a few short years later when that society slipped into chaos.

In the 1930s, fragile democracies in Germany and Italy moved not toward anarchy and chaos but toward totalitarianism with horrific consequences for much of the world.

The challenge for modern societies -- including our own -- is of course to avoid either extreme -- either chaos or stagnation -- by maintaining the essential balance between stability and creativity.

And part of the challenge is how to integrate the changes that flow out of new technologies and new scientific knowledge, the new powers and enhanced capabilities, and use them as a source of energy for adaptive change that benefits society as a whole.

There is a model for understanding how such change occurs that I have found helpful.

Nineteen years ago, as a freshman Congressman, I met a scientist named Ilya Prigogine who had just won the Nobel Prize for Chemistry for describing how systems can adapt to sudden and dramatic change.

He described characteristics of what are called "open systems" -- meaning systems where energy or matter (or both) flow in and through and out the other side. When the flow of energy in such a system suddenly and dramatically increases, the system responds in a two-step process: first, it breaks down; second, it reorganizes at a higher degree of complexity.

Societies can behave the same way, when there is a sudden and dramatic increase in the flow of energy through the society -- automobiles in place of horses and buggies, massive waves of immigration, new trading relationships with new flows of products, surges of new information with the introduction of new technologies like television or the Internet. First, long-stable patterns break down. Then new ones emerge at a higher degree of complexity.

Societies are vulnerable to misinterpreting the first stage as a descent into chaos and then overreacting with the imposition of a rigid, stagnating order.

The science historian Gerald Holton wrote, "History has shown repeatedly that a disaffection with science and its view of the world can turn into far more sinister movements." So while we are right to raise questions about the challenges to our society posed by new technologies -- as many of you did in your e-mails to me -- we must strongly reject the neo-Luddite voices in our society seen in their most extreme and repugnant form in the writings and actions of the Unabomber.

By contrast, the conditions that maximize a society's ability to integrate rapid change in a healthy pattern include: the maintenance of the free flow of information; the maintenance of strong intermediate institutions such as families, schools, places of worships, civic associations, and communities; and the avoidance of gross inequities. As one graduating senior put it, "I fear that technological advances, if done in the wrong way, will cut off the poor or anyone who doesn't have access to these changes."

If individuals within a society are left behind when others gain new powers and capacities, they can lose their attachment to the society, begin to feel powerless and then define their relationship to the whole in terms of anger and alienation.

For four years President Clinton and I have been working to ensure that as we enter this new age, our nation addresses the challenge of maintaining a free flow of information, avoiding gross inequities in the access to such knowledge, and in sustaining the private institutions that promote dissemination of this learning.

Just last week, the President announced a new plan to put two years of college in the grasp of all Americans -- young and old -- with a refundable tax credit that would make tuition free at most community colleges. We have also proposed new tax deductions for educational costs, lessened the cost of student loans, and promoted an ambitious plan to have every classroom and library in the country connected to the information superhighway by the year 2000.

New information technologies have a special power to engender dramatic change in society. For example, the invention of print technology in the 15th century distributed large quantities of civic information, thereby creating the conditions which made possible the emergence of the nation-state and eventually representative democracy.

In our day, the new technologies of radio and television broadcasting have dramatically increased the flow of information throughout the world. In Tianenmen Square, fax machines and CNN were seen by Chinese authorities as deadly threats to civic order. The Ayatollah Khomeini spread his revolution inside Iran with audio cassette tapes and telephone lines. The Internet will soon distribute a million times the information accessible in print to billions of people on every continent.

As another member of the graduating class says, "Each of us may speak with equal voice and be easily heard by any who choose to listen. The powerful or rich no longer have the monopoly on mass communications."

Along with the Internet, the most important new tool we now have to extend our ability to create new personal paradigms of understanding is the computer. Computers can magnify our ability to cope with the information explosion in four important ways:

First, they can sift through vast quantities of data, searching for the needles in the haystacks that are directly relevant to the questions of interest to us.

Second, they can form these data into patterns that are far more accessible to our brains than endless bits of information strung together sequentially.

Third, they can artificially alter the scale and speed of the world to make images too large or too small for our comprehension just the right size for us to understand. Processes that are extremely slow can be speeded up for our inspection, and processes that occur naturally at the blink of an eye can be slowed down for our convenient analysis.

And finally, the largest and most powerful of these machines have led to the emergence of a completely new form of knowledge creation. In addition to inductive reasoning and deductive reasoning, we now have a new variety that blends aspects of the first two. "Computational science" can create artificial realities within which experiments can be conducted.

How will society adapt to the dramatic changes that will accompany this new revolution?

The reemergence in our world of rigid, stultifying, fundamentalist ideologies can be seen as one extreme in reaction to the vast increase in data that is now washing through world civilization.

At the opposite extreme, the fear of chaos was expressed by another graduating senior on the Athena system: "Free speech uncontrolled can break down our social norms and common beliefs, allowing extreme opinions to find and strengthen each other or allowing unsubstantiated unfounded 'truths' to be disseminated without challenge or resistance."

Hers is a concern I share. For example, I believe we have an obligation to assist parents who want to exercise responsibility for protecting young children from materials which they as parents believe their children are not ready for.

But let me also state my clear and unequivocal view that a fear of chaos cannot justify unwarranted censorship of free speech, whether that speech occurs in newspapers, on the broadcast airwaves -- or over the Internet.

Our best reaction to the speech we loathe is to speak out, to reject, to respond, even with emotion and fervor, but to censor -- no. That has not been our way for 200 years, and it should not become our way now.

In 1962, the great historian of science, Thomas Kuhn, described the way in which our understanding of the world evolves when faced with a sudden increase in the amount of information. More precisely, he showed how well-established theories collapse under the weight of new facts and observations which cannot be explained, and then accumulate to the point where the once useful theory is clearly obsolete. As new facts continue to accumulate, a new threshold is reached, beyond which a new pattern is suddenly perceptible and a new theory explaining this pattern emerges.

It is an important process not only at the societal level but for each of us as individuals as we try to make sense of the growing mountain of information placed at our disposal.

But while the breakthroughs in understanding that we need in order to adapt to change may be facilitated by the new capabilities computers and the Internet make possible, they will not be *caused* by computers and they will not take place *inside* computers. They will only take place in our *lives*. They will only have meaning in relation to human *values*.

The noise level in our civilization is rising. The flood of information on every subject makes the task of understanding change more difficult than ever. The temptation to rely on new technologies as a substitute for reflective thought is a dangerous trap.

How many of you have tried to see the hidden three-dimensional images in modern computer-generated pictures called, by one brand name, the "Magic Eye?" Could I see a show of hands? For those of you who have not seen these novelty pictures, they consist of complex patterns that seem like busy, partly incoherent designs, and they are intended to be viewed in a special way. My children taught me the technique. You hold them close to your eye and focus on a distant point beyond and through the plane of the image. Then you wait until your brain has processed the information in the image, which then reveals a three-dimensional picture that comes into sharper focus when you slowly move the image back, keeping your eyes focused beyond the plane.

The most important breakthroughs and advances in understanding can only come when we take the time to look beyond the surface of the problems we face and focus on what is most important in our lives. The same is true for you today.

If you are seeking a deeper understanding of what your life is all about, you will not find that meaning on the surface of your life. You must look beyond and through your life, and focus on a distant point far from this plane and be patient.

Nor can you understand your life in isolation from its context: your family, your community, your nation, your world, and the fabric of existence of which you are a part. If you are seeking healing in your life, healing is to be found in these relationships. If you are seeking spiritual meaning in your life, you will not find it by thinking of what you want to do next, but rather by reflecting on your whole life in its largest context.

If you are pursuing happiness, it will not be found in a set of rigid nostrums, nor in the undisciplined pursuit of pleasures, but is more likely to be found by living your life with enough stability to faithfully discharge your responsibilities to others, and also with enough spontaneity to adapt continually to the new challenges you will encounter and to seize the new opportunities inherent in a life with creativity and balance.

That is my wish for you. God bless you, and good luck.

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THE WHITE HOUSE

WASHINGTON

November 12, 1997

MEMORANDUM FOR THE VICE PRESIDENT

FROM: TOM KALIL, JIM KOHLENBERGER

THROUGH: DON GIPS

RE: DIGITAL GLOBE PROJECT

After additional research, we think that the vision that you have outlined for a Digital Globe is achievable. This is particularly the case given the dramatic improvements in storage technology and the availability of one-meter resolution commercial satellite imagery. We also think that it may be possible to take advantage of the military's keen interest in acquiring high-resolution coverage of the planet from commercial sources, assuming that any national security and intellectual property issues can be worked out.

The project will need some focus if it is to achieve some near-term results. The volume of data that could conceivably be collected as part of a Digital Globe is potentially unlimited. Imagine a digital library project that set out to put "all authored works of mankind" online! We think that it would make sense to choose a few motivating applications as a way of focusing the project. We recommend (1) education; and (2) support for decision-making on one or more high-priority environmental issues, such as climate change. For an education application, for example, one might start out by having very high levels of resolution for at least one of each of the major biomes. There will also be cases where it is much easier for us to get data for the United States than for the rest of the world. Many other countries have much more restrictive policies with respect to data dissemination than we do.

We also think that it may make sense to pursue this project in a few stages:

- **Stage 1:** Integration of existing data
- **Stage 2:** A digital map of the planet at 1 meter resolution
- **Stage 3:** Full coverage of the planet with historical data and multiple thematic data sets

Our other major conclusion is that a potential big "win" from the Digital Globe is the establishment of a framework and a set of standards that allows hundreds of thousands of individuals and organizations to contribute to its development. The history of the World Wide Web, and your concept of "distributed intelligence", is instructive. Agreement on a few standards allowed everyone to contribute to the development of a global information space. Admittedly, this will be more difficult, given that the standards associated with representing geospatial information are more complicated. But a large Digital Globe testbed could bootstrap the process - and create the "increasing returns" that Brian Arthur (Santa Fe Institute) has described.

Making this vision a reality will not happen unless you unveil your vision, and challenge government, industry, and academia to make it happen. Below are the steps we believe you should take to move this project forward:

1. **Publish a high-level vision statement**: Attached is a draft short article that spells out your vision of the Digital Globe. This could be published in either (1) a science journal e.g. (*Scientific American*, *Science*, *Nature)*; (2) an industry journal on geographical information systems (*GIS World)*; or (3) as an op-ed in a paper like the *San Jose Mercury News*, with a link to the full version on your Web site. Per your request, we have not circulated this vision statement to anyone within the U.S. Government or to any outside experts. We think it would make sense to do so before publishing it.

2. **Charter an inter-agency working group to develop a more detailed action plan for the Digital Globe**: After your vision piece is published, you should task an inter-agency working group to develop a more detailed action plan, engage the private sector and the university community, and identify policy issues such as privacy and intellectual property rights. We recommend Interior as the chair, given that they chair the Federal Geographic Data Committee, and given Secretary Babbit's personal interest in this. Secretary Babbit is co-hosting a meeting in October with EU Commissioner Bangemann to discuss a Global Spatial Data Infrastructure. Other participants might include NASA, NIMA (National Imagery and Mapping Agency), NOAA, DARPA, NSF, and Census. You could meet with this group to lay out your vision, and participate in an annual symposium similar to the one you convene on the PNGV. You should know that you have tasked many of these same agencies to develop a Global Disaster Information Network. This group has been meeting to develop mechanisms for better sharing of both classified and unclassified information to respond to disasters. It may also be necessary to establish a high-level project office with full-time managers and technical experts.

3. **Ask the National Academy of Sciences for outside expert advice**: The National Academy of Sciences already has a working group that is interested in "geo-libraries." This is an effort to bring together the GIS community and the digital libraries community, and could support your vision. We think that getting advice from the NAS would be very helpful, since it would provide a mechanism for getting input from both university

researchers and companies.

4. **Ensure that the Administration's budget contains some level of funding in FY99**: Unless we act during the coming budget cycle, we would not be able to request funding from Congress until FY2000. We think that even without funding, it would be possible for agencies to make some progress on this. For example, the Defense Science Board has recommended that NIMA develop "an Internet-like structure in which geospatial information services are provided by a large number of autonomous entities through a global communications network." However, we think that the project would move forward more rapidly with some targeted funding (e.g. $20 - $25 million).

5. **Task the National Endowment of the Humanities, the Library of Congress, and the Department of Education with the development of a "world history" application of the Digital Globe**: We think that the NEH, the Department of Education and the Library of Congress are the appropriate agencies to encourage the development of a "world history" application of the Digital Globe, and to convene leading historians to pursue this project.

Draft November 12, 1997

The Digital Globe:
Understanding our planet in the 21st Century

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet and a wide variety of environmental and cultural phenomena. Much of this information will be "georeferenced" - that is, it will refer to some specific place on the Earth's surface.

The hard part of taking advantage of this flood of geospatial information will be making sense of it - turning raw data in to understandable information. Today, we often find that we have more information than we know what to do with. The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire Earth's surface every two weeks and it's been doing that for more than 20 years. In spite of the great need for that information, 95% of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data. We used to have an agricultural policy where we stored grain in Midwestern silos and let it rot while millions of people starved to death. We now have an insatiable hunger for knowledge. Yet the data sits rotting away by remaining unused.

Part of the problem has to do with the way information is displayed. Someone once said that if we tried to describe the human brain in computer terms, it looks as if we have a low bit rate, but very high resolution. For example, researchers have long known that we have trouble remembering more than seven pieces of data in our short-term memory. That's a low bit-rate. On the other hand, we can absorb billions of bits of information instantly if they are arrayed in a recognizable pattern within which each is related to all the others -- a human face, or a galaxy of stars.

The user interfaces that we have used to interact with data, such as the desktop metaphor, may no longer be up to the challenges ahead. A "Digital Globe," a multi-resolution, three-dimensional representation of the planet, is just what we need.

Imagine, for example, a young child going to a Digital Globe exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, at higher and higher levels of resolution, to see continents, countries, cities, and finally, individual houses, trees, and other natural and man-made objects. Having found an area the planet she is interested in exploring, she takes the equivalent of a "magic carpet ride" through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data she can interact with. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE

project. This information can be seamlessly fused with the digital map or terrain data. She can get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare for her family's vacation to Yellowstone National Park, for example, she plans the perfect hike to see the geysers, bison, and bighorn sheep that she has just read about.

She is not limited to moving through space, but can also travel though time. After taking a virtual field-trip to Paris to visit the Louvre, she moves backwards in time to learn about French history, perusing digitized maps, newsreel footage, oral history, newspapers, and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in to the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.

Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations. Although some of the data for the Digital Globe would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a "collaboratory" -- a laboratory without walls -- for research scientists seeking to understand the complex interaction between humanity and our environment.

Technologies needed for a Digital Globe

Although this scenario may seem like science fiction, many of the technologies and capabilities that would be required to build a Digital Globe are either here or under development. Of course, the capabilities of a Digital Globe will continue to evolve over time. What we will be able to do in 2005 will look primitive compared to the Digital Globe of the year 2020. Below are just a few of the technologies that are needed:

- **Computational science**: Until the advent of computers, both experimental and theoretical ways of creating knowledge have been limited. Many of the phenomena that experimental scientists would like to study are too hard to observe - they may be too small, too far away, or occur in a billionth of a second. Pure theory, on the other hand, can not predict the outcomes of complex natural phenomena like thunderstorms or airflows over airplanes. But with high-speed computers as a new tool, we can simulate phenomena that are impossible to observe, or better understand data from observations. In this way, computational science allows us to overcome the limitations of both experimental and theoretical science. Modeling and simulation will give us new insights in to the data that we are collecting about our planet.

- **Mass storage**: The Digital Globe will require storing quadrillions of bytes of information. Already, NASA's Mission to Planet Earth program generates a terabyte of information each day. Fortunately, we are continuing to make dramatic improvements in this area.

- **Satellite imagery**: The Administration has licensed commercial satellite systems that will provide 1-meter resolution imagery beginning in late 1997. This provides a level of accuracy sufficient for detailed maps, and that was previously only available using aerial photography. This technology, originally developed for the U.S. intelligence community, is incredibly accurate. As one company put it, "It's like having a camera capable of looking from London to Paris and knowing where each object in the picture is to within the width of a car headlight."

- **Broadband networks**: The data needed for a digital globe will be maintained by thousands of different organizations, not in one monolithic database. That means that the servers that are participating in the Digital Globe will need to be connected by high-speed networks. Driven by the explosive growth of Internet traffic, telecommunications carriers are already experimenting with 10 gigabit/second networks, and terabit networking technology is one of the technical goals of the Next Generation Internet initiative. The bad news is that it will take a while before most of us have this kind of bandwidth to our home, which is why it will be necessary to have Digital Globe access points in public places like museums.

- **Interoperability**: The Internet and the World Wide Web have succeeded because of the emergence of a few, simple, widely agreed upon protocols, such as the Internet Protocol. The Digital Globe will also need some level of interoperability, so that geographical information generated by one kind of application software can be read by another. The GIS industry is seeking to address many of these issues through the Open GIS Consortium.

- **Metadata**: Metadata is "data about data." For imagery or other georeferenced information to be helpful, it might be necessary to know its name, location, author or source, date, data format, resolution, etc. The Federal Geographic Data Committee is working with industry and state and local government to develop voluntary standards for metadata.

Of course, further technological progress is needed to realize the full potential of the Digital Globe, especially in areas such as automatic interpretation of imagery, the fusion of data from multiple sources, and intelligent agents that could find and link to information on the Web about a particular spot on the planet. But enough of the pieces are in place now to warrant proceeding with this exciting initiative.

Potential applications

The applications that will be possible with broad, easy to use access to global geospatial information will be limited only by our imagination. We can get a sense of the possibilities by looking at today's applications of GIS and sensor data, some of which have been driven by industry, others by leading-edge public sector users:

- **Conducting virtual diplomacy**: To support the Bosnia peace negotiations, the Pentagon developed a virtual-reality landscape that allowed the negotiators to take a simulated aerial tour of the proposed borders. At one point in the negotiations, the Serbian President agreed to a wider corridor between Sarajevo and the Muslim enclave of Gorazde, after he saw that mountains made a narrow corridor impractical.

- **Fighting crime**: The City of Salinas, California has reduced youth handgun violence by using a GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.

- **Preserving biodiversity**: Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.

- **Predicting climate change**: One of the significant unknowns in modeling climate change in the rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire are able to monitor changes in land cover and thus determine the rate and location of deforestation.

- **Increasing agricultural productivity**: Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it most. This is known as precision farming, or "farming by the inch."

The Way Forward

We have an unparalleled opportunity to turn a flood of raw data into understandable information about our society and our planet. This data will include not only high-resolution satellite imagery of the planet, digital maps, and economic, social, and demographic information. If we are successful, it will have broad societal and commercial benefits in areas such as education, decision-making for a sustainable future, land-use planning, agriculture, and crisis management. We could even create a "situation room" for the Earth. This would allow us to

Tom VanZant

respond to manmade or natural disasters - or to collaborate on the long-term environmental challenges we face.

A Digital Globe could provide a mechanism for users to navigate and search for geospatial information - and for producers to publish it. The Digital Globe would be composed of both the "user interface" - a browsable, 3-D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources.

A comparison with the World Wide Web is constructive. [In fact, it might build on several key Web and Internet standards.] Like the Web, a Digital Globe would organically evolve over time, as technology improves and the information available expands. Rather than being maintained by a single organization, it would be composed of both publicly available information and commercial products and services from thousands of different organizations. Just as interoperability was key for the Web, the ability to discover and display data contained in different formats would be essential.

I believe that the way to spark the development of a Digital Globe is to sponsor a testbed, with participation from government, industry, and academia. This testbed would focus on a few applications, such as education and the environment, as well as the tough technical issues associated with interoperability, and policy issues such as privacy. As prototypes became available, it would also be possible to interact with the Digital Globe in multiple places around the country with access to high-speed networks, and get a more limited level of access over the Internet.

Clearly, the Digital Globe will not happen over night. In the first stage, we should focus on integrating the data from multiple sources that we already have. Next, we should endeavor to develop a digital map of the world at 1 meter resolution. In the long run, we should seek to put the full range of data about our planet and our history at our fingertips.

In the months ahead, I intend to challenge experts in government, industry, academia, and non-profit organizations to help develop a strategy for realizing this vision. Working together, we can solve many of the most pressing problems facing our society, inspire our children to learn more about the world around them, and accelerate the growth of a multi-billion dollar industry. To comment, or to stay informed about the progress we're making, you can check out our web site, at http://www.whitehouse.gov/globe/.

REMARKS BY VICE PRESIDENT AL GORE
COUNCIL ON COMPETITIVENESS INNOVATION SUMMIT
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Friday, March 13, 1998

It's great to be back with the Council on Competitiveness, and it's great to be back at MIT. I was honored to deliver the commencement address here two years ago. And I always enjoy returning to Cambridge, where I spent so many happy days as a student at a school down the road.

I recall that the last time I delivered a formal address at MIT was when I had the honor of speaking at commencement a couple of years ago. I'm reminded that, on that occasion, I told the story of how MIT's founder returned in 1882 to deliver the commencement address and dropped dead while delivering his speech. As terrible as that is, I was comforted by the thought that no matter how poorly I did, I would only be MIT's second stiffest commencement speaker.

* * * * *

Let me say how grateful I am to the Council on Competitiveness -- not just for convening this critical national summit, but also for your important work, all year long, in helping us to understand the dramatic changes taking place in our economy and society. As someone with a longtime interest both in innovation and in its considerable economic benefits, I've followed the Council's work very closely since its founding a dozen years ago. And I am convinced that only by bringing together business, labor, academia, and government at all levels -- only by mobilizing everyone with a stake in our economic future -- can we truly make the most of this moment in our history. This is an impressive gathering -- and a necessary one as well.

It's no exaggeration to say that we meet at the dawn of a true Innovation Age. Consider these facts: it's estimated that the entire store of human knowledge now doubles every five years. For example, we are just a few years away from the complete sequencing of the human genome -- giving us, for the very first time, the full instruction manual for the human body. Within a couple of years, microchips will routinely contain one billion transistors per chip, the size of a fingernail -- and the patterns etched onto them will be as complicated as a roadmap of the entire planet. Within six months, a brand new low-earth orbiting systems will make it possible to make a cell phone call from any point on the earth's surface to any other point -- other systems will soon follow. And within three years, we will be able to have wireless Internet access from anywhere on Earth. We are on the verge of fulfilling Hawthorne's vision in the middle of the last century. Fifteen years after the invention of the telegraph he wrote, "By means of electricity, the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time . . . the round globe is a vast . . . brain, instinct with intelligence!"

Often, it is easy to chart the exact benefits of a new breakthrough -- to our health, to our hard disk drives, to our pocketbooks. But today, I want to talk about innovation in a broader context. I want to talk about innovation not merely as a material goal, but as an ethic, as a

constant concern. MIT's motto -- "Mens et Manus," mind and hand -- sums up this challenge. True innovation encompasses not only the labor of our hands, but also the labor of our minds. If America industry is to keep growing and thriving, we must be willing to think and act anew -- to keep pushing the boundaries of knowledge and discovery -- to reshape our economy by redefining the way we view our world.

At a few precious moments in our history, we have literally redefined the way we view our world. More than 500 years ago, Columbus set sail. By discovering the New World, he gave us a new vision of Earth. A century later, Galileo first turned a telescope toward the sky and shattered centuries old-notions about the mechanics of our solar system.

The discoveries of the age of exploration unleashed the greatest explosion of trade and commerce the world had ever seen. New lands brought new ideas -- and the need for new inventions. Europe's contact with other cultures and customs -- while certainly not always mutually positive -- stimulated new thinking in the Old World.

Almost half a millennium after Columbus, we broke free from the grasp of our planet with the Apollo program. Yet one of the most important effects of those missions came not in how we viewed our distant Moon, but in how we viewed ourselves and the planet we call home.

Dominating a wall of my office in the White House just down the hall from the Oval Office -- I call it the Square Office -- is a photograph of our planet taken by the astronauts aboard Apollo 17. For some, it is hard to recall the significance of those first images of Earth from space when they appeared nearly three decades ago. But those images of our planet -- the first time we had ever seen what we looked like from a distance -- had a powerful impact. As the British astrophysicist Fred Hoyle predicted in 1948, "Once a photograph of the Earth, taken from outside, is available -- once the sheer isolation of the Earth becomes plain -- a new idea as powerful as any in history will be let loose." It wasn't until the Apollo missions twenty years later that we found out the truth of that prophecy.

Like a child's first glimpse of herself in a mirror, those photographs from the frosty reaches of space changed our own self-image. We saw a world that was not as vast, expansive, or incomprehensible as we had thought -- but surprisingly smaller, more interconnected, more fragile and communal.

As the great poet Archibald MacLeish wrote after the first of these images, "To see the earth as we see it now, small and blue and beautiful in that eternal silence where it floats; is to see ourselves as riders on the earth together, brothers on the bright loveliness in the unending night -- brothers who see now they are truly brothers." This new image, this new understanding, shifted centuries of human understanding, and brought about dramatic results.

Certainly, such a quantum leap in our worldview does not occur very often. When they do, it often takes decades to know where they will lead. But in spirit, it is little different from the

work many of you do, each and every day -- pushing the ever-expanding boundaries of knowledge and discovery -- creating and innovating for the ultimate benefit of all our people. For, at its heart, what innovation means is looking at the world in new and different ways. Our challenge is to create the right climate for that kind of innovation, both small and large -- and to harness its enormous economic potential in the 21st Century.

We've already come a long way. With help from so many of you, we are building a new economy -- one that is takes innovation as its starting point, not a mere by-product. The new economy is driven by innovation -- information and technology are its fuels. The new economy values the productivity and creativity of our people above all else. The new economy is connected to the global marketplace -- where we zap dollars and data around the world at the speed of light.

Today, the American economy is once again the envy of the world. Interest rates and inflation are at record lows. Investment and modernization are rising. We have 15 million new jobs, and the lowest unemployment in a generation.

Today, a full third of our GDP growth now comes from information technology. Our fast-growing environmental technology industry is already bigger than our steel, textile, or aerospace industries. More Americans build semiconductors than construction machinery. More Americans spend their days processing data than refining petroleum. More Americans make computers than make cars.

Perhaps more importantly, today there is far less difference between the two. Open up a car today and it doesn't look a lot different than most computers. In fact, today's Ford Taurus has more computing power than the Apollo landing capsules that landed on the Moon. And those that build those cars do so in ways that emphasize quality, performance, and innovation.

* PAPERLESS 777

* TELESCOPING LEAD TIME FOR NEW CAR DEVELOPMENT. FROM 7 to 5 to 3...HEADED FOR 1

* BIG THREE -- EXTRANET -- PNVG

Clearly, we are becoming not just an Information Society, but an Innovation Society as well. In the old economy, growth depended largely on capital and labor. Now, as the economist Paul Romer -- whom I met with just yesterday -- has argued, the true engines of growth are ideas and the technologies they create. Romer and others are teaching us that innovation is not something that happens outside the economy, as traditional economic theory had held. Innovation occurs inside the economy -- and it is essential for economies to grow. Ideas build on one another and each one opens the door to a thousand new roads of innovation.

Though we've had computers for a long time, we are just now seeing the convergence of technology which lets us use them to their full potential. We know from history that sometimes for innovations to bring about productivity gains organizations must adjust to new circumstances. During the Industrial Age, the effects of new electric motors took time to show results in productivity. Part of the reason was that our factories were still constructed in a vertical fashion in order to take advantage of obsolete steam energy. But once we rethought the way our factories worked and flattened them out; once the architecture and infrastructure was in place to use electric motors, the results in productivity were astounding.

And the similarities between that time and our present transformation run deep. The steam factories relied on centralized power emanating from a single source. These factories were replaced when alternating currents allowed us to distrbute energy over long distances enabled us to distribute power -- and when electric motors enabled us to distribute sources of mechanical energy throughout a factory. So too today, the old top-down organizations which relied on hierarchies and a centralized source of intelligence and decision-making are being replaced by distributed intelligence. Today's technology is allowing us to tap a higher fraction of the potential of our people; allowing us to reach those who, in previous years, would have been left out of the world of innovation. We never know where we will find the person responsible for the next great scientific or intellectual breakthrough. It could be a janitor right here at MIT!

There is simply no question that if we want to make the most of the 21st Century, and the new economy -- if we want to achieve the full promise of American business -- we must do everything we can to fuel new innovation and discovery. We must build partnerships that encourage, support, and reward cutting-edge ideas -- and keep our economy strong enough and efficient enough to take advantage of them right away.

As far as I'm concerned, we can <u>never</u> do enough to promote innovation -- and for me, that had been a long crusade. As a Congressman, I co-authored legislation that created the Small Business Innovation Research initiative, which helps America's small businesses turn new technologies into new products. I also sponsored legislation which provided some of the earliest funding for developing the Human Genome Project and the Internet. And over the past five years, thanks to President Clinton, we've done an enormous amount to encourage innovation. Today, the facts are clear: for a quarter of a century, and for most of the 1980's, the number of patent applications for inventions filed by Americans hovered between 60,000 and 70,000 a year. The past few years have seen that number rise above 100,000. Similarly, we have increased the number of patent awards by 50% from the early 1980's.

We plan to seize that promise by continuing the bold new economic strategy with which we have kept pace with the new economy: eliminating the deficit; opening foreign markets to our products; and investing more in America's future.

First, we will balance the budget, and we will do it this year. The budget the President just proposed to Congress takes a deficit that used to have <u>eleven</u> zeroes and makes it, simply,

zero. Especially for young industries with little immediate revenue and extensive research and development needs, it is critical to free up large and steady supplies of capital. Companies shouldn't have to compete in credit markets with an 800-pound gorilla named Uncle Sam -- so we put Uncle Sam on a strict diet of fiscal discipline. By making tough choices based on hard numbers, we have freed up hundreds of billions of dollars in capital to finance private investments.

There is another reason for our emphasis on deficit reduction. Forget about the gold standard; the new economy operates on the information standard. Financial markets around the world make decisions about a government's fiscal policies every day through millions of transactions; and the future implications of policy changes are judged and acted upon in the present. If financial markets see a fiscal train wreck coming, they don't wait for the crash to get out of the railroad business. Likewise, by taking a responsible approach -- by rejecting second-hand smoke and rear view mirrors -- we have earned a premium. Investment capital has flowed to our shores, and will continue to flow to the innovators and entrepreneurs in our economy.

The second component of our economic strategy is to keep opening markets for American products overseas -- to reach the 96% of the world's consumers who live outside our borders. We've already signed more than 200 new trade agreements in the past five years. And increasingly, we are seeing our geopolitical relationships defined not by military conflict, but by economic cooperation.

The third part of our economic strategy is making targeted investments in the future. To fill the high-brainpower jobs in biotechnology and information technology, we need more education, more job training, and more computers in our classrooms and schools. That is why education is our number-one priority -- and that is why we fought for and won the largest increase in education opportunity in 30 years.

Of course, while investing in the future means teaching about old discoveries, it also means making new ones. Even as we have shrunk the deficit, we have increased NIH funding every single year. Now we are proposing a new 21st Century Research Fund for path-breaking scientific inquiry -- the largest investment in civilian research and development in American history. And this fund will include the largest ever increases in the budgets of the National Institutes of Health and the National Science Foundation. We are investing not just in targeted research, but also in the undirected research that often yields the biggest long-term gains -- and often would not occur without federal investment. Of course, it takes private sector investment as well. That's why we have proposed an extension of America's $2.2 billion Research and Experimentation tax credit, which is critical to our most innovative industries.

Part of our strategy of promoting innovation has been unshackling the dynamism of the new economy from the heavy hand of old government thinking. We are fighting hard in Congress to streamline the patent law and make the patent office a truly performance-based organization with increased flexibility and a focus on results. We cut 350,000 government

workers to give us the smallest federal government -- as a percentage of the workforce -- since the New Deal. We eliminated 200 outdated government programs, slashed more than 16000 pages of red tape, and saved he American people $137 billion. We not only made government smaller, we made it better and more effective for those it should serve.

We are paying special attention to the growth and development of the Internet. We have an aggressive strategy to foster electronic commerce. Trade and commerce on the Internet are now doubling or tripling every year -- and in just a few years will be generating hundreds of billions of dollars in sales of goods and services. We want to establish an environment in which electronic commerce can grow and flourish, so every computer can be a window open to every business, large and small, everywhere in the world. That means minimal government, no new taxes, and no cumbersome regulation. We are working to make the Internet a global free-trade zone, to take advantage of its full potential for prosperity.

And our 21st Century Research Fund invests hundreds of millions of dollars to help speed the development of the Next Generation Internet. Think about how today's Internet has revolutionized your life and business. Just imagine what the next generation, moving 1,000 times faster, could help us achieve.

I believe very strongly that our approach is the right one for America's future competitiveness. Thanks to your hard work, it is hard to even compare our economic strength and standing to that of five years ago. Without chronic deficits to weigh us down -- and with a bold new investment plan for the 21st Century -- mark my words, we have only just begun to innovate.

But while every company must be poised to innovate and to act and think anew, we must also do so as a country, and as a community. For me, that single, stunning picture of the planet Earth on my office wall serves as a constant reminder of how much there is to learn and discover -- about the world and about ourselves. And today, I want to issue a challenge that I hope will advance that knowledge and discovery, and give us a richer understanding of the world we inhabit.

Five centuries ago, according to historians, a Spanish sailor named Rodrigo de Triana -- standing in the forecastle of Columbus' ship, the Pinta -- caught a first glimpse of the New World. Today, a clearer view of our own world could help us reach new heights of understanding and insight. That's why today I am proposing that NASA launch a satellite named Triana -- a spacecraft which would provide the very first live, continuous images of the entire Earth from space. It will bring into the digital age those remarkable pictures we received of our Earth a generation ago.

[START VIDEO]

Aboard Apollo 11 and on his rendezvous with history, Michael Collins said, "Houston,

I've got the world in my window." Triana will provide a permanent window onto our world for the good of all humanity.

Triana would be located at what scientists call the L1 point -- the point, about 1 million miles away, where the Earth's and the Sun's gravitational attractions are balanced. That balance is also critical to Triana's mission -- to both pull us out to explore the depths of space, and to pull us back to better understand our Earth.

The unique, full-color view of Earth to be captured by this satellite for the first time will complement existing space-based Earth observations of clouds and their movement. And it would track the global implications of events like hurricanes and storms as they occur. Today, we have to stitch together the pictures from multiple satellites. But with Triana, for the first time ever, the full illuminated portion of Earth will be viewed constantly with a single satellite.

The Triana's live, continuous, round-the-clock, high-resolution images of the globe will be available to television broadcasters and over the Internet. I call this broadcast the Earth - Satellite Picture Access Network or Earth - SPAN. Along with its potential uses in science and education, the Earth - SPAN broadcast from Triana could be used for monitoring and predicting the weather in real-time.

Under Dan Goldin's powerful leadership, NASA has put a premium on doing things faster, better, and cheaper. That's why I propose that Triana be launched in two years as an example of this initiative. As a nation, Triana would help us do what you as innovators do individually every day -- to step back from the smaller concerns of everyday existence and take the broader view which leads to new understanding, new ideas, new innovation. As Socrates said, 2,500 years ago, "Man must rise above the Earth, to the top of the atmosphere and beyond, for only thus will he fully understand the world in which he lives."

The astronaut Rusty Schweickart once described the feeling of looking homeward while orbiting the moon. "You realize that on that small spot, that little blue and white thing, is everything that matters to you. All of history and music, and poetry and art and war and death and birth and love, tears, joy, games, all of it is on that little spot out there that you can cover with your thumb." With Triana, that same experience could be available to all of us.

My hope is that Triana will serve as a scientific resource, and as a source of new information and ideas about space and Earth. But like the pictures from Apollo 17, it can also be a metaphor for what we must seek in our own businesses, and in our own lives -- ways to shatter our preconceptions; ways to construct new paradigms; and ways to take that first, fresh look at a new idea or a new world.

Daniel Boorstin, the great former Librarian of Congress, wrote that "The most promising words ever written on the maps of human knowledge are terra incognita -- unknown territory." That is the territory you are helping us to explore, and we have already seen the fruits of your

labor. I am proud to say that you have a ready and willing partner in this administration, and that we will do everything we can to keep growth and innovation high, and productivity strong. So let us continue to blaze new paths to American competitiveness. Let us continue to search for uncharted territories -- be they near or far. In the spirit of this great institution, let us apply our hands, our minds, and our hearts to that endeavor. For that is how we will build the 21st Century and the new economy of our dreams.

Crank-Computing Update

This is to follow up on your concept for a "crank computer" or a "global information appliance" that could allow anyone anywhere on the planet to connect to the Internet from anywhere without power, a telephone line, or a keyboard. The idea takes advantage of four converging trends:

- ✓ Moore's law advances that are making computing power affordable
- ✓ new communications systems making it possible to connect to the Internet and communicate from anywhere on the globe
- ✓ new crank and other technologies that allow users to create the electricity for the device with their own hands
- ✓ new speech recognition and other technologies that help to ensure that these devices are easy to use.

Current State of Technology: In looking closely at the state of technology needed to develop an affordable global information appliance, the technological challenge is greater than it would appear at first blush. Crank technologies need to be able to deliver significantly more power, communications technologies need to be more affordable, speech recognition technologies need to be more robust.

Basic Research for Core Technologies. Fortunately, the IT² initiative that you announced will develop some of the core technologies that will be necessary to develop a truly affordable global information appliance.

The IT² initiative will help develop key self powered computing technologies including:

- **Affordability.** New high-speed wireless networks that could be more affordable than today's networks

- **Connectivity.** deeply networked systems able to communicate with more and more connected devices

- **Useability.** better speech recognition, speech translation and trans-lingual information management.

Other technologies critical to the concept that agencies are funding include:

- **Minimizing energy use.** The energy usage of every component in such a device needs to be minimized. From hard drives to communications systems, every milliamp counts.

- **Human powered energy generation.** Carbon steel spring cranks like BayGen's are just one class of human powered energy sources. Other power technologies might include using a crank technology to compress a gas, which would then be

slowly released to regenerate power: flywheel generators: chemical conversions (cranking reversible fuel cells), as well as parasitic energy generation -- which uses a persons natural movements to generate power.

Limitations of Current Technologies:

BayGen's Crank Technology Applied to Computers: BayGen has already successfully powered the Apple E-mate computer -- a limited computer often used in classrooms that uses very little power because it lacks both a hard and floppy drive. Even with this limited computer, BayGen's 3 volt crank can only provide power for 15 minutes at a time -- not long enough to be useful. BayGen's concept doesn't include the connectivity or the language interface idea which are central to your concept. BayGen's test reveals that powering a real laptop computer that has the ability to connect to the Internet from anywhere will require several times the power and thus may be unachievable using BayGen's existing carbon steel spring crank technology. Additionally, communications technology is fairly energy intensive. Increasing the energy output means increasing the spring which can increases the weight to an impracticable level using existing technology. There may be other crank technologies that BayGen or others can develop that may turn out to be lighter and more efficient in the long run than a carbon steel spring.

Affordable Connectivity. The biggest challenge in the short run may be in the costs associated with the communications technology. Connecting through Iridium at 2400 baud speed today would cost three to four dollars a minute. A company in Africa has used shortwave radio for connecting to the Internet at a cost of several dollars per page of text transmitted -- still too expensive. There may be other datacast technologies that could be very cheap, but only provide one-way data connections. As more of global satellite systems come on line in the first years of the next century -- those costs should drop dramatically and make connecting easy and affordable.

Next Steps

Laying out The Vision. In order for you to capture ownership of the crank-computing idea, we are developing an op-ed laying out your vision of extending the digital revolution to the farthest corners of the globe.

A Technology Roadmap. After the op-ed runs, NIST at Commerce will coordinate a workshop bringing together leaders from the various technology sectors required to design a global information appliance. Those sectors include: computing; global wireless technologies; self-powering technologies; and human interface technologies like voice recognition

Design Competition. Following the workshop, NIST will explore launch a design competition to develop prototypes and cost models to allow the device to be ubiquitously deployed.

Demonstration Pilot Projects. Once affordable prototypes exists, we can work with the Administration's Internet in developing countries initiative to deploy them in the field.

Your Challenge to BayGen. As a part of your visit to BayGen in South Africa, it would be a missed opportunity not to challenge them (privately) to develop a crank device that can do for Internet computing what they have already done for radio. Given the structure of the event, the fact that BayGen probably cannot create an Internet connect able crank computer on its own, and the technology challenges associated with the crank computer, it may make more sense to lay out a broader public challenge domestically. In the end, companies like BayGen, although not well suited for research and development, will be the companies that eventually make these global information appliances.

Op-ed by VP Gore

The Digital Earth:

Understanding our planet in the 21st Century

A new wave of technological innovation is allowing us to capture, store, process and display an unprecedented amount of information about our planet and a wide variety of environmental and cultural phenomena. Much of this information will be "georeferenced" - that is, it will refer to some specific place on the Earth's surface.

The hard part of taking advantage of this flood of geospatial information will be making sense of it - turning raw data in to understandable information. Today, we often find that we have more information than we know what to do with. The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire Earth's surface every two weeks, and it's been doing that for more than 20 years. In spite of the great need for that information, 95% of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data. We used to have an agricultural policy where we stored grain in Midwestern silos and let it rot while millions of people starved to death. We now have an insatiable hunger for knowledge. Yet the data sits rotting away by remaining unused.

Part of the problem has to do with the way information is displayed. Someone once said that

if we tried to describe the human brain in computer terms, it looks as if we have a low bit rate, but very high resolution. For example, researchers have long known that we have trouble remembering more than seven pieces of data in our short-term memory. That's a low bit-rate. On the other hand, we can absorb billions of bits of information instantly if they are arrayed in a recognizable pattern within which each is related to all the others -- a human face, or a galaxy of stars.

The user interfaces that we have used to interact with data, such as the desktop metaphor, may no longer be up to the challenges ahead. A "Digital Earth, " a multi-resolution, three-dimensional representation of the planet, is just what we need.

Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, at higher and higher levels of resolution, to see continents, countries, cities, and finally, individual houses, trees, and other natural and man-made objects. Having found an area the planet she is interested in exploring, she takes the equivalent of a "magic carpet ride" through a 3-D visualization of the terrain. Of course, terrain is only one of the many kinds of data she can interact with. Using the systems' voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE project. This information can be seamlessly fused with the digital map or terrain data. She can

get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare for her family's vacation to Yellowstone National Park, for example, she plans the perfect hike to see the geysers, bison, and bighorn sheep that she has just read about.

She is not limited to moving through space, but can also travel though time. After taking a virtual field-trip to Paris to visit the Louvre, she moves backwards in time to learn about French history, perusing digitized maps, newsreel footage, oral history, newspapers, and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in to the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.

Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations. Although some of the data for the Digital Earth would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a "collaboratory" -- a laboratory without walls -- for research scientists seeking to understand the complex interaction between humanity and our environment.

Technologies needed for a Digital Earth

Although this scenario may seem like science fiction, many of the technologies and capabilities that would be required to build a Digital Earth are either here or under development. Of course, the capabilities of a Digital Earth will continue to evolve over time. What we will be able to do in 2005 will look primitive compared to the Digital Earth of the year 2020. Below are just a few of the technologies that are needed:

- **Computational science**: Until the advent of computers, both experimental and theoretical ways of creating knowledge have been limited. Many of the phenomena that experimental scientists would like to study are too hard to observe - they may be too small, too far away, or occur in a billionth of a second. Pure theory, on the other hand, can not predict the outcomes of complex natural phenomena like thunderstorms or airflows over airplanes. But with high-speed computers as a new tool, we can simulate phenomena that are impossible to observe, or better understand data from observations. In this way, computational science allows us to overcome the limitations of both experimental and theoretical science. Modeling and simulation will give us new insights in to the data that we are collecting about our planet.

- **Mass storage**: The Digital Earth will require storing quadrillions of bytes of information. Already, NASA's Mission to Planet Earth program generates a terabyte of information each day. Fortunately, we are continuing to make dramatic improvements in this area.

- **Satellite imagery**: The Administration has licensed commercial satellite systems that will provide 1-meter resolution imagery beginning in late 1997. This provides a level of accuracy sufficient for detailed maps, and that was previously only available using aerial photography. This technology, originally developed for the U.S. intelligence community, is incredibly accurate. As one company put it, "It's like having a camera capable of looking from London to Paris and knowing where each object in the picture is to within the width of a car headlight."

- **Broadband networks**: The data needed for a digital globe will be maintained by thousands of different organizations, not in one monolithic database. That means that the servers that are participating in the Digital Earth will need to be connected by high-speed networks. Driven by the explosive growth of Internet traffic, telecommunications carriers are already experimenting with 10 gigabit/second networks, and terabit networking technology is one of the technical goals of the Next Generation Internet initiative. The bad news is that it will take a while before most of us have this kind of bandwidth to our home, which is why it will be necessary to have Digital Earth access points in public

places like children's museums and science museums.

- **Interoperability**: The Internet and the World Wide Web have succeeded because of the emergence of a few, simple, widely agreed upon protocols, such as the Internet Protocol. The Digital Globe will also need some level of interoperability, so that geographical information generated by one kind of application software can be read by another. The GIS industry is seeking to address many of these issues through the Open GIS Consortium.

- **Metadata**: Metadata is "data about data." For imagery or other georeferenced information to be helpful, it might be necessary to know its name, location, author or source, date, data format, resolution, etc. The Federal Geographic Data Committee is working with industry and state and local government to develop voluntary standards for metadata.

Of course, further technological progress is needed to realize the full potential of the Digital Globe, especially in areas such as automatic interpretation of imagery, the fusion of data from multiple sources, and intelligent agents that could find and link to information on the Web about a particular spot on the planet. But enough of the pieces are in place now to warrant proceeding with this exciting initiative.

Potential applications

The applications that will be possible with broad, easy to use access to global geospatial information will be limited only by our imagination. We can get a sense of the possibilities by looking at today's applications of GIS and sensor data, some of which have been driven by industry, others by leading-edge public sector users:

- **Conducting virtual diplomacy**: To support the Bosnia peace negotiations, the Pentagon developed a virtual-reality landscape that allowed the negotiators to take a simulated aerial tour of the proposed borders. At one point in the negotiations, the Serbian President agreed to a wider corridor between Sarajevo and the Muslim enclave of Gorazde, after he saw that mountains made a narrow corridor impractical.

- **Fighting crime**: The City of Salinas, California has reduced youth handgun violence by using a GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.

- **Preserving biodiversity**: Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual

rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.

- **Predicting climate change**: One of the significant unknowns in modeling climate change in the rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire are able to monitor changes in land cover and thus determine the rate and location of deforestation.

- **Increasing agricultural productivity**: Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it most. This is known as precision farming, or "farming by the inch."

The Way Forward

We have an unparalleled opportunity to turn a flood of raw data into understandable information about our society and our planet. This data will include not only high-resolution satellite imagery of the planet, digital maps, and economic, social, and demographic information. If we are successful, it will have broad societal and commercial benefits in areas such as education, decision-making for a sustainable future, land-use planning, agriculture, and crisis management. The Digital Earth project could allow us to respond to manmade or natural disasters - or to collaborate on the long-term environmental challenges we face.

A Digital Earth could provide a mechanism for users to navigate and search for geospatial information - and for producers to publish it. The Digital Earth would be composed of both the "user interface" - a browsable, 3-D version of the planet available at various levels of resolution, a rapidly growing universe of networked geospatial information, and the mechanisms for integrating and displaying information from multiple sources.

A comparison with the World Wide Web is constructive. [In fact, it might build on several key Web and Internet standards.] Like the Web, the Digital Earth would organically evolve over time, as technology improves and the information available expands. Rather than being maintained by a single organization, it would be composed of both publicly available information and commercial products and services from thousands of different organizations. Just as interoperability was key for the Web, the ability to discover and display data contained in different formats would be essential.

I believe that the way to spark the development of a Digital Earth is to sponsor a testbed, with participation from government, industry, and academia. This testbed would focus on a few applications, such as education and the environment, as well as the tough technical issues associated with interoperability, and policy issues such as privacy. As prototypes became available, it would also be possible to interact with the Digital Earth in multiple places around the country with access to high-speed networks, and get a more limited level of access over the Internet.

Clearly, the Digital Earth will not happen over night.

- In the first stage, we should focus on integrating the data from multiple sources that we already have. We should also connect our leading children's museums and science museums to high-speed networks such as the Next Generation Internet so that children can explore our planet. University researchers would be encouraged to partner with local schools and museums to enrich the Digital Earth project -- possibly by concentrating on local geospatial information.

- Next, we should endeavor to develop a digital map of the world at 1 meter resolution.

- In the long run, we should seek to put the full range of data about our planet and our history at our fingertips.

In the months ahead, I intend to challenge experts in government, industry, academia, and non-profit organizations to help develop a strategy for realizing this vision. Working together, we can solve many of the most pressing problems facing our society, inspire our children to learn more about the world around them, and accelerate the growth of a multi-billion dollar industry. To comment, or to stay informed about the progress we're making, you can check out our web site, at http://www.whitehouse.gov/earth/

NASA/WHS

Earth as photographed in 1972 by Apollo 17 astronaut Ronald E. Evans.

The World, Turning, In a Click

A1

By Kathy Sawyer
Washington Post Staff Writer

Based on a moment of midnight inspiration, Vice President Gore today will announce his plan to make a live video image of the full, sunlit Earth—spinning on its axis against the blackness of space—continuously available to the world, via television and the Internet.

The vice president's idea and, perhaps more important, his sense of urgency have triggered a scramble at NASA to make it happen inexpensively—and fast.

Gore plans to unveil the project today at MIT, in a speech to be delivered at a technology conference. He conceived the project a month ago, officials say, and he hopes to see it launched by 2000.

The "all-Earth, all-the-time" images, to be transmitted from a small spacecraft stationed between Earth and the sun, would resemble the historic portrait of the fragile and isolated blue planet snapped by Apollo 17 astronauts—the last men on the moon—on Dec. 7, 1972, a picture that has become an

See EARTH, A13, Col. 1

EARTH, From A1

icon. But the new version, capturing surface features as small as five miles square, would depict the motions of changing clouds, the advance of hurricanes, large-scale fires in oil fields or forests and other phenomena as they actually exist virtually at that same moment.

NASA Administrator Daniel S. Goldin said he hopes to keep the project's cost close to $20 million and definitely below $50 million, and will solicit commercial participation—by a cable TV company, for example—to lower the costs even further.

One earth scientist, upon hearing a description of the previously undisclosed project, said some experts may question the scientific value of the project, which has never been proposed through routine channels.

But Gore, who has a blow-up of the Apollo 17 image mounted on the wall of his office in the West Wing of the White House, said he is convinced the project will have scientific, educational and spiritual benefits.

"I believe there is tremendous scientific value in having constant live television pictures of the Earth. ... With the entire hemisphere in view, fully lit by the sun, scientists will be able to analyze weather systems and cloud patterns in ways they cannot today," he said in an interview yesterday. "With global warming a growing concern, and with problems like El Niño causing growing concern, this will be of tremendous value."

Anwar R. Ghassem, NASA's chief of earth science, and others noted that no such full-Earth images are currently available, though much of the globe can be pieced together in a mosaic from existing satellite images, and the Galileo probe took some snapshots as it rounded Earth on its way to Jupiter.

The live Earth picture would be transmitted from a 330-pound spacecraft—about five feet in diameter—stationed 1 million miles out, orbiting the sun in tandem with Earth at the point where the sun's gravity exactly counterbalances that of Earth. Positioning the craft at that point will enable it to remain constantly aimed at the hemisphere of Earth that is in full sunlight and will minimize the need for engine firings to maintain its post.

Gore said he has suggested that the spacecraft be named Triana, after Rodrigo de Triana, the lookout on Columbus's ship who first sighted the New World. The ground station network, he said, could be called Earth-Span, "with apologies to C-Span."

The spacecraft is to be equipped with an eight-inch telescope and a three-color camera capable of twice the sharpness of high-definition TV, with the image to be "refreshed" every few minutes, Goldin said. Ground stations for the satellite are to be operated by university students, in keeping with the Clinton administration's push to increase interest in science and math.

Some of those familiar with the project acknowledged that there are many "unknowns" connected with the mission and that there might be some skepticism about its value. But they pointed out that, before the first geostationary satellites were placed high above Earth, no one predicted all the uses that would be made of them.

Gore, who has made protection of the global environment one of the core commitments of his political career, said he believes the Apollo program's "blue marble" images of Earth helped trigger the environmental movement. Of the new project, he said, "I believe it will have an inspirational value that's hard to describe."

Goldin said he first learned of the planned announcement only last Friday, when Gore phoned him just as the NASA administrator was finishing a speech in Houston. And that was just weeks after Gore first presented the idea to Goldin, in mid-February. "My head is still spinning," Goldin said.

After Friday, NASA added two more people to the four full-time employees working on the plan, he said. "They are on fire," he said. The team is trying to move quickly, he added, in keeping with Gore's wishes, but also hoping to avoid a "ready, shoot, aim" problem in racing the concept to implementation. Goldin emphasized that he hopes to bring the Republican-led Congress into the planning as soon as possible, within a few weeks.

Gore almost literally dreamed up the idea in his sleep about a month ago, waking at 3 a.m. one night, according to a White House official. Later that morning, Gore did about 20 minutes' worth of research on the Internet, called Goldin, and by that afternoon had a NASA team assembled at the White House to discuss the idea and begin working out engineering concepts.

FOR MORE INFORMATION

To read about NASA's TV broadcasts on the NASA Web site, click on the above symbol on the front page of The Post's Web site at www.washingtonpost.com

The Washington Post

Friday, March 13, 1998

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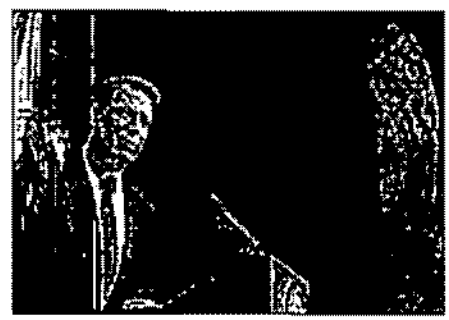
RELATED STORY
MIT Conference stresses innovation

Gore, in MIT speech, announces new satellite to broadcast images of Earth on Internet, TV

By Terence Hunt, Associated Press, 03/13/98

WASHINGTON - Under instructions from Vice President Al Gore, NASA is scrambling to put a satellite in space that for the first time would broadcast live, video pictures of the Earth 24 hours a day on the Internet and television outlets.



VP Al Gore speaks to a group of VIPs at the National Innovation Summit at MIT's Tang Center about how the government will help industry. (Globe Staff Photo / Tom Landers)

The project is expected to cost between $20 million and $50 million. Gore sees it as an invaluable resource for scientific, educational and weather research.

It would show hurricanes and other threatening weather patterns, forest fires, cloud formations and other phenomena in real time, officials said Thursday.

The vice president announced the program this morning at a technology conference at the Massachusetts Institute of Technology in Cambridge, Mass.

"As we connect all our classrooms to the Internet, we have the opportunity to bring new education and potential scientific projects as well as global weather observations to millions of American classrooms and living rooms via television and computer," Gore said in an hour-long speech before an audience of academics, industry leaders and politicians.

The program would advance Gore's reputation as a computer buff and environmentalist as the 2000 presidential race nears. Gore hopes to have the satellite in space within two years.

From a stationary orbit 1 million miles away in space, the satellite's high-definition, color camera would provide the first-ever continuous pictures of a sunlit Earth against the blackness of space.

pictures of a sunlit Earth against the blackness of space.

"This is the vice president's brainchild and he's very excited about it," said Gore's communications director, Lawrence Haas, interviewed from San Jose, Calif., on a trip with the vice president.

"He's extremely enthused about the educational and environmental value of this wonderful initiative," Haas said. "He envisions that within a couple of years, every child in America may be able to view a live image of the Earth by turning on their television set or hooking onto the Internet."

Gore believes that the project "will have the same impact that the first images of Earth that came back from Apollo 8 had in shaping peoples' understanding that we all share a very fragile Earth and that we need to care for it."

The video pictures would be put on the Internet and made available to television outlets for broadcast. The satellite's position would keep it constantly aimed at the hemisphere of the Earth that is in full sunlight against the blackness of space.

Congress would have to approve money for the project, officials said, and Gore was expected to open consultations with lawmakers.

There are no full-Earth images currently available, though existing satellites track regions of the world.

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THE WHITE HOUSE

Office of the Vice President

FOR IMMEDIATE RELEASE:
Friday, March 13, 1998

Contact:
(202) 456-7035

VICE PRESIDENT GORE CHALLENGES NASA TO BUILD A NEW SATELLITE TO PROVIDE LIVE IMAGES OF EARTH FROM OUTER SPACE

Washington, DC-- Vice President Gore proposed today that NASA scientists and engineers design, build and operate a satellite that will make available a live image of earth 24 hours a day on the Internet.

In a speech at the National Innovation Summit at MIT, the Vice President proposed that NASA launch a new micro satellite that will provide live images of the earth from space by the year 2000. This satellite will depict the motions of changing clouds, the advance of hurricanes, large-scale fires in oil fields or forests and other phenomena at the precise moment they occur.

"This new satellite, called Triana, will allow people around the globe to gaze at our planet as it travels in its orbit around the sun for the first time in history," Vice President Gore said. "With the next millennium just around the corner, developing this High Definition TV quality image of the full disk of the continuously lit Earth and making it available 24 hours a day on the Internet will awaken a new generation to the environment and educate millions of children around the globe."

This new space craft will be carried into low earth orbit where a small motor will place it in orbit 1 million miles from earth at the L1 point (short for the Lagrangian libration point), the point between the earth and sun where gravitational attractions are balanced. The satellite will carry a small telescope and camera to provide these new compelling images.

In the history of space exploration there are only a few photographs of the full earth that have resonated with the public. Christmas 1968 was an epiphany for many Americans, when they first saw the image "Earth Rising." It is considered one of the fundamentally profound images of this century. Another photograph, "The Blue Marble" taken in 1972 during Apollo 17, began an era of global awareness.

"These images of the earth moved thousands of Americans and encouraged them to become active stakeholders in our planet's well-being," Vice President Gore said. "As we connect all our classrooms to the Internet, we have the opportunity to bring new education and potential scientific projects as well as global weather observations to millions of American classrooms and living rooms via television and computer."

Gore Proposes Video Channel To Show Earth, All the Time

By KATHARINE Q. SEELYE

WASHINGTON, March 13 — The idea hit Al Gore one night at 3 A.M., and he sat bolt upright in bed: Let's send a satellite into space that would beam back sun-washed images of the whole Earth — something more majestic than the tight shots seen on the Weather Channel, something that would show storm systems and forest fires and cloud formations in real time, a channel devoted to all Earth, all the time.

Later that morning, the Vice President jumped on the Internet, made some calculations and called his friends at the National Aeronautics and Space Administration. NASA scientists started designing the system. And today in a speech at the Massachusetts Institute of Technology, Mr. Gore shared his dream.

"As Socrates said 2,500 years ago, 'Man must rise above the earth to the top of the atmosphere and beyond, for only thus will he understand the earth in which he lives,'" he said.

The high-definition video pictures would show the portion of Earth that is always drenched in sunlight, from the North Pole to the South, against the black backdrop of outer space. The Vice President hopes the images, which would be available by 2000 on television and the Internet, would increase earthlings' appreciation for the fragility of the planet and their place in the universe.

Skeptics said the project would be useless and seemed designed mainly to increase voters' appreciation for Mr. Gore's Presidential aspirations — a sort of all-Gore, all-the-time bulletin board. They also said there was almost no chance that the Republican-controlled Congress would approve the $20 million to $50 million that the project would cost.

"When you're running for office, you need to attract attention to yourself," said Representative Dana Rohrabacher, the California Republican who is chairman of the Space and Aeronautics subcommittee.

Mr. Rohrabacher said the project had virtually no chance in Congress, but he predicted that private companies would finance it.

He added that the Clinton Administration had its priorities backward by pushing a project like this, which he said was of dubious scientific value, and vetoing an asteroid-detection program, even as asteroids hurtle toward Earth.

Rich Galen, executive director of Gopac, the Republican political action committee, branded Mr. Gore's proposal "ridiculous," adding, "I cannot imagine that Congress will appropriate $20 million for a satellite that in essence allows people to sit in front of the TV set and think about nothing."

Nonetheless, Daniel S. Goldin, the NASA Administrator, said he was optimistic that Congress would approve the money. He said the space agency would meet with environmental and scientific groups to "shape this program for maximum impact for the American people."

Mr. Goldin said its value would come in providing a unique view of Earth. Weather satellites show only part of Earth, and those images have to be stitched together to show whole regions and even then do not show the North and South poles, he said.

Responding to suggestions that the project was a boondoggle to boost Mr. Gore's Presidential bid, Mr. Goldin said: "This program is about education. America came in No. 21 in math and science scores worldwide. I'm very confident we're doing the right thing."

More national news appears on page A32.

The New York Times

SATURDAY, MARCH 14, 1998

House Republic[illegible] Gore: No Room for This View

WPOST 5/11/2000

[illegible]LIE EILPERIN
[illegible]ington Post Staff Writer

[illegible] Gore's plan to beam images of Earth [illegible] the Internet 24 hours a day could [illegible]me one of the early casualties of this [illegible]idential campaign.

[illegible]publicans have deleted funding for the [illegible]oal, as part of a $41 billion NASA [illegible]ing bill going to the House floor today. [illegible]y Democrats have accused the GOP of [illegible]ing the provision only out of a desire to [illegible]ass the vice president, the leading [illegible]date for the Democratic presidential [illegible]ination next year. [illegible] bring this up just out of partisan [illegible]or, I'm afraid, is going to sink a good [illegible]ere trying to put together," said Rep. [illegible] Gordon (Tenn.), the top Democrat on [illegible]ence Committee's space and aeronautics [illegible]ubcommittee and the [illegible] in the House. "For anyone who thinks any [illegible]idential votes are going to hinge on this [illegible]dicrous, and it's going to be launched [illegible] the presidential race."

[illegible]t Republicans said it was Democrats [illegible] were politicizing the issue by pushing [illegible] wasteful spending project that some in [illegible]GOP characterized as "crazy." House [illegible]rity Leader Richard K. Armey (R-Tex.) [illegible] reporters yesterday, "The partisan reac[illegible] was on the part of the Democrats."

[illegible]ll, the dispute offers an early preview of [illegible] the 2000 presidential race is likely to [illegible] legislative maneuvering in the months [illegible]me. House Republicans, including Ar[illegible] are already monitoring potential mis[illegible] by the vice president and have escalat[illegible]eir attacks on Gore over such issues as [illegible]

[illegible] Washington Post
Vice President Gore wants space agency to beam images of Earth over the Internet 24 hours a day from a satellite named Triana.

the Year 2000 computer bug.

Gore has said the idea for the Internet project came to him in the middle of the night last March. Under the plan, a spacecraft dubbed Triana—after the lookout on Columbus's ship who first spotted the New World—would transmit pictures from orbit, offering scientists images of changing clouds, large-scale fires, and other natural phenomena. Gore said the project would help scientists analyze weather systems and cloud patterns in ways they can't today.

NASA administrator Daniel S. Goldin estimated last year that the project would cost between $20 million and $50 million but that price tag has risen to $75 million, excluding the $100 million launch cost for the satellite. The satellite is set to be launched in December 2000 and, even if Congress stopped funding for the program now, according to congressional estimates, the federal government would have spent nearly $41 million on it by the end of the year.

Problems with the bill arose last Thursday when GOP Reps. George Nethercutt (Wash.) and Dave Weldon (Fla.) offered an amendment in the Science Committee to transfer $32.6 million for Triana to life and microgravity research.

The amendment passed on a party-line vote, 21 to 18, and Gordon warned darkly that he had spoken the day before with Goldin, who he said was considering recommending that President Clinton veto the bill if Triana is axed.

In the final committee vote on the overall bill, only five Democrats joined the Republicans in supporting the authorization for NASA. Democrats said yesterday the bill is likely to pass the House, but then they would work to restore the Internet-Earth-view provision during negotiations with the Senate.

"What the Republicans are doing is putting politics above leadership, partisanship over progress, and now Campaign 2000 is even trumping science," said Gore spokesman Chris Lehane. "They're quickly devolving into the party of troglodytes."

But Weldon said he considers the program "an abuse of power," because NASA found money for Gore's initiative after laying off 600 employees in late 1997. "For Congress to sit back and do nothing is an insult to the people who go, rank-and-file in my district," Weldon said.

House Majority Whip Tom DeLay (R-Tex.) managed to eliminate funding for the project in Weldon's appropriations bill. But Sen. Barbara A. Mikulski (D-Md.), whose state houses one of the centers conducting research on it, successfully led the fight to restore the money. DeLay [illegible] the idea of pictures of Earth [illegible] "[illegible] the Earth often do the Weather Channel [illegible] through. We go to bed [illegible] on TV and [illegible] from space [illegible] would [illegible] for a satellite [illegible] frequently [illegible] have them," he said. "I am [illegible] need a second shot."

ON THE NET

Republican presidential candidate Lamar Alexander is scheduled to answer reader questions live Wednesday at 11 a.m. on The Post's Website.

On washingtonpost.com: [illegible] on Politics.

House Republicans kill Gore's dream Earth-view plan

ASSOCIATED PRESS

House Republicans yesterday killed an Internet Earth-viewing project initiated by Vice President Al Gore — an idea he came up with after awaking in the middle of the night last year.

The chairman of the House Science Committee, Rep. F. James Sensenbrenner Jr., Wisconsin Republican, said it was "more important to spend $32 million on medical research than on funding the vice president's late-night inspiration for a multimillion-dollar screen-saver called Triana."

The House Science Committee, on a party-line 21-18 vote, decided yesterday to eliminate funding and close down the program. The full House voted 259-168 to pull the project from the larger bill.

One-quarter of House Democrats — 53 — opposed Mr. Gore's pet project in the vote.

Mr. Gore last year initiated the idea of putting a satellite in orbit that would provide 24-hour views of the Earth for TV viewers and Internet users, despite the fact that cable television provides two channels to view the Earth and the Internet has at least four such sites.

He said the idea hit him one night last year at 3 a.m., prompting him to sit bolt upright in bed. Mr. Gore envisioned a satellite beaming back real-time images of the whole Earth — something more breathtaking than the tight shots seen on the Weather Channel.

Later that morning, he logged on to the Internet, made some calculations and called his friends at NASA, who agreed the project had scientific and educational value. The space agency wants to launch the Triana spacecraft in December next year.

But Rep. Dave Weldon, Florida Republican, who initiated the move to kill the project, said yesterday he considered it an "insult" that NASA was laying off 600 workers at Kennedy Space Center at the same time it was "finding tens of millions of dollars to fulfill a vision for the vice president."

House Majority Leader Dick Armey argued that four Web sites already allow browsers to view up-to-date pictures of the Earth from outer space:

- www.fourmilab.ch/earthview
- www.webstorekeeper.com/mediastorm/vrml.htm
- www.terraserver.microsoft.com
- www.weather.com

Democrats, however, charged that the elimination of funds to continue Mr. Gore's Triana project was an attempt to embarrass the party's 2000 presidential frontrunner.

Republicans are "Luddites" who are politicizing science, said Gore spokesman Chris Lehane, referring to the 19th century workers who smashed newfangled machines in a vain effort to hold onto their jobs.

"We are going to need a safety lock on the GOP to help protect the American people from such blatant partisanship," Mr. Lehane said.

Rep. Bart Gordon of Tennessee, ranking Democrat on the space subcommittee, said the move was "totally parochial, totally partisan." He said NASA has already spent $40 million on the $75 million project and it would cost more to cancel it than to save it.

"We hope they will change their mind," said Dave Steitz, spokesman for NASA. "We would like them to base their decision on the science of the mission."

White House aides said NASA Administrator Daniel Goldin might recommend a presidential veto of the bill, which also funds the space station and the space shuttle over the next three years, if the Triana money is not restored.

Several Democrats said they would reluctantly vote to kill the project, but hoped the Senate would restore the money for the project, which is named for the sailor who first spotted the New World on the journey with Christopher Columbus.

The three-year, $42 billion NASA bill also provides $7 billion for the U.S. portion of the international space station, $7.8 billion for space shuttle operations and $4.2 billion for earth science programs.

Meanwhile, the House defeated, 313-117, an amendment that would have ended Russian participation in the space station. Under the proposal by Rep. Tim Roemer, Indiana Democrat, Russia could contract for future space station work but would no longer be a partner in the 16-nation project.

The Washington Times
THURSDAY, MAY 20, 1999

The New York Times

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March 9, 2000

Science Panel Supports Gore Satellite Plan

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- Politics Keep an Earth-Viewing Satellite Earthbound (June 1, 1999)
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Forum

- Join a Discussion on Space Exploration

By WARREN E. LEARY

WASHINGTON, March 8 -- A satellite project initially proposed by Vice President Al Gore and opposed by Congressional Republicans appears to have scientific merit to justify it, a National Academy of Sciences task force said today.

The project, which would deploy a satellite called Triana in a high orbit to observe the entire Earth, could make contributions to Earth and solar science at a relatively reasonable cost, said a panel of experts assembled by the academy's National Research Council.

NASA

For more information visit The Solar System: Earth

In a report requested last summer by Congress, the eight-member panel said the scientific objectives of the $70 million project "are consonant with published science strategies and priorities for collection of climate data sets and the need for development of new technologies."

In a cover letter to the report, the panel, whose chairman was Dr. James J. Duderstadt of the University of Michigan, said it did not have the time and expertise to conduct a full cost-benefit analysis.But it said: "The task group found that the cost of Triana is not out of line for a relatively small mission that explores a new Earth observing perspective and provides unique data."

The Triana project sprang from a 1998 idea of Mr. Gore to have NASA fly an inexpensive spacecraft that would make continuous, live pictures of the full, sunlit Earth from far out in space, something that cannot currently be done. Mr. Gore said such views, constantly

CURI HEAD from Sa McCain succes Democr distress
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made available to the world on the Internet and on television, would encourage environmental consciousness and educational programs.

After initial studies that resulted in adding instruments to the satellite and expanding its scientific mission, NASA found $30 million to start the program. But critics, including Republican politicians and some scientists, immediately questioned the value of the project, sometimes derisively called Goreeam or Goresat.

In addition to continuously monitoring Earth in one view and the amount of energy it gets from the sun and reflects into space, Triana would also have instruments to measure ozone, cloud height and the amounts of aerosols suspended in the air, from a vantage point one million miles away.

Last May, the Republican-controlled House approved a three-year NASA financing bill that eliminated Triana's financing. A House-Senate conference committee later agreed to suspend spending and delay the satellite's launching to early 2001 from December while the panel from the independent science academy studied it.

Dr. Neal Lane, the White House science adviser, today praised the academy's report in a statement, saying it showed that Triana could produce technologically sound results at a reasonable cost.

"Triana is worthy of bipartisan Congressional support and should not be kept earthbound," Dr. Lane said, "Instead, it should fly as scheduled next year."

A staff member with the House Science Committee, which voted last year along party lines not to finance the program, said Congressional opponents would have to study the new report before commenting.

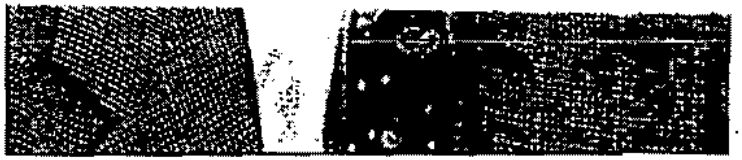
"There are still questions as to whether this is the best use of space research dollars, particularly when there are other worthy areas of research that are not being adequately funded," said the staff member, who spoke on condition of anonymity.

The Galileo system, totaling 25 to 30 satellites in medium-Earth orbit, and perhaps three more in higher geostationary orbit, is scheduled to receive formal approval by ESA and the executive commission of the European Union in December. It is slated to be fully operational in 2008.

The costs of building and deploying the system will not be known until February 2001, when the industrial consortia now designing it are scheduled to present a detailed cost proposal. But ESA and the European Commission have estimat-

"The governments realize that there is a public-service aspect to this that has no revenue stream," this official said. "And the portion of the service that will generate revenues will not do so in any substantial way before, say, 2010. At that point, when the revenue picture is clearer, we can invest."

Mastracci said Europe's current system designed to boost the reliability and accuracy of U.S. Global Positioning System (GPS) satellite navigation signals should provide an early confirmation that Galileo can



SPACE NEWS PHOTO BY AFP

generate enough sales to offset its operating and maintenance costs.

The GPS augmentation system, called European Geostationary Navigation Overlay Service, is expected to enter service in 2003 using communications satellites equipped with a small navigation package to verify GPS accuracy through a network of ground facilities. European governments, led by ESA, have invested 190 million euros in this service.

ESA and the commission have agreed to invest a combined 80 million euros in the current Galileo study phase, which ends early in 2001. They have also agreed to invest a combined 1 billion euros in the system once the basic design parameters and

See GALILEO, Page 20

Satellite Delays Push Triana Launch to 2002

NASA Blames Stand Down Ordered by Congress

By BRIAN BERGER
Space News Staff Writer

WASHINGTON — NASA will likely have to wait until at least 2002 to launch its Triana satellite, a pet project of U.S. Vice President Al Gore.

Space shuttle program managers removed Triana from its mission manifest after the U.S. space agency's Earth science officials reported that the satellite would not be finished in time for a scheduled launch of the shuttle Columbia in June 2001.

NASA officials attribute the delay in the Triana program to a five-month stand down ordered by the U.S. Congress in October to give the National Academy of Sciences time to review the scientific merits of the $75 million-plus Earth-observing satellite.

The Academy concluded in March that Triana will produce "relevant and useful" scientific data, but recommended NASA spend more time testing the satellite prior to launch.

The five-month stand down combined with the time it will take to implement the Academy's recommendations have put Triana about 10 months behind schedule, said David Steitz, a spokesman for NASA's Earth science programs. Work on Triana should wrap up by the end of October 2001, he said.

Steitz said NASA is anticipating the cost of the Triana mission to grow, but could not say by how much.

"We do expect the stand down and incorporation of the Academy recommendations to increase [the] cost of the mission. That cost increase is being worked by our budget people as we speak. I can't give you a firm number as of this date," Steitz said April 17.

The Triana mission has been under fire from Congressional Republicans since Gore first proposed in 1998 placing a NASA-funded satellite 1.5 million kilometers in space to send back nearly continuous television-quality video of Earth's surface. Although criticized for its perceived lack of scientific merit and White House origins, the Triana program has survived several attempts in Congress to eliminate its funding.

Last October, members of Congress hostile to the program enacted legislation requiring NASA to stop work on Triana until the National Academy of Sciences completed a review of the scientific merits of the program.

Work on Triana resumed in March after the Academy reported to Congress that NASA had crafted a credible science program around Gore's vision.

Triana was slated to fly on Columbia's next mission, a research flight dubbed STS-107.

But Steitz said Triana will not be ready in time to make Columbia's June 2001 launch date.

A microgravity science payload called Freestar has been picked to fly next summer instead, sharing Columbia's cargo bay with a SpaceHab Double Research Module.

By giving up its spot on STS-107, Triana may have to wait until 2002 for a shuttle ride, said James Hartsfield, a spokesman for NASA's Johnson Space Center, Houston, which manages the agency's space shuttle program.

With NASA's other three shuttle orbiters tied up with international space station assembly, the agency intends to rely on the heavier Columbia orbiter for research flights, satellite servicing missions and the occasional deployment of payloads such as Triana.

Columbia's next flight after STS-107 is a Hubble Space Telescope servicing mission currently slated for November 2001, Hartsfield said.

The first opportunity to launch Triana is in April 2002, when Columbia is slated for another research flight, he said.

Steitz said NASA has no plans to launch Triana on an expendable rocket because the program is not budgeted for such an expense.

Corrections

The article "US, Russian Officials Meet About Latest Proton Malfunction" [July 17, page 6] should have said that two Proton launch vehicle failures delayed the launch of the Zvezda service module for the international space station.

* * *

The brief "EuropeStar Fills Slot With Rented Satellite" [July 10, page 2] should have said that EuropeStar rented an orbiting satellite and moved it to EuropeStar's 45 degree east longitude position.

* * *

The Space Log article "Emergent Modifying PanAmSat Corp. Software" [July 24, page 20] should have identified Chuck DeVore as Emergent's vice president of communications.

THE SAN DIEGO UNION-TRIBUNE ■ SATURDAY, AUGUST 21, 1999 B-14

The San Diego
Union-Tribune.

AUG 23 1999

Consider the merits

Congress should fund Triana satellite project

When Congress reconvenes after Labor Day, the House-Senate conference committee that will refine a $41 billion spending measure should be able to find $35 million to continue funding for the important Triana satellite project.

This scientifically promising endeavor, being developed by UCSD's Scripps Institution of Oceanography, would monitor the Earth's climate from deep space.

From its strategic vantage point between the Earth and the sun, Triana would measure the effects of global warming. It would also help ascertain with "an unprecedented degree of accuracy" how much of the sun's energy is reflected from Earth and how much is being absorbed throughout the planet.

So says Francisco Valero, chief scientist on the Triana project, who is understandably alarmed by the efforts of some on Capitol Hill to pull the plug on this operation. Critics claim the money would be better spent on other scientific programs.

Never mind that Triana is within 16 months of being fully operational. Or that scrapping it at this critical juncture would amount to flushing $40 million down the porcelain fixture, with nothing to show for the efforts to design, build and equip the sophisticated spacecraft.

NASA Administrator Daniel Goldin has urged President Clinton to veto the entire appropriations bill unless it includes full funding for Triana. It won't come to that if Republican and Democratic conferees simply consider the project's many scientific merits. If they do, we are confident they will find the $35 million needed to ensure Triana's completion.

Albany Times-Union
Sept. 1, 1999

Investing in Triana only helps Earth

By A. THOMAS YOUNG

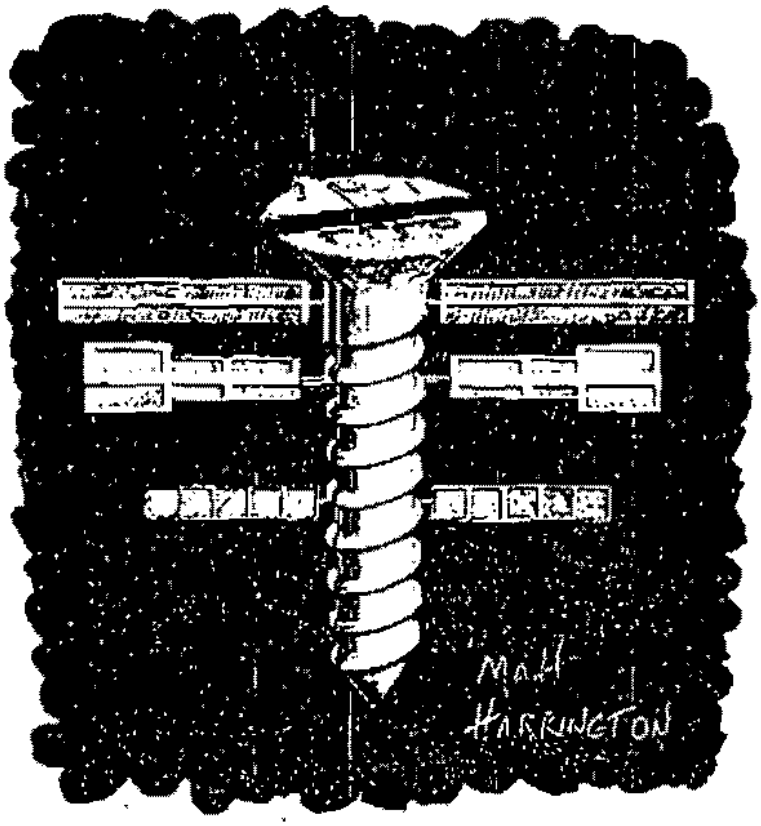
BETHESDA, Md. — Having worked closely with the space program as mission director of the 1976 *Viking* mission to Mars, it is disturbing to me that Congress is considering massive cuts to several of NASA's important space and science projects.

Americans have supported space research because of its exciting potential to improve our understanding of Earth and to inspire the minds of young people. Without the support of NASA projects, we cannot tap into the significant benefits of space research, which are critical to expanding our knowledge. NASA's observations of the Earth are the basis for a worldwide effort to study interactions among the oceans, atmosphere and land. The Triana mission, a scientifically sound project, is included in the proposed NASA budget cuts. That is a shame.

Triana would give us a full, continuous view of the Earth that would enhance our understanding of climate systems and the implications of solar radiation on weather patterns. Triana could provide a window on mankind's future, helping us learn more about climate systems and how they change over time.

The Triana mission, led by researchers at the Scripps Institute of Oceanography at the University of California at San Diego, would improve our understanding of the earth's radiation balance, the primary driver of our climate system.

Additional basic research would investigate changes in the ozone layer and atmospheric circulation and winds. Triana's remote sensing also would measure vegetation health and coverage, ultraviolet radiation levels, solar winds and provide timely analysis of solar activity that can disrupt telecommunications.



NASA's Goddard Space Flight Center, where I served as director, is enhancing the scientific value of the Triana mission by playing a key role in spacecraft development.

From its vantage point 1 million miles from Earth, located where the gravitational pulls of the sun and Earth are equal, Triana would turn its telescopes and instruments to view our world. And what a view it would be. By providing near real-time views of the sunlit Earth, Triana would gather fundamental scientific data impossible to obtain any other way, thus enhancing the field of education by stimulating a sense of awe and encouraging discovery.

As students study weather and climate, Triana would be feeding continuously updated pictures into classrooms, illustrating how these processes are developing around us. As students learn about geography and social sciences, Triana would be there with an ever-changing view of our dynamic world, providing not just static displays of continents and political borders but also the visual excitement needed to maintain student interest.

Mathematics, computer science, perhaps even art classes would be influenced and helped by the power of the whole Earth image. While helping scientists unravel the mysteries of the Earth's climate system, Triana would play a key role in shaping the next generation of scientists, through inspiring voyages of discovery in the classroom.

We have only one Earth, one planet to call home. Investing in projects such as Triana, which help us better understand our planet and ourselves, is critical for the development of the human race.

NASA must have bipartisan support in Congress to move forward with Triana and other important missions. As Congress considers the NASA appropriations this summer, the remaining funds for Triana should be viewed as an investment in sound science — and our future.

Abandoning valuable research will only close critical windows of discovery — portals to a better future we all want for the generations to come.

A. Thomas Young is the former president and chief operating officer of Martin Marietta Corp. in Bethesda, Md.

LOS ANGELES DAILY NEWS
Aug 31, 1999

Space missions vital to understanding home planet

By A. Thomas Young

BETHESDA, Md.

HAVING worked closely with the space program as mission director of the 1976 Viking mission to Mars, I find it disturbing that Congress is considering massive cuts to several of National Aeronautics and Space Administration's (NASA) important projects.

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A. Thomas Young is the former president and chief operating officer of Martin Marietta Corp. in Bethesda, Md. Write him at Scripps Institution of Oceanography at the University of California, San Diego, 9500 Gilman Drive, University Box No. 0233, La Jolla, CA 92093-0233. Or e-mail him at sioconm@sio.ucsd.edu.

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Outlook

Cutting NASA budget would dim our view of world

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Admiral Owens Op-ed
Satellite/Business
8/23/99

The looming Congressional cuts to NASA's overall budget severely threaten several earth science projects aimed at gaining a deeper understanding of our environment. The Triana satellite mission is one key program at risk. With new solar and climate data, Triana will help protect international investments in telecommunications satellite systems.

Triana is a critical opportunity that should not be missed. As we enter the next millennium, international business and commerce is becoming increasingly dependent on satellite networks to link global communications systems. Companies such as Teledesic are investing in this future with new satellite networks that will be capable of meeting growing demands for new and faster communications and data services. Teledesic is building a global, broadband Internet-in-the-Sky satellite communications network. Using a constellation of low-Earth-orbit satellites, Teledesic and its international partners are creating the world's first network to provide affordable, worldwide, "fiber-like" access to telecommunications services such as computer networking, broadband Internet access, high-quality voice and other digital data needs. The U.S. companies that are investing billions of dollars in satellites are vitally aware that satellites may be affected by a particular kind of "weather" - sudden solar storms in which the sun sprays out particles that can cause power surges and short-circuit a satellite's electronics.

The Defense Department has estimated that space weather disruptions to government satellites cost taxpayers about $100 million a year, and in 1991, during one particularly bad period, government satellites suffered more than 300 solar disruptions. With appropriate warnings of solar events, satellites can be powered down, and other steps could have been taken to minimize the damage from power surges induced by space weather.

In 1997, NASA launched ACE, a research satellite positioned at the "L-1" point between the sun and Earth. It has been a major success, allowing NOAA, the government agency responsible for space weather forecasting, to provide reliable alerts and warnings one hour in advance of approaching large solar storms. ACE, however, is a one-time research vehicle and is currently entering into the last year of its original design lifetime.

With its sun-viewing instrument to measure the solar wind (Faraday cup) and a magnetometer, Triana has the two key instruments needed by NOAA to continue the advanced warning service. The launch of Triana is projected to occur just

after the end of the design life of ACE and several years before any other system can be launched, thus Triana represents the only near-term follow-on to ACE.

Teledesic will also benefit from the data gathered by Triana's Earth-looking instruments. Understanding environmental conditions in this part of the atmosphere will be a key to the success of this effort to improve and expand our communications network. Triana's ability to monitor ozone will enable us to trace high altitude winds by the circulation patterns they generate in the ozone field. For the first time, researchers will be able to directly study important features of atmospheric circulation. Unlike the perspective from geostationary satellites, Triana will gather images of these dynamic regions every few minutes and provide frequent, high-resolution measurements that are unprecedented in atmospheric circulation research.

Opponents of Triana have argued that the program should be terminated because it lacks valuable science. This is simply not true.

I urge Congress to recognize the opportunity offered by Triana and to provide funds to launch the mission. Not only will Triana help protect investments in satellite communications; it will also lead to important advancements in our understanding of Earth's climate system.

###

Admiral William A. Owens is the Co-Chief Executive Officer and Vice Chairman Teledesic LLC.

Interview with Kathy Sawyer

West Wing Office
12:55 - 1:15 pm, Monday March 9th, 1998

Meeting requested by You
Briefing prepared by Jim Kohlenberger

EVENT

This is an embargoed one-on-one interview with Kathy Sawyer of the Washington Post regarding your announcement later in the week about a new effort to give the world its first live view of the earth from space. There will be a short briefing in your office prior to the Interview. Below are a few extra details about the actual spacecraft, the picture on your wall, how images of the earth have affected us in the past, and the conference where you will announce it.

The Spacecraft

NASA will launch a new microsatellite that will, by the year 2000, provide live images of the earth from space. This new space craft will be carried into low earth orbit where a small motor will place it in orbit 1 million miles from earth at the L1 point (short for the Lagrangian libration point), the point between the earth and sun where gravitational attractions are balanced. The satellite will carry a small telescope and camera to provide new images. Although you shouldn't give Kathy a cost figure and NASA is still working to bring costs down even more, the initiative should cost less than $30 million.

-- **The Image of Earth** -- The image will be available to anyone anywhere over the Internet 24 hours a day and will be made available to television broadcasters. It will show that portion of the earth that is lit by the sun at that moment in time. The resolution of the image will be of HDTV quality and roughly on par with the image in your office. The data will be received and processed at three university operated ground stations. The pictures will be distributed to the world via an Internet web site, designed and maintained by students.

-- **Other Scientific Objectives for the Craft** -- The spacecraft will have other scientific objectives as well. For instance it could be used for global weather monitoring.

The Image on your Wall

The Picture on your wall is an important example of how an image of earth can change the way we view ourselves. That picture shows the Earth as seen from the Apollo 17 crew en route to the moon on December 7, 1972 on our last expedition to the moon. The spaceship was aligned with the earth and the sun providing the astronauts with a view of the full hemisphere from a distance of about 40,000 km from earth. Because the mission took place during our northern hemisphere winter, the southern hemisphere and Antarctica are in full sunlight.

Impact of Earth Images

More important than a single photo is the reaction that images generate on earth. The timing of the Apollo 17 photograph, for instance, coincided with a public concern over industrial pollution, calls for protection of endangered species and new laws to protect natural habitats. The first Earth Day was organized in 1970, soon after the first picture of Earth from a lunar distance was taken by Frank Borman aboard Apollo 8 in 1968, and the Apollo 11 crew took an image of Africa and Europe (although it wasn't a full disk.) Soon the term "Blue Marble" was used to describe the Earth. Some have said that when we first saw the Earth from space it was like a child looking into the mirror for the first time. It allowed us to reflect on who we were. The changing of centuries provides an opportune point in time to reflect upon who we are.

Archibald MacLeish summed it all up in a poem he wrote just after man's first journey to the moon -- "Apollo 8"

> *"To see the Earth as it truly is, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the Earth together, brothers on that bright loveliness in the eternal cold -- brothers who know now that they are truly brothers."*

Rusty Schweickart, an Apollo 9 astronaut, described the feeling of looking homeward while orbiting the moon:

> *"You realize that on that small spot, that little blue and white thing is everything that matters to you. All of history and music, and poetry and art and war and death and birth and love, tears, joy, games, all of it is on that little spot out there that you can cover with your thumb."*

The National Innovation Summit. You will be making this new announcement at the National Innovation Summit of Friday at MIT. The conference is cosponsored by MIT and the Competitiveness Council and will focus on the importance of innovation and the challenges we face in unleashing its potential. NASA will have a high resolution movie that we will give to reporters that demonstrates how the spacecraft will work by showing its launch and ascent to the L1 point, the spacecraft as it unfolds, and the earth as it will look from the L1 point.

LOGISTICS (As of this writing, subject to change)

- Jim Kohlenberger, Don Gips, and Larry Haas will brief you prior to the Interview.
- Kathy will be escorted into your office for the interview.

ATTACHMENTS

- Fact sheet from NASA will be provided in the briefing.

DRAFT (3/9/98)
Mission Proposal

Instrument 20 Kg

14 cm (6 inch) diameter telescope, with a 0.7° field of view

Three color camera, with 2K x 2K array (i.e. twice HDTV resolution), 8 bit color resolution

Spacecraft 90Kg

Star tracker (2-3 arc sec stability over 5 sec period)

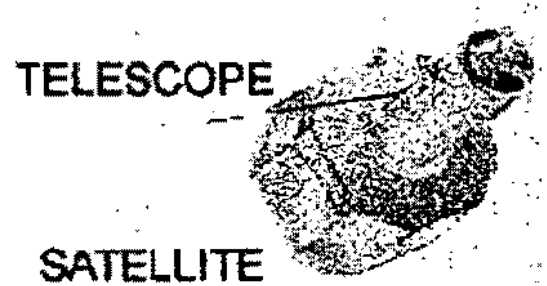
X band, 30 cm antenna, with 14Kbps data rate

Hydrazine system for stationkeeping

Star 27 Thiokol kick motor

Startup battery, solar array

On orbit power 111 W (peak power), operate at 0°

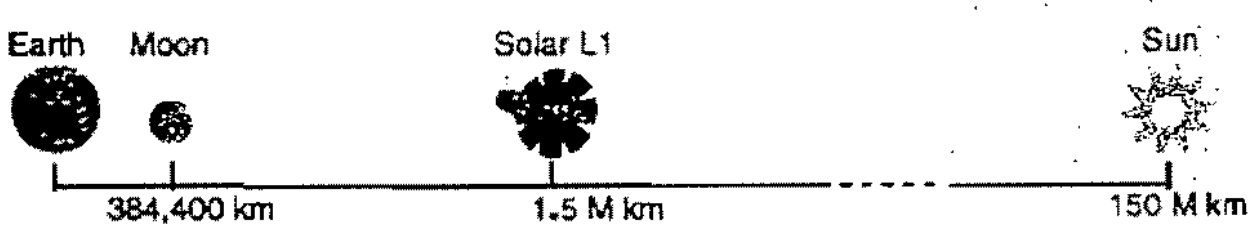


Ground Operations

3 ground stations (continuous coverage) 3- 5 meter antenna

Routine post launch operations, telemetry gathering and housekeeping

Commercial computer system for data processing and distribution



March 18, 1998

MEMORANDUM FOR RON KLAIN
PAT EWING

FROM: JIM KOHLENBERGER

SUBJECT: BUILDING PUBLIC SUPPORT FOR TRIANA

Below are some initial thoughts about what we can be doing to build broader support for the Vice President's Triana Satellite initiative. The criticism that has come generally takes one of three themes: 1) the scientific justification, 2) the cost, or 3) the Vice President's ownership of the idea and the way he came up with the idea. We can move on these issues respectively by 1) building a stronger justification for the effort, 2) looking for opportunities for lowering its costs, and 3) reaching out to opinion leaders, and building better support within Congress, the environmental, educational and scientific communities.

OPINION LEADERS

There are several important opinion leaders that we need to involve to help sell the effort. They include:

✓ **The Astronaut Corps** -- Each Astronaut who has been in space who has his/her own personal perceptions about what seeing the whole earth meant to them. This is a group of opinion leaders who believe in this worldview and who regularly speak across the country. We can work with NASA to make this a part of their message.

✓ **John Glenn** -- As the most famous of the Astronaut Corps and the first American to see the Earth from space, John Glenn could be a helpful ally and spokesperson. The Vice President could call Glenn and ask for his help in selling the program.

✓ **Tom Hanks** -- Tom Hanks, who is soon releasing a new HBO special on the Apollo moon effort, is now one of the biggest space boosters in the country. Tom Hanks, whose special recently previewed in the White House, has been helpful in the past and could be again.

✓ **Bill Nye the Science Guy** -- Bill Nye the Science Guy could be important to telling why such a picture is important in science education. He has been helpful to us on several occasions in the past.

CONGRESS

Hearings. The House Space Subcommittee (Sensenbrenner/Rohrbacher) had started putting together a hearing on "GoreSat" for next Thursday where they would invite the Vice President or a staff person from his office involved in the process to testify. Although we were able to work through NASA to get the hearing postponed, we can expect it in the future. They are primarily interested in the process of how the idea became a reality.

Hill Briefings. NASA will do briefings on the hill this Friday, laying out details, timing, why they are enthusiastic about it, and why this fits exactly with NASA's mission.

The Lott letter. Although we don't have the Lott letter (its on his desk), Lott's staff is still enthusiastic about the project and about the prospects for a letter. I think the prospects are dim.

THE ENVIRONMENTAL COMMUNITY

The Environmental community is likely to be one of our biggest allies.

Earth Day event. We can join the Triana satellite with our Earth Day message by tying together the relationship between the first Earth Day and first pictures of earth from space. We can use a High Definition slowly spinning globe as a visual for whatever we do.

Environmental Leader Briefing -- On April 4th, the CEOs of the Green group, the major environmental groups leaders, will be in town and have requested a meeting. We could use this opportunity to brief them on the mission, highlight its importance to broader environmental awareness, and ask for their support and involvement.

CNN Interview -- On April 19th, the VP could do an interview on CNN with Astronaut Rick Linnehan on the space shuttle who is a specialist in how images from space and earth observations have helped us understand more about our earth (weather patterns, whale and animal migration, ocean currents). John Holloman will conduct the interview. Jean Michelle Cousteau (Jacques' son) will also be a part of the discussion -- he will focus on The Year of the Ocean.

THE EDUCATION COMMUNITY

Ultimately, our best selling point for Triana is on what this means for education -- for the students who help design, build, launch, track and manage it as well as the students who could then take advantage of the satellite's data.

EdTech Community. We can involve Edulink, the coalition made up of every major national educational group that was formed to help support educational technology and

the e-rate. As we connect our schools to the Internet, more attention is being focussed on what it allows children to do. Ultimately both our edtech and Triana initiatives are about putting the world at our children's fingertips.

Globe Schools. We can reach out to our network of more than 4000 Globe schools that already see the benefit of having an earth online. We can also work with them to help in the development of a standards based curriculum based on the Triana satellite data.

TIMSS Connection. In the wake of the TIMSS test results, it is clear that American students are performing poorly in science. We have to be doing everything we can to get students excited about and interested in science. We can incorporate Triana into TIMSS briefings that OSTP and the Dept of Ed do as an example of inspiring children to get involved in earth sciences.

THE SCIENTIFIC COMMUNITY

While we ultimately have to sell the satellite on its education merit, we have to dispel the notion that there is no scientific value and better articulate the scientific basis for it

Scientific Validators. NASA is in the process of putting together a large group of scientific validators for the project that could then be used in a variety of ways. For example the head of the American Association for the Advancement of Science, the largest association of scientists, has written in support of the effort.

University Symposium. We can ask NASA to work with one of the Universities who will build and run the satellite to convene a symposium that involves teachers, scientists and others to develop other mission criteria.

STRONGER JUSTIFICATION.

Early next week NASA will send out a Request for Information to seek input from the scientific, business and educational communities to explore other important applications for the satellite. That process should take about 2 weeks and should give us a better justification for the satellite.

✓ **Scientific Applications.** NASA will explore other science that the community would recommend we do with a satellite at the L1 point. For instance, measuring the particles and x-rays coming from the Sun, solar wind experiments, measuring Sun corona activity, providing solar flair warnings that could harm Space Station inhabitants and terrestrial electric power grids, experiment with gravitational dynamics at the L1 point, research on the coming Solar Max, and other spectral instruments that could be pointed towards earth. What can we do with better tracking of forest fires and hurricanes in real time.

✓ **Business.** There appears to be some interesting commercial applications coming in. See below under lowering the cost.

✓ **Educational**. This satellite will be designed, built and managed by university students. There appear to be broader educational applications once the images are online. The educational community regularly comes up with some intriguing ideas for space shuttle missions. We expect no less here.

LOWERING THE COST

Right now we are using cost figures of between $20 and $50 million. There seem to be some exciting options for lowering the cost of the entire operation.

- **Commercial cooperation.** There a several collaborations that NASA can explore on the commercial side to lower costs dramatically. For instance since our announcement, Microsoft called NASA to explore a partnership that would involve MSNBC. The Discovery Channel apparently also has some interest. And there are now a host of other commercial imaging interests who may have other uses for a sattelite at L1.

- **Other Missions to L1.** There is another NASA science mission that is set to go to L1 as part of a science mission called Genesis. There may be an opportunity to piggyback the science and dramatically reduce costs.

Selected Press on Triana

Thomas Young, former President and Chief Operating Officer of Martin Marietta
Space Mission Vital to Understanding Home Planet
Los Angeles Daily News, 8/31/99

Op-ed
Consider the Merits; Congress Should Fund Triana Satellite Project
San Diego Union-Tribune, 08/21/99

Mr. Clair Burgener, former Congressman and former Chairman of the Board of Regents of the University of California
Letter to Representative James Walsh, House Appropriations Committee
07/13/99

Joseph Pelton and Ron Freedman
Chairman and President of Triana Worldcast
Shedding Light on Triana
Space News, 07/05/99

Frances Valero, Director Atmospheric Research Laboratory
Scripps Institution of Oceanography
Don't Let Politics Scuttle Climate Project
San Diego Union-Tribune, 07/04/99

K.C. Cole, Time Science Writer
Mind Over Matter; the Emotional Pull of Science
LA Times, 06/24/99

Elaine Hansen, Director of the Colorado Space Grant Consortium
Triana: An Educator's View
Space News, 06/07/99

Warren Leary, Science Writer
Politics Keeps a Satellite Earthbound
The New York Times, 06/01/99

Opinion and Comment
Triana Connects Earth to the Net
SPACEDAILY, 05/18/99

Michael Szpir
Globe Watching
American Scientist, 04/05/99

Los Angeles Daily News
8/31/99
Space missions vital to understanding home planet

By A. Thomas Young
Bethesda, Md.

Having worked closely with the space program as mission director of the 1976 Viking mission to Mars, I find it disturbing that Congress is considering massive cuts to several of National Aeronautics and Space Administration's (NASA) important projects.

Americans have supported space research because of its exciting potential to improve our understanding of Earth and to inspire the minds of young people. Without the support of NASA projects, we cannot tap into the significant benefits of space research, which are critical to expanding our knowledge. NASA's observations of the Earth are the basis for a worldwide effort to study interactions among the oceans, atmosphere and land. The Triana mission, a scientifically sound project, is included in the proposed NASA budget cuts. That is a shame.

Triana would give us a full, continuous view of the Earth that would enhance our understanding of climate systems and the implications of solar radiation on weather patterns. Triana could provide a window on mankind's future, helping us learn more about climate systems and how they change over time.

The Triana mission, led by researchers at the Scripps Institute of Oceanography at the University of California, San Diego, would improve our understanding of the Earth's radiation balance, the primary driver of our climate system.

Additional basic research would investigate changes in the ozone layer and atmospheric circulation and winds. Triana's remote sensing also would measure vegetation health and coverage, ultraviolet radiation levels and solar winds, and it would provide timely analysis of solar activity that can disrupt telecommunications on Earth.

NASA's Goddard Space Flight Center, where I served as director, is enhancing the scientific value of the Triana mission by playing a key role

in spacecraft development and mission operations.

>From its vantage point 1 million miles from Earth, located where the gravitational pulls of the sun and the Earth are equal, Triana would turn its telescopes and instruments to view our world. And what a view it would be. By providing near real-time views of the sunlit Earth, Triana would gather fundamental scientific data impossible to obtain any other way, thus enhancing the field of education by stimulating a sense of awe and encouraging discovery.

As students learn about weather and climate, Triana would be feeding continuously updated pictures into classrooms, illustrating how these processes are developing around us. As students learn about geography and social sciences, Triana would be there with an ever-changing view of our dynamic world, providing not just static displays of continents and political borders but also the visual excitement needed to maintain student interest.

Mathematics, computer science and perhaps even art classes would be influenced and helped by the power of the whole Earth image. While helping scientists unravel the mysteries of the Earth's climate system, Triana would play a key role in shaping the next generation of scientists through inspiring voyages of discovery in the classroom.

We have only one Earth, one planet to call home. Investing in projects such as Triana, which help us better understand our planet and ourselves, is critical for the development of the human race.

NASA must have bipartisan support in Congress to move forward with Triana and other important missions. As Congress considers the NASA appropriations this summer, the remaining funds for Triana should be viewed as an investment in sound science and our future.

Abandoning valuable research will only close critical windows of discovery - portals to a better future we all want for the generations to come.

A. Thomas Young is the former president and chief operating officer of Martin Marietta Corp. in Bethesda, Md. Write him at Scripps Institution of Oceanography at the University of California, San Diego, 9500 Gilman Drive, University Box No. 0233, La Jolla, CA 92093-0233, or e-mail him at siocomm@sio.ucsd.edu.

San Diego Union-Tribune Editorial
August 21, 1999

Consider the merits
Congress should fund Triana satellite project

When Congress reconvenes after Labor Day, the House-Senate conference committee that will refine a $41 billion spending measure should be able to find $35 million to continue funding for the important Triana satellite project.

This scientifically promising endeavor, being developed by UCSD's Scripps Institution of Oceanography, would monitor the Earth's climate from deep space.

From its strategic vantage point between the Earth and the sun, Triana would measure the effects of global warming. It would also help ascertain with "an unprecedented degree of accuracy" how much of the sun's energy is reflected from Earth and how much is being absorbed throughout the planet.

So says Francisco Valero, chief scientist on the Triana project, who is understandably alarmed by the efforts of some on Capitol Hill to pull the plug on this operation. Critics claim the money would be better spent on other scientific programs.

Never mind that Triana is within 16 months of being fully operational. Or that scrapping it at this critical juncture would amount to flushing $40 million down the porcelain fixture, with nothing to show for the efforts to design, build and equip the sophisticated spacecraft.

NASA Administrator Daniel Goldin has urged President Clinton to veto the entire appropriations bill unless it includes full funding for Triana. It won't come to that if Republican and Democratic conferees simply consider the project's many scientific merits. If they do, we are confident they will find the $35 million needed to ensure Triana's completion.

# # #

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July 13, 1999

Representative James T. Walsh
House Committee on Appropriations
U.S. House of Representatives
Washington, DC 20515-6015

Dear James:

I am writing to request your immediate assistance with funding for the Triana program in the FY 2000 VA/HUD/IA appropriations bill. My interest in this project developed over the nine years I served as member and ultimately Chairman of the Board of Regents of the University of California. As a former member of the House Appropriations Committee, I understand the difficult funding choices and fiscal constraints facing you this year. I have no financial interest in this project whatsoever. However, I strongly believe that Triana is a scientifically-vital space mission that must continue.

Triana's science will deepen our understanding of global climate dynamics by contributing essential knowledge to two of the major unsolved climate problems of our time. The first has to do with completing the Earth's energy budget by determining how much of the sun's energy is reflected away from the Earth. The second, equally important question, addresses how the sun's energy absorbed and distributed throughout the planet. Answering these questions will contribute critical information needed to develop better computer models of how the Earth's climate system works. Better, more accurate models are necessary to improve climate and weather predictions and to determine if/how human activities might influence climate. Triana is the first Earth observing mission to the Lagrange-1 point (L1), the neutral gravity point between the Sun and the Earth. From L1, Triana will have a continuous, "full-disk" view of the Sun-lit side of the Earth. From this position in space, Triana's advanced radiometers can measure the Earth's reflected and emitted energy with unprecedented accuracy.

Triana data can be used to protect U.S. investments in other satellites, including commercial telecommunications satellites, by providing early warnings of solar flares and other extreme solar events that pose significant threats. NOAA, the agency responsible for space weather forecasting, is already preparing to receive Triana data. The sensitive scientific instruments on Triana will be able to track plumes from major fires, desert-dust sources, and volcanoes. If this data proves useful, then it could be utilized by the Federal Aviation Administration to reroute planes to avoid these potentially dangerous plumes.

Triana will also collect information on the amount of aerosols and clouds in the atmosphere. This data, when put together with data Triana will gather on ozone, will allow us to predict the level of damaging ultraviolet radiation at the Earth's surface. Use of this data may be used to reduce UV radiation hazards, which have been linked to skin cancer.

Another exciting and significant payoff will be Triana's education initiatives. Professional educators will develop high-quality educational products using Triana's views of the sunlit Earth. These materials will be shared over the Internet to allow students to study science issues such as global change in cloud cover, weather patterns, ozone, pollution plumes, and seasonal changes.

Finally, I am writing as a taxpayer that is concerned that if Triana was terminated in FY 2000, nearly $40 million of U.S. tax dollars would have been spent for nothing. Reversing the course now on Triana is costly both in terms of wasted tax dollars and lost opportunity to better understand complex scientific concepts of intense political and public importance. I ask that you support full funding for Triana in the FY 2000 VA/HUD/IA appropriations bill and urge your colleagues on the Appropriations Committee to do the same.

Sincerely,

Clair W. Burgener

Space News July 5, 1999

Joseph N. Pelton and Ron Freedman

Shedding Light on Triana

The recent heat surrounding NASA's Triana satellite may have obscured the light behind this novel space mission. Overlooked is the fact that this new satellite offers unique benefits to U.S. and world society.

Triana will help answer one of the most important and least understood scientific questions of our time: How much of the sun's energy does the Earth absorb?

This simple piece of information lies at the heart of all our projections about climate change and global warming. At the moment, scientists do not know the answer. They rely on patchy data from a thin network of terrestrial and space sensors. Society places a great amount of value on more accurate climate forecasts. For example, the worldwide property insurance industry and its policyholders have trillions of dollars at risk.

Triana's instruments also will provide early warning of solar storms. Such storms, especially the solar maximum, or peak of solar activity that arrives in April 2000, threaten a multi-billion dollar investment in U.S.-owned space hardware, including important intelligence satellites, as well as the communications satellites on which our citizens and our military both depend.

A recent global study of satellite communications conducted for both NASA and the National Science Foundation found elements of risk to space assets related to orbital debris, year 2000 problems and, most especially, solar and electromagnetic events. Solar disruptions can, and have, caused the shutdown of regional power grids. Our society has an enormous reliance on uninterrupted power. A single large-scale power failure would cost billions. Triana's sensors would provide a warning in time for satellite and energy operators to take preventive measures.

Less well-known is Triana's potential impact on jobs and the economy. The project already has spawned a new worldwide media enterprise, Triana Worldcast, Inc., that can give the United States new prominence on the space frontier by furthering the survival of our species in the next millennium live via satellite — a sort of CNN for space and environment.

Following a NASA competition, Triana Worldcast is working with the Scripps Institution of Oceanography and NASA to commercialize Triana's stunning television imagery. Under a license agreement now being negotiated, Triana Worldcast plans to use Triana's high-definition television pictures as the core of a new worldwide Earth, space and environment broadcasting network. This private-sector financial investment will help create new information-age jobs in America.

The U.S. Congress has been pressing NASA to commercialize its space activities and lessen reliance on government funding. Most people understand this will take some time to accomplish. Triana represents one of a new generation of commercial space opportunities. Admittedly, it is only a beginning, but space commercialization needs to start somewhere. Finally, hundreds of graduate and undergraduate students will use Triana data as part of their studies. And hundreds of thousands of high school and elementary school students will learn about Earth through Triana's powerful eye.

If a few 35-millimeter Apollo still photos of far-off Earth could inspire two generations of Americans, imagine how many minds could be awakened by a continuous stream of live high-definition images distributed over the Internet and via global TV. Triana Worldcast will, in time, let us see the dark side of the moon in full sunlit splendor. It also will show the opening and closing of the ozone hole, the spread of aerosol pollution and planetary and oceanic developments as never seen before. Triana Worldcast currently is in discussions with leading broadcasters all over the world.

Put it all together and you have a scientifically important project with the potential to save billions of dollars for American space assets and create real private-sector jobs on Earth.

And, as a side benefit, the project provides a chance to motivate the next generation of young people in a more positive direction than America has recently seen. We hope Congress will give Triana and Triana Worldcast a new look in the brightest possible illumination of a new sunlit day.

Professor Joseph N. Pelton is chairman of Triana Worldcast Inc. and Ron Freedman is president of the company.

spacenews.com

To learn more about the Triana mission, visit the Weekly Links section under Resources at www.spacenews.com.

Harold P. Klein

Confounding the Sample-Return Issue

In the May 10 issue of *Space News* Gilbert Levin discussed the upcoming Mars sample-return mission and presented arguments against such a mission, concluding

suggest that subsurface regions would be much more conducive to biology. As a result, one can expect that NASA will be ac-

Earth's environment: so-called life-detection investigations and hazard determinations. No specifics on either of these

Pitfalls also are waiting for NASA when it comes to hazard testing of the Mars samples. If the agency is serious about protecting Earth's environment, then the protocols for hazard testing will need to be extremely broad and inclusive, bordering on the impossible. What assurances can be given that any portion of the Mars sample taken for hazard testing will be representative of the entire sample? Do we need to

Union-Tribune.

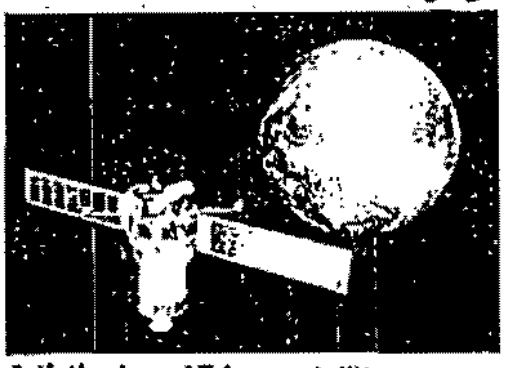
THE SAN DIEGO UNION-TRIBUNE ■ SUNDAY, JULY 4, 1999

Satellite sabotage

Don't let politics scuttle climate project

Approaching presidential elections prompt political partisans to do some silly things. House Republicans look particularly foolish for trying to scuttle a scientifically sound project simply because it is a pet project of Vice President Al Gore, next year's presumptive Democratic nominee.

The Triana satellite project, which is being run by UCSD's Scripps Institution of Oceanography, is designed to gauge the Earth's climate, with particular emphasis on the effects of global warming. It could help determine how much of the sun's energy is reflected from the globe and how much of that energy is being absorbed and distributed throughout the planet.



Artist's view of Triana satellite

Because of its unique vantage point between the Earth and the sun, the Triana satellite would also collect all manner of valuable information. This data would enable scientists to make informed judgments about a wide range of issues affecting global climate change. That would be quite an improvement over the present system, under which scientists have to rely on the merging of thousands of measurements from lower-flying satellites that are less precise in their observations.

Scripps landed the Triana project in October 1998 after a rigorous peer-review process scrutinizing nine competing proposals. By September, scientists will have spent $35 million building the spacecraft and its sophisticated scientific instruments. They are scheduled for launch at the end of next year.

That timetable is in limbo, however, because the Republican controlled House has stripped federal funding for Triana, except for the cost of shutting it down. That means the taxpayers would be on the hook for approximately $40 million, with nothing whatsoever to show for their efforts to get this worthwhile endeavor off the ground.

So much for the Republican House leadership's claim that zapping Triana is a cost-saving move. Rather, it's petty politics, pure and simple. Many GOP lawmakers are looking to torpedo a scientifically valuable project simply to stick it to Gore.

Rep. Brian Bilbray, R-Imperial Beach, said as much when he rose on the House floor to defend the project. While acknowledging that people of good will have conflicting points of view on the causes and consequences of global warming, Bilbray hastened to add that the Scripps study could help resolve the controversy. He's right.

Triana's fate now depends on the Senate, which supports full funding of the project as part of a $41 billion annual NASA appropriation. In the months to come, a House-Senate conference committee will sort out the differences. Meantime, Bilbray has been assured that funding for the project will be restored once both sides reach consensus.

NASA Administrator Daniel Goldin is so committed to Triana that he has urged President Clinton to veto the entire appropriations bill if it does not include funding for the project. Republican lawmakers would do well to ponder his principled stand and stop trying to sabotage a satellite that could expand our scientific horizons.

Metro; Metro Desk
SCIENCE FILE Mind Over Matter The Emotional Pull of Science
K. C. COLE

06/24/1999
Los Angeles Times
Home Edition
Page B-2
Copyright 1999 / The Times Mirror Company

Scientific research, above all, is supposed to be practical.

That's one reason certain members of Congress are refusing to fund a modest NASA satellite called Triana that would fix a steady gaze on Earth from space—giving the folks back home an opportunity for real-time, round-the-clock navel gazing.

Unlike other satellites that take patchwork snapshots, Triana would beam back a live image of the whole planet, 24 hours a day. All the planet, all the time, available to everyone through the Internet and cable TV.

"Boondoggle," House Majority Leader Dick Armey (R-Texas) called it.

"Tripe science," said Rep. Dave Weldon (R-Fla.).

It didn't help with Republicans that the idea was hatched in the head of Vice President Al Gore, during a dream, no less. The image of our small blue marble floating alone in space, Gore said, would inspire people to take better care of the planet.

But is the purpose of science to be inspirational? Since when is science supposed to be soul food? Isn't its aim to produce the kind of technology that puts real food on the table?

After all, taxpayers have a right to want their money's worth. So whenever a new discovery is announced, politicians (and newspaper editors) are forever asking: What good is it? Of what practical use?

Scientists, in turn, have become adept at ticking off practical benefits of even the most esoteric research. During the early days of the space program, we heard a lot about spinoffs like Tang and Mylar. These days, we're more likely to hear about space-age drugs and computers, or medical imaging technology like PET scans--brought to us courtesy of a particle of antimatter called the positron.

Rarely, however, do people talk about the emotional payoffs of science. Like art museums and national parks, science fills deep philosophical yearnings. One doesn't have to look far to find these emotional

fruits of science. Consider how much our feelings have changed about our place in the universe since Galileo discovered the moons of Jupiter, showing that not everything orbits around Earth; since Newton found that the laws of gravity that make apples fall on Earth are the same everywhere in the cosmos.

No longer could people view the dance of the stars and planets as a performance put on specifically for us. We were part of the action--and a small part, at that.

These days, astronomers tell us that perhaps 90% of the universe is made out of matter completely unlike the stuff that makes up our own world. No one knows the exact nature of this "dark matter," but whatever it is, it's alien to us. Or more accurately: We are the aliens in a universe constructed mostly of other kinds of stuff.

Scientists as well as politicians sometimes underestimate the emotional pull of science. The late physicist Frank Oppenheimer--banned from physics by the politics of the McCarthy era in the 1950s--taught high school for some time in the small town of Pagosa Springs, Colo. Teenagers, he thought, would be naturally interested in cars, so he'd take his classes to the junkyard to study the physics of auto parts.

He was surprised, one day, when the students complained. It was all well and good to learn about mechanics, they said. "But we want to know about the stars!"

No doubt, the same yearnings prompted millions of people to stay tuned to their TV sets for days after the adventures of a small rover called Sojourner on the surface of Mars a few years ago. The Pathfinder mission was, above all, a sentimental journey.

Triana, though, has grown up over the past year from a mere dream to a full-fledged scientific mission with a practical job in space. In addition to providing a permanent "mirror" on ourselves, it would keep an eye on environmental shifts and climate changes.

Still, one shouldn't underestimate the power of dreams. Most scientists, at some level, are dreamers. Practicality can get you to the next step in science. But only dreams can guide the next great leap.

Indeed, last month NASA chief Dan Goldin scolded particle physicists for forgetting how to dream--for being, in effect, too practical. "If we don't dare to dream, we won't find anything," he said in a speech at Fermi National Laboratory outside Chicago. Dreams, he said, are "how the most exciting science happens."

This sentiment was perhaps best expressed by Fermilab's own founder, physicist and sculptor Robert Wilson. When Wilson was trying to get money out of Congress to build Fermilab in the 1970s, he was asked to explain the practical purpose of the new accelerator. How would the knowledge that came out of smashing atoms help secure the national defense?

Wilson responded that the new accelerator would have no value in that respect. Instead, he argued, eloquently: "It only has to do with the respect with which we regard one another, the dignity of people, our love of culture. In that sense, this new knowledge has nothing to do directly with defending our country--except to help make it worth defending."

A lot of scientists would second that emotion.

Elaine R. Hansen

Triana: An Educator's View

The recent vote in the U.S. House of Representatives to bar NASA from spending money on the Triana satellite program is short-sighted. Before agreeing to include that language in NASA's 2000 budget authorization, members of Congress should weigh the full educational value of the Triana mission and its potential to inspire future scientists, engineers, managers, educators and entrepreneurs.

The excitement and possibilities of space have inspired students of all ages to dig into learning activities, experience the joy of discovery and increase their awareness of Earth's environment. Involvement in space-related activities sparks interest in science, math and technical literacy.

Several NASA missions already have taken advantage of students' remarkable zeal for space. In the EarthKam project, for example, students submit requests to space shuttle astronauts for selected Earth images and relay the data back to their classrooms.

Students in the Moonlink program participate in a staged mission using actual data from the Lunar Prospector mission. In the upcoming Citizen Explorer mission, the satellite will broadcast ozone measurements to receivers at participating schools around the world. Now NASA is introducing a new mission concept, with what promises to have an enormous educational impact.

Triana — a satellite named after the sailor on Columbus' voyage who first saw the new world — will be positioned at the LaGrange 1 point, a location between the Earth and sun that is 1.5 million kilometers from Earth. From this vantage point, Triana will provide a continuous view of the sun-lit side of Earth to obtain global images of the surface and of ozone, aerosols, water vapor, cloud cover, cloud height and vegetation.

Triana also will promote student literacy in science, math and technology. It will increase students' awareness and understanding of their environment by enabling them to be actively involved in real and useful measurements of their environment.

These map-like images will be distributed for free over the Internet — where they will be available to teachers, students and anyone around the world. Triana also will transmit pictures of the far side of the moon, hurricanes, forest fires, lunar eclipses and other celestial bodies as they pass through the satellite's line of sight. Through Triana, students of all ages can be active participants in a space mission.

They can collect and monitor valuable environmental data; access real data from a space satellite as it is transmitted; evaluate Earth as a dynamic system; make complementary measurements from the ground; evaluate important changes in Earth's atmosphere, oceans, ice caps, land and vegetation; share data and conclusions with other students; and provide a powerful, worldwide, student-driven, Earth-observing network.

The educational benefits of the Triana mission, with such a high degree of student involvement, are enormous.

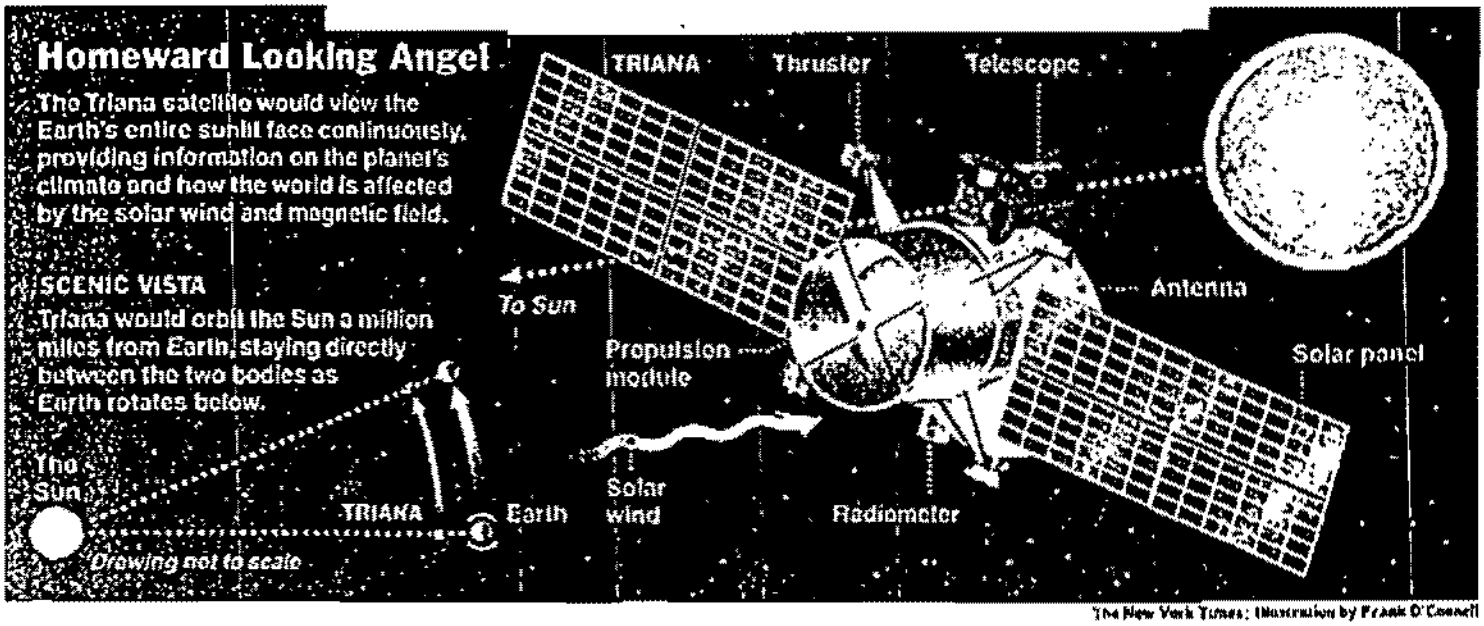
It will provide students with a global perspective. It will transform math, science, technology and technical literacy from classroom theory into exciting reality, and help meet educational standards in a stimulating context. Triana also will promote student literacy in science, math and technology. It will increase students' awareness and understanding of their environment by enabling them to be actively involved in real and useful measurements of their environment. It will expose these student scientists and engineers to a range of scientific and technical disciplines and challenges. We encourage the House and the Senate to recognize the tremendous educational benefits provided by the Triana mission to inspire our youth in math, science and technical literacy, and to motivate these students to excellence.

Elaine R. Hansen is director of the California Space Grant Consortium.

spacenews.com

For more information on space education, click on the Outer Orbit link at http://home.spacenews.com.

SPACE NEWS June 7, 1999 Vol 10, no 22



The New York Times; Illustration by Frank O'Connell

Politics Keeps a Satellite Earthbound

By WARREN E. LEARY

As spacecraft go, it is small, inexpensive and normally would hardly stand out among the dozens of satellites and probes NASA is planning to send into space. But Triana, because of its unusual origin and mission, has attracted a lot of attention. And it is in trouble because of it.

The goals of this simple satellite, designed to view the Earth from afar, have become complicated by the reality of Washington politics. The debate over whether the mission is a good idea or not is muddled by the awareness of whose idea it was in the first place.

Triana, in its earliest incarnation, is the brainchild of Vice President Al Gore. In a speech on March 13, 1998, at the Massachusetts Institute of Technology, Mr. Gore challenged NASA to build and fly an inexpensive spacecraft that would make continuous, live pictures of the full, sunlit Earth from far out in space that would be available to the world at all times via the Internet and television.

Weather and scientific satellites view the Earth all the time, but they orbit so close that they only see a portion of the planet at a time. Any "whole Earth" view has to be stitched together from several images, and none of these displays can be done in real time.

Mr. Gore said that seeing the entire Earth against the blackness of space at any time, which is not now possible, would inspire environmental consciousness and encourage new educational and scientific efforts. As the nation's classrooms and homes are connected to the Internet and cable television, he said, the images could arouse new feelings among millions of Americans about their home planet.

As White House aides tell it, Mr. Gore's idea came to him almost in a dream. He awoke at 3 A.M. one day in February 1998, and thought about a global view of Earth, they say, perhaps inspired by the famous "Blue Marble" photograph of the planet taken in December 1972 by the returning crew of Apollo 17, the last moon mission. A copy of the picture hangs in Mr. Gore's office.

Mr. Gore also gave the Earth-watching project its name, after Rodrigo de Triana, the lookout aboard Christopher Columbus's ship who first saw the New World in 1492.

After Mr. Gore told the NASA administrator, Daniel S. Goldin, about the idea and asked if it was feasible, the agency made a

Continued on Page 2

Politics Keep an Earth-Viewing Satellite Earthbound

Continued From First Science Page

ck study of the proposal and con-
ded that it could be done for be-
en $20 million and $50 million,
after NASA asked for bids on the
ject, it grew from a simple cam-
-in-space idea — nicknamed by
ne the Goreacam or Goresat — to a
re elaborate spacecraft that
uld also do environmental moni-
ing of the Earth and the Sun. Last
tober, after an evaluation of nine
mpeting proposals, the agency se-
ted one from the Scripps Institu-
n of Oceanography at the Univer-
y of California at San Diego for a
million mission.

Instead of just a video camera for
ding pictures of the Earth, the
ripps mission includes a multi-
ectral imager that sees a variety
wavelengths of light, from ultravi-
et to near infrared, to measure
one, cloud height, the amounts of
rosols and particulates suspended
the air and other parameters. It
o includes a radiometer for moni-
ring the solar radiation reflected
ck into space by Earth and an
rrument package for monitoring
ar events that could affect electri-
l equipment on Earth.

"By no means is this the 'Gore-
am,'" said Dr. Francisco P.J. Va-
ro, director of the Atmospheric Re-
earch Laboratory at Scripps and
incipal investigator for Triana.
"We wouldn't get into this unless
ere is good, substantial science. We
ll be looking at the planet in a way
hat never been looked at before."

But as interest in Triana grew, so
d opposition from some space sci-
entists concerned about diminishing
ASA budgets and politicians on
apitol Hill, particularly Republi-
ans. NASA found $33 million in its
scal 1999 budget to begin the
roject, but ran into renewed opposi-
on this spring in trying to get $32
illion for Triana for the 2000 fiscal
ear.

On May 13, the Republican-con-
rolled House Science Committee
oted 21 to 13 along party lines to
end a $13.2 billion, three-year NASA
uthorization bill to the full House
ithout Triana financing. The measu-
e included an amendment by Rep-
resentative Dave Weldon, Republi-

Associated Press

In a proposal now caught in budget wars, Vice President Al Gore last year suggested building a satellite that would make live pictures of the full Earth continuously available on the Internet and television.

can of Florida, who called Triana "a multimillion-dollar screen saver" and "tripe science," that shifted money for the project to other research.

Speaking against Mr. Weldon's amendment, Representative Bart Gordon, Democrat of Tennessee, accused Republicans of attacking Triana in a partisan effort to hurt Mr. Gore's Presidential aspirations while ignoring the scientific and educational uses of the program.

On May 19, when the House considered the NASA financing bill, Republicans attacked the project, with the majority leader, Dick Armey of Texas, calling it a "far-out boondoggle" and Representative F. James Sensenbrenner Jr. of Wisconsin branding it "the Vice President's late-night inspiration." The House voted 250 to 158 to pass the measure without Triana financing.

Democratic leaders said they would ask their Senate colleagues to reinsert money for Triana this summer when conference committees of both houses meet to reconcile their

A modest satellite with political baggage and its share of skeptics.

spending bills. In addition, White House and NASA aides said Mr. Goldin might recommend a Presidential veto of a final agency spending bill that did not include Triana.

If Triana survives the budget wars, there is still discussion among scientists on what the spacecraft will do and how valuable a scientific contribution it can make.

The spacecraft is scheduled for launching from a space shuttle during a flight in December 2000. After a six-month journey, it is to enter an orbit about a million miles from Earth at a point called Lagrange 1. At this point, the gravitational pulls of the Sun and the Earth balance one another, leaving a spacecraft to match the Earth's track around the Sun. There are several spacecraft already at Lagrange 1, but they all face the Sun.

Triana would always have the Sun at its back and its face toward the sunlit side of Earth turning beneath it. There it would constantly image the planet. Several times a year, Triana would take detailed pictures of the far side of the Moon, fully lighted by the Sun, as it passed between Triana's camera and Earth.

Dr. Valero, the project's principal scientist, said Triana would be the first craft to study Earth's energy balance and how it affects climate. The planet absorbs energy from the Sun that drives its weather and climate, but it also reflects an unknown amount of energy into space. The instruments would also track clouds and the types of particles in them to see how they affect energy exchanges in the atmosphere and how much potentially harmful ultraviolet radiation reaches Earth's surface.

"We have thought about doing science like this for years, and now it's possible," Dr. Valero said. "A lot of thought has gone into these experiments. Science like this does not come out of a dream."

But there is disagreement about the project's worthiness.

"If you went to the scientific community and asked what is needed most for Earth science, this would not be it," said Dr. Richard S. Lindzen, a professor of earth, atmospheric and planetary science at the Massachusetts Institute of Technology. "I don't see a big benefit to science coming out of this. This is a strange way to go about designing a project, starting with the Vice President having a dream."

Dr. Lindzen said that if NASA wanted to devote part of its resources to public relations, the agency might be justified in doing so. But he said it should not call these projects "science" or devote too much of its limited funds to them.

Dr. Steven C. Wofsy, a professor of atmospheric sciences at Harvard University, says he was initially very skeptical about the Triana proposal, but now says believes it may produce useful science. He is not involved with the project, but serves on a scientific committee that was briefed on it.

"I was impressed by how carefully thought out the experiments were," Dr. Wofsy said. "These people were determined to make something out of it and they did. It's more than a world-cam, which no one needs, and offers potentially unique results."

Dr. Donald Johnson, a retired professor of atmospheric sciences at the University of Wisconsin who is now with the Universities Space Research Association, says he can understand why some people oppose Triana because of its political origins or its use of money that could go to other projects.

"It comes with some political baggage," he said, "but it still can be useful."

Aside from any scientific payoff, he said, continued monitoring of Earth can attract attention to the planet's problems globally and be a useful educational tool.

"There is some value in just making people aware of their world," Dr. Johnson said.

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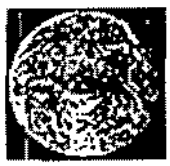
Triana Connects Earth To The Net



San Diego - May 6, 1999 - The Al Gore inspired project Triana has received a great deal of critism in recent months with many (including this publication) questioning the scientific value of the mission.

While the would-be Presidental overtones of the project cannot be overstated - the fact remains the project will be a balance between real science and providing a "hands-on/interactive" satellite in orbit that's wired to the Net for web surfers the world over to use.

Like GPS and the Net itself we have no idea at this stage what new consumer applications will come out of Triana and other future Net-wired satellites.

But with a permanent multi-tasking satellite at L1 feeding data to the Net it will be only a matter of hours before Web hackers such as this editor himself are harvesting Triana's data and turning it into web content for sites like SpaceDaily.com.

In an extended opinion piece for SpaceDaily, Francisco P. J. Valero, the director of atmospheric research at the Scripps Institution of Oceanography outlines the Institute's scientific rational and goals underscoring Triana. Editor

Triana: An Island View at L1

By Francisco P. J. Valero - Scripps Institution of Oceanography

The Triana space mission is an exciting opportunity to advance Earth and space science and simultaneously provide significant new educational materials to our students-the students that are the future of our science and space endeavors.

Triana complements current and planned missions for both low and geosynchronous orbit Earth observation, and for space weather monitoring. This mission will be a pathfinder, discovering new and better ways to observe our Earth system from deep space.

The Triana spacecraft will orbit the Lagrange-1 (L1) neutral gravity point, a point one million miles from Earth where the pull of Earth's gravity matches the pull from the sun. While there have been sun observing missions at L1, Triana will be the first Earth science satellite stationed there.

This unique vantage point provides a continuous view of the Sun-lit side of the Earth, as the planet slowly revolves about its axis. In contrast, Earth-observing satellites in low Earth orbit only sample a small and changing area while even geostationary satellites only view a portion of the Earth at any time.

The full disk, Sun-lit view of the Earth afforded by the L1 location has tremendous potential for Earth science. Triana will the first mission to explore that potential.

Triana will use an SMEX-Lite spacecraft developed by the NASA Goddard Space Flight Center. The scientific payload will consist of two Earth science instruments; the Scripps-NISTAR advanced active cavity absolute radiometers, and the Scripps-EPIC, a ten-channel telescope, plus a solar monitoring Plasma-Mag instrument package.

The instrumentation has been carefully chosen and specified to answer important questions about Earth science, and to maximize their potential to complement science data being collected from low and geosynchronous satellites. A brief summary of the Earth science to be addressed by Triana is provided below.

Earth Science Objectives

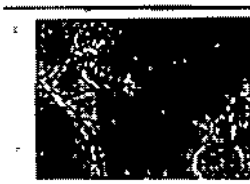
amazon.com
Remote Sensing
Earth Observation Books
EO Systems for Resource and Environmental Control
Clough and Morley
$69.50 1977 - Plenum
Earth Observation Data Policy
Raymond Harris
$57.95 1997 - John Wiley

KPMG
SPACE PRACTICE

Cooperation in Remote Sensing and Earth Observation
Caroline S. Wagner
$NK 1998 Rand
Advances in Environmental Remote Sensing
Danson and Plummer
$170.00 1995 - John Wiley
Introduction to Satellite Image Interpretation
Eric D. Conway
$29.95 1997 - Johns Hopkins
Remote Sensing Principles and Interpretation
Floyd F. Sabins
$84.95 1996 - Freeman
Models and Methods for Image Processing
Robert A. Schowengerdt
$75.00 1997 - Academic
Oceanographic Application of Remote Sensing
Ikeda and Dobson
$69.95 1995 CRC

AMERICAN WORLDWIDE INSPECTIONS
Experts For Launch Campaign Support

Introduction to Remote Sensing
James B. Campbell
$60.00 1996 - Guilford
History of Geographic Information Systems
Timothy W. Foresman
$69.00 1997 - Prentice Hall



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- **Radiation and Climate** Solar radiant energy is a major driver of the Earth's climate. The reflection, absorption, and re-emission as infrared radiation (heat) of that energy, via clouds, aerosols, atmospheric composition, oceans, ice and land surfaces, determines the response of the Earth system to the incoming energy. Triana's advanced radiometers will measure the radiances of reflected and emitted energy over a critical angle range with unprecedented accuracy. Such accurate measurements are needed to refine and test our understanding of climate, climate change and the Earth's radiative processes. Furthermore, future deep space observatories distributed around the Earth would be able to simultaneously sample radiances from a variety of scattering angles with consequent further improvement in radiative balance estimates.

- **Cloud Microphysical Properties** Ice crystal shape and size determine the basic radiative properties of cirrus clouds. By routinely combining the Scripps-EPIC instrument data with reflectances measured with the Earth Observing System, geostationary, or other satellites at corresponding wavelengths, we can improve our capability to monitor cloud particle shape at all latitudes and times of day. These results will be valuable for further constraining climate models in their critical calculations of cloud interactions with solar radiation.

- **Ultraviolet Radiation** Atmospheric Ozone shields the surface of the Earth from much of the lethal ultraviolet radiation emitted by the Sun. Triana's Scripps-EPIC instrument will serve as an important complement to the Total Ozone Mapping Spectrometer (TOMS) instruments on other Earth science satellites, providing data on the full sunrise to sunset changes in ozone, clouds, and aerosol amounts that influence not only climate but also the amount of UV radiation reaching the surface.

- **Clouds.** Cloud cover is the key factor affecting UV exposure at the ground. Measurements of cloud reflectivity at 380 nm have been used to determine cloud transmittance, and have been shown to be accurate using data acquired by TOMS. Unlike TOMS, Triana will measure the clouds throughout the day at a given location giving an accurate picture of the UV reduction by clouds, and therefore the UV exposure of humans and plants. Only the GOES-type geostationary satellites have similar coverage for clouds, but without the closely correlated ozone and aerosol amounts needed to understand the penetration of UV radiation through the atmosphere.

- **UV Radiation at the Surface.** As researchers have learned to do with TOMS data, monitoring of UV radiation reaching the Earth's surface will also be possible with data from the Scripps-EPIC instrument. Triana's sunrise to sunset view of the full disk of the Earth will enable hourly estimates of surface UV over the entire globe.

- **Aerosols** Particles suspended in the atmosphere, called aerosols, impact climate directly by absorbing and scattering solar and infrared radiation, and indirectly by modifying the microphysical structure of clouds. The magnitude of the aerosol forcing of climate is highly uncertain because aerosol concentration and composition exhibit substantial spatial and temporal variability on scales ranging from regional to global. Triana's Scripps-EPIC instrument will be the first to combine visible and UV viewing channels, enabling scientists to derive measures of particle size distributions as well as aerosol optical depth. With much greater resolution than TOMS (8 Km vs 100 km), Scripps-EPIC data will also be better able to track aerosol plumes from fires, desert-dust sources, and volcanoes. Data concerning volcanic ash is important to the FAA for aircraft routing, and smoke plume data are important to the US Forest Service and others who manage large areas of fire-prone lands or monitor air quality.

- **Vegetation Canopy Measurement**
  Due to its location near the Sun-Earth L1 point, Triana will acquire images of the Earth in and near the solar retro-reflection direction, also known as the hotspot direction. Changes in amount of vegetation-leaf structure, or fraction of covered land area can be detected by this method. As a minimum, Triana data will provide the radiometric calibration for hotspot and other related data.

Solar Wind & Space Weather Science

The Triana satellite will also have a sun-observing instrument, the

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Geological and Environmental Remote Sensing
Robert K. Vincent
$80.00 1997 - Prentice Hall
Using Color-Coded Satellite Images
Claire L. Parkinson
$24.00 1997 - Univ Science

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Assessing the Accuracy of Remotely Sensed Data
Congalton and Green
$49.95 1998 - Lewis
Remote Sensing for Landscape Ecology
Robert C. Frohn
$85.00 1998 Lewis

Plasma-Magnetometer. It will provide early warning for solar flares and other extreme solar events that could allow utility companies and satellite operators to execute timely procedures to protect their assets. It might also provide some warning to manned space missions such as the space station or shuttle. These capabilities have already been demonstrated by the plasma magnetometer instruments on the Advance Composition Explorer (ACE), a space science satellite currently operating at L1 which is nearing the end of its design lifetime. Triana's Plasma-Mag Instrument suite is an advanced, smaller version of the ACE instrumentation, and should arrive at L1 in time to continue this valuable service. NOAA, the US agency with responsibility for space weather forecasting, is already preparing to receive Triana data, as they do now with ACE.

Educational Opportunities

Finally, a most exciting and significant payoff for the Triana mission may be in the area of education. Under the sponsorship of NASA, a separate educational enhancement follow-on project will involve professional educators in developing high quality educational products. These efforts will start with the inspirational views of the full sunlit Earth, and will lead to up-to-date educational materials that can be shared over the Internet. We see this enabling students to work on and experience science issues such as global changes in ozone, cloud cover, weather patterns, tracking of pollution plumes and seasonal changes. We will support new and innovative inquiry based learning that involves multiple disciplines, such as mathematics, geography, computer technology, and physical sciences.

Summary

If an objective view of Triana is taken, it should be evident that significant new Earth and space science can be derived from this important mission. The science instruments have been designed to complement existing Earth and space science satellites, while addressing new and unique questions that could not be answered without the deep space viewing position. We fully expect that the results will lead to additional Earth observing missions from deep space. Triana science, coupled with the educational opportunities that can be developed around the Triana data will make this a most exciting and effective mission.

* Atmospheric Research Laboratory at Scripps
* Scripps Institution of Oceanography

Triana At Spacer.Com

* LockMart Wins Gore-Cam Camera
* Gore-Cam To Be Launched After Election 2000
* Gore "Space Camera" Idea Lost In Space?

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Globe watching
Michael Szpir
05/01/1999

American Scientist
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Earthlings have been observing the changing faces of nearby planets ever since Galileo first pointed his telescope toward the sky. For centuries, the colorful disks of Jupiter, Saturn and Mars were the only planets that offered much of a show. Most other worlds in our solar system were simply too far away to present an interesting view. And the planet that could provide the most entertaining view of all-the earth-was simply too close. It took a while for us to develop the technology to observe our planet, but as anyone familiar with television or the Internet can tell you, we now do so with a vengeance.

Just click onto the World Wide Web and you can see an image of our home world that is usually no more than a few hours old. There's always a full plate of planetary phenomena to see: Watch the eerie flow of the earth's water vapor (which makes the globe look somewhat like the surface of an alien's cerebral cortex), follow the changing temperatures of the world's lands and seas (more complex than you might suspect) and the wispy, almost dreamlike covering of the planet's clouds (better than the Weather Channel), and get up to date on the location of the 21 most recent earthquakes (which are more frequent than you might think).

These global views are remarkable in themselves, but they're also not quite legitimate planet watching: All of them are composites or maps derived from satellite images or from ground-based stations. It's not like looking at the earth through a telescope. This will change in the year 2001, however, when Web surfers will be treated to a global view of our planet as imaged by a spacecraft situated a million miles away. The spacecraft, called Triana , will be located at the Lagrange L1 libration point (where the gravitational tugs of the sun and the earth are effectively neutralized). At that distance, the earth will cover no more than half a degree in Triana 's sky-about the size of the full moon-and the onboard camera will have to peer at the earth through a telescope.

The notion of observing the earth from the L1 vantage point has been a vision of space scientists for decades, but as most scientists know, having an idea is nearly worthless if you don't have the money to make it a reality. This is where the nighttime dreams of Vice-President Al Gore came into play early in 1998. As the story goes, Gore woke up one morning thinking it might be nice to have a highdefinition-TV-quality image of the sunlit disk of the earth available on the Internet 24 hours a day, a concept he called "Digital Earth." By the autumn of 1998, less than a year after Gore's vision, the Triana project was born. (There is a lesson here for young people considering a career in science.)

Although Gore's concept was originally criticized by some scientists as having little scientific value, the incarnation of the Triana mission will address some fundamental questions about the earth's climate. The principal investigator of the Triana project, Francisco Valero at the Scripps Institution of Oceanography in La Jolla, California, is adamant that project won't produce "just another screen saver."

Valero's plan for Triana includes a broadband radiometer that will measure the amount of the sun's energy that the earth reflects back to space. Since sunlight is the principal engine driving our weather, an accurate measure of how much solar energy the earth absorbs is critical for climate models. Current means of measuring the reflected energy require the integration of several satellite scans that cover a relatively narrow strip of the earth. "There is a disparity of eight percent

between the theoretical and the experimental measures of this value," says Valero. "Part of the problem may be that several satellite scans have to be stitched together to produce a global measure of reflected energy. Triana will be much more accurate because we can average many global snapshots of the earth." In Valero's mind there's little question that good science will come from Triana , and he is already hatching schemes to place earth-observing telescopes at other Lagrange points.

Triana is scheduled to be launched from the Space Shuttle late in 2000, on the eve of the new millennium and nearly 400 years after Galileo. There's something poetic about observing our planet through a telescope: We'll have finally brought the Galilean revolution full circle.

-Michael Szpir