America has lost its lead in space science

Former NASA Associate Administrator Burt Edelson describes the loss of U.S. leadership in space science, and the question of Soviet cooperation on a Mars program.

Dr. Burton I. Edelson resigned from his five-year post as Associate Administrator for Space Science and Applications at the National Aeronautics and Space Administration in July. The multi-year delays in planetary and other space science missions due to the two-year stand-down in the Space Shuttle program, and overall disarray in future launch vehicle capabilities, have demoralized many in the space science community, and made it almost impossible to plan future scientific missions.

In this interview, conducted on Sept. 17 by Marsha Freeman, Dr. Edelson discusses a proposal for U.S.-Soviet cooperation on unmanned missions to Mars. Although this proposal was originally promoted by anti-SDI television star Carl Sagan, it has begun to look more and more attractive to U.S. scientists, as a combination of paltry budgets and lack of commitment to any long-range space planning is viewed in comparison to the aggressive Soviet Mars effort.

EIR: Could you please describe your background, and interest in the space program?

Edelson: My first career was as a naval officer. I graduated from the Naval Academy in 1947 and spent 20 years as a naval officer, and then retired. During my Navy service, I was an engineering duty officer, and I had some experience relevant to the space program. When I was posted to the White House for three years, in the Carter and Johnson administrations, I was a staff member of the National Space Council. I also served for several years with the Office of Naval Research in the development of satellite communication systems. I left the Navy in 1967 and worked for the Communications Satellite Corporation (COMSAT) for 14 years as director of COMSAT laboratories and as vice president and later senior vice president for engineering.

When I was at COMSAT, I had the opportunity to serve on President Reagan's transition team for NASA, so I got very interested in NASA and its activities. I was invited by [former NASA Administrator] Jim Beggs to be Associate Administrator for Space Science and Applications at the time of a NASA reorganization in late 1981. While I was at NASA, I was responsible for the $1.5 billion per year science program and the space applications program. In addition to that, I was responsible for two centers, the Goddard Spaceflight Center, and the Jet Propulsion Laboratory.

I left NASA in July and reported to Johns Hopkins University in August. I am now serving as a fellow in the Foreign Policy Institute of the School of Advanced International Studies. I'll be working in international technological and scientific affairs, doing research, teaching, and writing in that area.

EIR: In the international sphere, an issue has come up in the past year concerning the possibility of a joint U.S.-Soviet mission to Mars. This has been a very controversial issue since the Soviet Union is not a political ally, and is not involved with us in the space station or any of the manned programs at this time. What is your idea of how this question should be approached?

Edelson: I consider it a very attractive opportunity for the United States, on balance. With my own military background and my years of striving for U.S. technological leadership, I've had to wrestle with the question of whether cooperation with the Soviet Union to attain some desirable scientific and exploratory purposes would be done at the expense of some military or intelligence damage, or whether it would attenuate U.S. technological leadership. Having given that a lot of thought, and examined the program very carefully, I feel that it can be done in a way that not only doesn't diminish, but in fact increases our real and reputational leadership in the world in technology. I would claim that technological leadership is a force for national security in the same way that defense preparedness is, in a different way, but in many ways more powerfully than simple military preparedness. Let me go back and give you some of the history of this.

The Soviets have, in recent years, dedicated their planetary program very much to specific goals and have made significant accomplishments. The U.S. early took the lead and stayed way ahead in space science and space exploration. In the planetary area, we started out with the Mariner missions and the Viking, Voyager, and Pioneer missions, and explored both the inner planets and more distant planets, and carried on a great program of space astronomy and astrophysics, space plasma physics and Earth science from space. The Soviets attempted without significant or spectacular results to do much of the same.

However, in the 1970s, they decided to concentrate their program on the planet Venus, and over the last five years, have been extremely successful at it. During this later period of time, they've put four successful landers on Venus, which did scientific exploration; they put two radar spacecraft in orbit around the planet Venus and conducted very excellent microwave surveillance of that planet, using a synthetic aperture radar which demonstrates outstanding technology and very good science. In their Vega missions to comet Halley, they stopped by Venus and dropped off two balloons to make studies of the Venutian atmosphere, which were highly successful and again demonstrated significant technology. They do have something to be proud of, from their point of view, and they have an area of in-depth exploration of the planet Venus which greatly exceeds that which the United States has done.

Now they have shifted their emphasis to the the red planet. They have gone to unprecedented lengths to identify the specific missions and schedules which they plan to follow through the late 1990s, to the end of this century. They have lined up a program which involves a launch less than a year from now, June of 1988, the Phobos project, which will launch two spacecraft to Mars to study the planet itself, the moon Phobos in detail, and possibly, if they're completely successful with the first spacecraft, they will also explore the moon Deimos with the second spacecraft. Following that, in 1992 they're planning another Mars mission, an asteroid mission, and a series of Mars landers, rovers, and even a sample return in 1996 and 1998.

As you know, one can't go to the planets just any time you want, because of the placement of the planets. A good window of opportunity comes up only every 25 months [for Mars] and it turns out in even years now can we launch a mission to Mars. The United States, on the other hand, does not have a very significant plan to go to Mars. We have only the Mars *Observer*, which is a small spacecraft, although scientifically, a very important one, instrumented with outstanding instruments. It's only one mission—no back-up—and it will not be launched until 1992 because of the delay in all of the launch schedules we have.


Burt Edelson: "Much of the technology that NASA has developed has not been given recognition."

EIR: Will this be the first U.S. planetary mission that will be launched without a second, back-up spacecraft?

Edelson: Heretofore we have almost always launched planetary missions in multiples. There was a long series of Pioneers, there were two Voyagers, two Vikings, etc. However, now we have a single spacecraft for Galileo [to Jupiter], which should be the next one, and for Magellan, which is a Venus radar mapper. Parenthetically, what we're doing with the Venus radar mapper when we launch it, possibly in 1989 but more likely in 1990 or 1991, will be a repeat, with somewhat better coverage and somewhat better precision, of what the Soviets did earlier. It's an indication that we're not significantly advancing the frontier. The thing in our missions now, is gaining broader and deeper scientific data which is important and very valuable, but world acclaim goes to those who take steps to push back the frontiers as we did with Viking and Voyager, and which appears to be missing in some of the much less ambitious things we have planned now.

Back to your original question, on cooperation in a Mars program. With this new announcement of a new Mars schedule, the Soviet spokesmen, primarily Roald Sagdev, the head of the Space Research Institute, but also Valery Barsokov, the head of the Vernadsky Institute, have strongly invited the participation of U.S. scientists in their program and have publicly stated how happy they would be if the United States were to cooperate with them in Mars exploration. They have suggested joint Mars rover/sample return missions. The mission which they have suggested and even drawn on blackboards and shown on viewgraphs provides for an American large roving science base which is landed on the Martian surface, moves around with various scientific instruments, makes measurements of the Martian surface and the Martian atmosphere, and tries to get a penetrator into the soil. In addition, it picks up and maintains samples of the Martian surface.

The Soviets would provide a return vehicle. After the rover has done its scientific evaluation and picked up samples, the rover would rendezvous with the return vehicle, which the Soviets would have put down on the surface, and the Soviet vehicle would return to the Earth [with the samples]. The Soviets have also suggested that the European Space Agency might be responsible for the Mars orbiter which would provide communications, navigation, and orbital scientific support to the rover mission (U.S.) and the return mission (the Soviets). So we would have a true international mission with Soviet, American, and European contributions. They also have invited, but in more general terms, participation by the Japanese space agencies.

EIR: What is the current state of negotiations on taking the Soviets up on their offer? There have been differences of opinion on the U.S. side. Recently, the State Department refused to allow U.S. satellite owners to launch on the Soviet Proton booster, for example.

Edelson: The Soviets have specifically asked various scientists to participate in their mission, to provide instruments and to be co-investigators in various experiments. These American scientists have come to NASA and asked for guidance as to whether they can accept the invitation, and whether NASA would be willing to help support them financially, for example, with the instrument development program, or even just travel funding to go to the Soviet Union. Basically, NASA has kept them on hold and said, "We don't have any agreement with the Soviet Union on that, so we can't really allow or honor any commitments made by individual scientists." We do have an agreement, signed several months ago, with the Soviet Union to resume the bilateral cooperation that we terminated in 1982. So after a five-year hiatus, we do have an umbrella agreement, which allows us to cooperate with the Soviet Union. We have organized a number of [bilateral] committees, and one of them is on planetary exploration. However, this agreement does not provide for any intimate cooperation in individual missions such as launching our instruments on their spacecraft or exchange of engineering or design information of the type that would be necessary to integrate two spacecraft together or an instrument on a spacecraft. What it does provide is for coordination of approved projects, so you can't, under the agreement, originate a new project. What you can do, is coordinate existing projects. We've already had a meeting, and definitely plan to coordinate our Mars Observer mission with their Phobos mission.

With respect to a U.S. government response, we have essentially, officially ignored their invitation. We've said the Soviets have not actually offered an invitation to the United States government. What they have done is invited American scientists individually, sometimes in public speeches, such as the presentation Barsokov gave at the planetary exploration conference in Pasadena in May, in which he, as an individual, invited American participation in the Mars rover/sample return mission. My own feeling is that the Soviets will not embarrass themselves by making an official invitation which we would possibly refuse, but their senior officials have publicly offered the opportunity, and they're waiting for some kind of response from us before they take the next step.

I feel that we really have three choices: We can accept their invitation, and that's very easy to do by any statement or expression on the part of a senior official of the U.S. government, leading to conferences, and so on. We can reject their invitation and compete with them on a Mars rover/sample return. And number three, we can continue to ignore their invitation, not have a Mars program of our own, and go about doing different things, such as a comet mission, or a mission to Saturn—both of which we have planned—and not include a significant Mars effort. I think that number one—to accept—provides a very attractive opportunity. Number two, reject, would be a very foolish thing to do. It would cause resistance and resentment, not only of the international community, but of our own scientific community, and we would be without the ability to effectively compete. We simply could not mount a Mars sample return mission in this century. We don't have the capability to launch it, and won't for several years, let alone to design, test, and conduct the mission. Nor would we have the funds to pay for it.

EIR: Leaving the question of the money aside, you are saying that we have not developed the technology base to do a sample return Mars mission?

Edelson: No, I think it could be effectively argued that we do have all the technology that's needed. Basically, we don't have the operational capability to do it—the launching and logistics base. This would be a mission that would be of the same level of technology and same order as Viking [the 1976 unmanned landing on Mars]. Despite the fact that we have a lot more technology, and more modern technology to do it, which is an advantage, we have far less base to do it from, and much less operating capability. It's going to be years before we have an effective launching capability that we could count upon to meet a heavy-lift and short-window situation.

The third opportunity, ignoring it, is the most likely thing we will do; it is what we seem to be doing and there is no indication that we could gather our forces to change it. I think that it's a bad thing to do, because the Soviet Union which will actually do the sample return mission, with less science and less capability on the Martian surface than we could provide; they will do it to a great deal of international recognition and acclaim and that would be a great political loss for the United States.

On the question of technology transfer—you realize that the Mars rover/sample return mission, as I described what the Soviets suggested, has no technology transfer except on the Martian surface, so there would really be no necessity for the Russians and Americans to sit down together, to work at each others' factories, research laboratories, or to exchange design or engineering data at any intimate level. Of course we'd have to do our system engineering together to make sure that the whole program plays together, but that does not significantly hurt technology transfer.

Finally, I would say that the exchange of instruments which seems to have a lot of opposition on the part of the Defense Department, particularly, Richard Perle's old office, is in my opinion, a red herring. All of the responsible individuals in the study that was led by [retired General] Lew Allen [head of the Jet Propulsion Laboratory] and such knowledgeable people on it as [former CIA official] Bobby Inman, claimed that there was no significant technology transfer simply through allowing them to look at and launch a black box instrument; that there's very little they could observe even if they would do what we doubt that they would do, which is to saw open the box and take it apart, and look at the pieces and parts, devices and components that are inside the box. Reverse engineering of electronic devices and circuits is an extremely ineffective and inefficient way to gain technology.

Therefore, I think there is much to be said for [cooperation],. This mission is absolutely consistent with the unmanned planetary program in Sally Ride's report. The bottom line, as far as I'm concerned, is that we should accept the Soviet invitation to participate with them in a Mars rover/sample return mission in the latter part of the 1990s. The way to do that, I think, is to agree now because it doesn't cost any money and it doesn't involve any technology transfer, and it's politically stimulating and useful to agree now to sit down for two years and plan the mission. Then the decision to actually commit resources and do the mission is contingent on coming up with a good plan and is something made by the next administration, and doesn't commit us or cause any harm. It would be something that this administration could gain a lot of benefit from and it would fit in very neatly in the current high-level Soviet-American talks.

EIR: I know that your office had been involved in a study concerning the technnology developed from the space science programs. Most people are familiar with the new technology from the Apollo program, but do not know about the developments from the space science areas. Could you describe the study?

Edelson: NASA has two efforts which are aimed at developing technology. One is the space technology program in the Office of Aeronautics and Space Technology, and the second is the technology utilization program which is in the Office of Commercial Programs. The former tries specifically to develop the technologies which are foreseen to be needed in the next few years. The latter tries to describe and promote the new technologies developed into the commercial sector.

However, I've been aware for a long time, that much of the technology that NASA has developed has not been given recognition. New technology, I felt, was involved in the very advanced projects that we did—for example, to explore the planets, or to develop very sensitive instruments to explore the Earth, or celestial objects. I felt that those technologies were essentially not labeled and publicized because they were done in the course of and incidental to the development of space vehicles. They were performed under a program manager rather than a technology discipline manager, and they were generally [developed because of] obstacles that were overcome in the course of the program, and as soon as they were overcome, they were forgotten.

With that belief, I caused a study to be made about three years ago, which took two years to do on that subject: To what extent are important technologies developed in the course of major programs? We used the Hubble Space Telescope and the Galileo mission to Jupiter, performed under the direction of the Marshall Space Flight Center and the Jet Propulsion Laboratory, as case studies. We had a contract team investigate those two programs in great detail, speaking to the program manager, project manager, the people who worked on the program in the center, the project managers at the various prime and subcontractors, and in every case, with a series of questions, to try to identify what was overcome. It wasn't easy to do because those various individuals are not very attuned to this. At first, there was a little bit of resistance, thinking that the contract team was some kind of an auditing team to find problems . . . but I assured them we weren't trying to find errors or audit their books. Quite the contrary, we were trying to find significant successes that had been made in the course of the work.

The results were that they did identify in the two projects, just over 100 important new technological developments, and of those, about 10 were in the category "highly significant." They are in various interesting fields: in materials development, electronics, optics, structures, and so on.

I'll give you one example. During the course of the development of the Hubble Space Telescope, a subcontract was let to Boeing Aerospace to develop what's known as the metering truss and the focal plane support structure. The metering truss is the support structure which supports the telescope tube. It keeps it straight, keeps it aligned. It's big, it's heavy, and it has a tendency to warp from thermal conditions [alternating hot and cold in Earth orbit] and the focal plane structure supports the scientific instruments. There are five big instruments plus the fine guidance sensors that are attached to the focal plane and make various measurements. There are a couple of cameras, there are two spectrographs, there's a photometer, and there are three guidance sensors. There are eight of these instruments, and they are very big and very finely tuned, and they have to be supported very rigidly and they have to have outstanding thermal properties—since they have to go through some temperature cycle, they can't bend or warp because you're looking for a very faint signal and everything has to be aligned and kept aligned very accurately. Specifically, the telescope has to be kept aligned to seven milliarc seconds—7 thousandths of a second. There are 360 degrees in a circle, and 60 minutes in a degree, and 60 seconds in a minute, and this is 7 thousandths of a second. That's very fine. It's so fine that you could point at a dime from Washington to New York and you wouldn't wander off the dime, for a period as long as 20 hours.

So this very large structure had to be lightweight, rigid, strong, with a low coefficient of thermal expansion. It was a very difficult structural problem. Boeing chose to build this out of a graphite epoxy. They made basic advances in materials, basic advances in the forming of the structure, in the attachment of the structure to itself, and of the graphite structure to the metal structure [of the telescope] and basic advances in the major structural software program.

The [computer software] program that does this is one that's been developed by NASA over years, called NASCOM. It shows how to design complex structures, and this required basic additions to that software package. It was generally known by the project people that Boeing had done a good job, but they didn't realize what a marvelous advancement in materials and structural hardware and software technology had been made by Boeing. That was one of the things that came out of the study.

EIR: Did you find other areas where this new material can be applied, either in other areas of the space program, or in industry more generally?

Edelson: We didn't in this study. The study was simply to identify them. NASA is now presenting and explaining the study and circulating the study around, hoping to get people to do just what you suggested, which is to use this technology in other areas. First you have to recognize that it exists, before you can transfer it and adapt it to other purposes. There's the problem of intellectual property. Various contractors don't want to give to other contractors a lot of help in getting the technology. That technology is in the public domain, because it's paid for by the taxpayers' fund. However, there is a little bit of resistance on the part of contractors to do that. If that same contractor gets another contract, he will use the same technology again, but it doesn't get widespread use.

One example is painting. It's kind of a minor technology in coatings, of various kinds. If there's one aircraft contractor or missile contractor, and they have trouble getting the paint to stick to a certain kind of metal, the contractor screws around with and tries various things, and when he gets one to work, why he says, "Fine, now we know how to do that." So, he paints that missile or that airplane with that particular kind of paint that he's developed, and he doesn't make a big deal about it and his people remember that. But every other airplane or missile project that we've got, is going through the same difficulty, and they all have to solve that problem, over and over again.

EIR: The United States has developed an exciting array of Earth remote sensing technology over the years. It would seem to me that if you put all of the data together from the oceans, the land, and the atmosphere, you could get a three-dimensional picture of the Earth which would give you information about agriculture, fishing, weather, and many other things. Can you tell us about the international geosphere/biosphere program, that you have been involved in, which will be starting soon, to do this global remote sensing?

Edelson: NASA has had an outstanding program of development of remote sensing capabilities as part of its applications program, starting with the Tiros [weather satellite] in 1960 and going up through 1981. The work that was done was for practical applications, and we had separate programs for observing the land, the sea, and the atmosphere—we had a Landsat, a Seasat, and we have meteorological satellites that did those three. Our goals were practical. We were trying to predict the weather, find Earth resources, and we were trying to provide a better knoweldge of the sea for the Navy and commercial shipping, and for fisheries.

It wasn't until they joined the Office of Applications and the Office of Science together that we were able to join these three programs together, and understand that the whole is very much greater than the sum of its parts, in this regard. We then had a different mission to justify the work that we were doing, and that mission was science—an understanding of the Earth as a system, how it works, whereas previously our goals, though laudable, were narrow and had to be intensely practical. Now they could be broader and more generalized. There were immediately, we understood, several points. One is that there is a synergy between missions, and synergy between disciplines. We found that we were finding out a lot of information about the land from Seasat, and we were finding out a lot about water use, ocean surfaces, ice coverage, and other oceanographic concerns with Landsat, and we were actually using meteorological instruments to survey both the land and the sea. We had a lot more than we realized we had.

Second, by using two instruments or more, we could get a lot more information about the same phenomena. For example, we could take radar information from Seasat or SIR-A or SIR-B—that's the Shuttle Imaging Radar that we flew—and use it with the optical infrared (IR) we got from Landsat, and get a very interesting picture that you couldn't get either with the radar alone or the optical IR alone. We decided to embark upon a total program to look at the Earth as a system and provide large platforms which had on each platform a combination of instruments to look at the land, sea, and atmosphere; in addition, the biosphere, which is the biota of the Earth, the living systems.

One other fortuitous development occurred to us in 1982 and 1983 when we began to put the program together, and that was that the state of the art in computation had advanced enormously, largely for other purposes—the development of supercomputers for numerical aerodynamic analysis, and so on. What we found out was that we had two great advantages. One was the vantage point of space, to mount multiple instruments to observe the Earth in various parts of the electromagnetic spectrum, and the other was a very outstanding information system, including satellite communications links, supercomputers, and advanced software to analyze and distribute the data. So, we had all the makings of a global Earth-system information program.

With that concept only dimly in mind, NASA made a presentation at the United Nations UNISPACE 82 conference held in Vienna, in August of 1982. We made a wonderful presentation calling for a global program and we called it Global Habitability. That program was received with great interest by the scientific community in various parts of the world, but [with] very little enthusiasm politically, and became controversial in several respects. That program, although not accepted by the world community [at that time], was studied over a period of two or three years, by bodies all over the world—in the United States, by the National Academy of Sciences—and then [was] recommended as an international program, and recently adopted last September by the International Council of Scientific Unions (ICSU), as an international program known as IGBP—A Program for Global Change. IGBP means International Geosphere/Biosphere Program.

It has as its goal an understanding of how the Earth operates as a system; the oceans, the atmosphere, the solid Earth, and its vegetative cover all inter-operate; how the nutrient cycles work—carbon, nitrogen, phosphorus—how they circulate through the atmosphere, the oceans, through living systems, and how that system is changing. In particular, how anthropogenic effects are causing what we now realize is a delicate balance in the Earth's system, to change, and in many cases we fear, irreversibly. An excellent example that is in the headlines today, is the ozone depletion. We have, through space observations, found somewhat of a depletion of ozone, we believe throughout the atmosphere, but it's spectacular in the Antarctic region. We're not sure of how it is happening or what the causes are. The data are from recent years. We're not sure whether we're seeing part of a cycle or whether it's monotonic. We're not sure whether it's caused chemically, by the chlorofluorocarbons, or whether it's caused by or related to the solar cycle, or whether it's simply dynamic, caused by atmospheric movements. It's all part of this program.

Other parts of it that are causing us concern are the build-up of carbon dioxide in the upper atmosphere, the build-up of methane in the upper atmosphere, the problems of acid rain, of pollution, of changing land use, the cutting down of the tropical forests in Brazil and the desertification of parts of Africa, the burning of fossil fuels—all of these things are part of this global ecological system, and we now have the tools and the capability of getting an understanding of how this system really works, what changes are taking place, and possibly altering or reversing some of these changes. But first, we have to understand it. So this is a wonderful program.

Where we are at the present time is that the International Council has approved the program. It will be a decade-long program, probably starting in 1992, which has been designated the International Space Year. I just attended a meeting in Hawaii where there was a lot of support for declaring 1992 the commencement of the IGBP. ICSU has formed a secretariat to coordinate the program. Within the United States, NASA, NOAA (the National Oceanographic and Atmospheric Administration), and the National Science Foundation have all done a joint study and came out with a joint report, and we've all agreed to work together to promote the program. It doesn't call for lots of new money. It merely calls for coordination of the things we are already doing, or have firm plans to do, but to coordinate them and to use them for the benefit of the national program and provide the exchange of data. NASA is already spending between $300-400 million a year that is directly contributing to this program.

EIR: This program will not require or involve the launching of new spacecraft or developing new technology for the United States?

Edelson: We have an ongoing program that will do this. We have the Landsats in orbit, and we're counting on Landsat 6 and 7. We have UARS [Upper Atmopshere Research Satellite] which is to be launched in 1990. That's a major program. We have TOPEX, that we're doing together with France. Those are all parts of the program. Most important of all, we have the polar platforms in project EOS, Earth Observation System. The polar platforms are [part of the] space station. There's one American platform and one European platform, and those are the platforms that will carry all the instruments I mentioned before. Those programs more than justify the whole space station program. In fact, in my opinion, they are the most important part of the space station program, and they're not given much [attention] because they're not controversial. Everyone loves them.

EIR: But the program can start even now, in terms of coordinating the data that a number of nations are already accumulating?

Edelson: What the international office will do under the program will be the coordination, control, and accumulation of the data; archiving and distribution of the data, and holding of symposia every year on progress on the IGBP. The actual contributions to the program will be made by national projects. There won't be an international satellite—there will be a U.S., a European, a Japanese, a Russian satellite, and they will all be coordinated and contribute their data. An international team of scientists will work on the data. It requires scientists, from the countries I named, but also from Brazil and India, because they're big players in this, and scientists from China and from the black African nations. We all are concerned about the planet's future and we now have reasons to be concerned, and we hope to benefit from it.

EIR: Can this data also be used for positive economic development for the industrializing nations?

Edelson: Yes, we have a Landsat station supported by NASA in the past and NOAA, but it is mostly supported by AID [Agency for International Development in the Department of State]. It's located in Nairobi and it's used for surveys of resources, the expansion of the desert, the burning of fossil fuels, and even disease agents. They use it to understand and predict the flights of locusts, because they can understand where they would be harbored and borne by the winds, and so on. We've made a multi-spectral image of the entire African continent, and we do it over again each year. You can see the changes in the growth of the desert, in the rainfall, the concerns of land-use changes, and climatic changes. We've even found effects of *El Niño* [cyclical warm-water current off the Pacific Coast of South America] which was first found in the Pacific, but it's got relations in South America and in Africa. The Earth is a big system, and we know little about the transfer of energy from the oceans to the atmosphere and back and forth. Heretofore, these [aspects] have been studied by entirely different people, with very spotty information.

Take oceanography—ten years ago, if you went to an oceanographic conference, the people there would be shipboard people, and they would have information about the ocean that was taken from a dozen ships at various locations, at various times. If you plotted [the data] on the Earth's surface, you'd see very scattered data points. Now, more than 50% of the people at any oceanographic conference are space scientists, and they have information that is very comprehensive that covers the total Earth's oceans, so whatever data they have is synoptic.

Space: the national

by Caspar Weinberger

Excerpts from U.S. Defense Secretary Caspar Weinberger's remarks to the Air Force Association convention in Washington, D.C., on Sept. 14, 1987:

Since the tragic loss of the *Challenger* and its courageous astronauts, our entire space program, both civilian and military, has come under the most intense scrutiny. And this is as it should be. We owe nothing less to the *Challenger* crew and to ourselves than to uncover the reasons for that failure and that tragedy, and in so doing, to map the future of our success. But that scrutiny, for all its benefits, has generated some idle talk about America being lost in space and without a goal and without a mission. And I'd like to just reject that characterization, and I thought you ought to know why.

Today more than at any time in the 30 years now of our space program, it's essential for the American people to appreciate the real challenge of space, the national security challenge. And to do this, we must first understand how space relates to defense. We have to adopt a national security perspective, free from the misperceptions that so frequently infect debate about defense in space. As with any other arena, whether it's land, sea or air, space is a region of political competition. It can be free and open to use by all nations, as are the oceans on Earth, or it can be the sole possession of a single nation or a political ideology. Free access to space does not mean that all nations have equal means of using space.

But again, just as in the case with international open waters, it means that space is not the exclusive domain of any one nation. It means respecting the rights of all nations to use space. And as the leader of the free world, our goal has always been to ensure that no power could stand in the way of unrestricted access to space. And as with politics among the nations on Earth that the purposeful assertion of freedom only means something when and if it is backed by political and military strength, and this realistic view of space is informed by experience, and is consistent with the history of nations.

This view focuses clearly on our responsibility for deterring any effort to deny free access to space. And further, from this perspective, we can appreciate how really bogus is the Soviet charge that we are militarizing space. Such a charge is nothing more than that transparent propaganda they use so much, and has nothing behind it than the invidious intent to