The President's Commission on Implementation Of United States Space Exploration Policy

PUBLIC HEARING
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9:00 a.m. to 3:00 p.m.

PETE ALDRIDGE

Well good morning everyone. We are here as the first meeting of the Commission which is titled officially "The President's Commission on Implementation of United States Space Exploration Policy." As you notice, we have shortened it a little bit - the Moon to Mars Commission, because that's a pretty long statement to make for the official title of the commission. I'm Pete Aldridge. I'm the chair of this Commission. Before I begin I'd just like to inform you that there are some materials available, a press release and press package available, that talks about our charter and gives a little more description of the backgrounds of the Commissioners. I would also like to introduce Susan Flowers, who will be the media and public relations, there's Susan right there. If you need anything, materials, information about the Commission, you can contact her, Or you can go to the website, which is shown on the chart Moon to Mars.org. Much of the material will be in that website. It also provides a location for people who want to present written materials or comments for the Commission. That website is also available for you to do that. Each of the inputs will in fact be reviewed and provided as appropriate to the Commissioners for their deliberations.

We are here because the President has asked us to chart the course that makes it possible to successfully sustain the journey to the Moon, to Mars, and beyond. As our full name states, we are a Commission on implementation of President Bush's Space Vision. We are not here to challenge the Vision or to modify it. That debate has already occurred and the Vision reflects the President's decision based upon a review of all of all the alternatives and directions and affordability and sustainability. But, we are here to determine how we can successfully implement this Vision.

Let me introduce the other Commissioners. To my far right there's a blank slot. Michael Jackson is not here yet. He plans to be here. He is a senior vice president for AECON Technology of Virginia. He was a former Department of Transportation deputy secretary and was involved in Transportation Security Administration after the 9-11 event. Dr. Laurie Leshin, Director of Arizona State University Center for Meteorite Studies and a distinguished professor of Geological Sciences at the university. Her research focuses on understanding formation and evolution of our solar system. General Les Lyles, U.S. Air Force, retired. A four-star general from the Air Force having devoted some 35 years of his life keeping the Air Force systems at ready. He was commander of the Air Force Materiel Command in his last assignment. He has been involved in space throughout his entire career. Dr. Paul Spudis, planetary scientist at Johns Hopkins University, Applied Physics Laboratory. His specialty is in geology of the Moon. He was a deputy leader of the science team for the Clementine Lunar Mission in 1994. Dr. Neil

Tyson. Neil is the astrophysicist and the director of the Hayden Planetarium in New York City. His professional research interests include star formation, exploding stars, dwarf galaxies, and the structure of the Milky Way. In 2002 he served the Commission on the Future of the U.S. Aerospace Industry, which it so happens was chaired by his next door neighbor, Bob Walker. He is the chairman and CEO of The Wexler and Walker Public Policy Associated. While in Congress from 1977 to 1997 he represented Pennsylvania As he served as chairman of the House Science and Technology Committee with NASA oversight. He recently, as I mentioned, served as the chair of the Commission on the Future of the Aerospace Industry in 2002. Dr. Maria Zuber. Maria is the E.A. Griswold professor of geophysics and planetary science at the Massachusetts Institute of Technology and leads the department of Earth, Atmospheric, and Planetary Sciences. Dr. Zuber has been involved in more than a half dozen NASA planetary missions aimed at mapping the Moon, Mars, Mercury, and several asteroids. Carly Fiorina is unable to be here today, but she serves as the chairwoman and chief executive officer of Hewlett Packard. She joined Hewlett Packard in July 1999 after having served as senior executive leadership positions at AT&T and Lucent Technologies. I'm Pete Aldridge, as I mentioned. I retired from Government service just this past May and also industry service. I was formerly under secretary of defense for acquisition, technology, and logistics, I was Air Force secretary, Air Force undersecretary, and director of the National Reconnaissance Office. I spent most of my career in space system planning and technology and space program management. Last but not least, Steve Schmidt at the end of the table is our executive director and is the designated federal official for this Commission.

The Executive Order establishing this Commission was signed on the 3rd of February by the President. The mission is to provide recommendations to the President's Vision as outlined in his policy statement, a renewed spirit of discovery. Specifically he asked for a space science research agenda, the exploration of technologies, demonstrations and strategies for sustained human and robotic exploration, the criteria to select future designations for human exploration. A long-term organizational options for managing implementation, the roles for appropriate and effective private sector and international participation, methods to encourage youth to study science, math, and engineering, and management of the implementation within the available resources. We understand that the keys to success of this Vision are sustainability and affordability. We had our first administrative meeting yesterday, February 9th, and we are delighted to be here today. We have 120 days to produce a report and an additional 60 days until the Commission officially closes. We expect to have several more hearings around the country to hear from the U.S. public and other organizations about their ideas for implementation and for sustaining the journey. The commission also understands that its customers are the President and the American people. We are seeking from these public hearings input and comment from various individuals and organizations on this implementation plan. In our early discussions we see four themes emerging. Science and technology to implement the Vision; education and youth to sustain the talent base; management processes and sustainability for such a major effort; and competitiveness and prosperity for the benefit of Americans and all of mankind. We are delighted to see the expression of interest by the number of people who are here in the audience today, and we look forward to 120 days of intense work, comment, and hopefully, some very positive results. This morning we have our first witness. Ray Ernst of the Aerospace Industries Association and the hair of the space council of that organization. Ray, welcome. We look forward to your testimony. There will be a period after your testimony for some Q’s and A’s.

RAY ERNST

Thank you and good morning. I'm delighted to be here, but certainly I'm here not for myself but on behalf of Mr. Douglas, who had a personal vacation commitment that he could not break and I understand that completely. But certainly if he were here he would be here with great enthusiasm and would probably have difficulty meeting the 30-minute limit, as most of you know.

PETE ALDRIDGE

Those of us who know John clearly understand that, yes.

RAY ERNST

I know John as well and I, of course, am going to try to keep the Commission on schedule and not get behind. So I just have a few slides for the remarks we are going to make. But also before I begin I would like to introduce the person on the right is Bruce Mahone who is the executive director of the AIA Space Council and was instrumental in helping poll the committee at large with various telecons over the last few days to gather all of the necessary comments from all of our members before these remarks were prepared. So I appreciate that very much and appreciate Bruce being here. And also, he is the guy that can help answer any other overarching AIA type questions that I won't be able to answer if we get into the Q's and A's. If I can have the first slide.

Those of you who aren't aware of what the AIA organization is, this represents primarily the entire aerospace industry infrastructure and these companies here, the 35 member companies, primarily constitute almost 98percent of all of the manufacturing of the space hardware that the country employs. So, in addition to these 35 members, the AIA of course, is made up another 204 other aerospace type organizations, all of which provide input and direction to what the AIA goals and objectives are. With that said, I will start

With the first chart, please, or the next chart. I want to start off and obviously talk about what AIA's goal or view of the Vision is, and of course we are delighted. We think this is exactly what NASA and the U.S. government needed to maintain leadership in both human space flight and space exploration as a whole and we are delighted with the President's initiative and we are basically on board 100percent. We feel that this obviously extends to the far future and provides the necessary measurable goals and leadership and objectives that the aerospace industry was looking for and hopefully will join in and support this activity 100percent. In addition, obviously it pulls together many of the main Enterprise programs within NASA and brings them into a common goal and initiative that I think will help pull this together and gain the necessary support that is needed. In addition, we feel that there has been a clear definition of the funding that we have seen from NASA. Most recently released in the President's '05 budget request. NASA has done a great job most recently in getting out and talking to the industry in the D.C. area and particularly explaining exactly what is in the budget and where all the budget numbers were developed from. They have mapped that out very well and we think that so far from what we have seen, we believe it is achievable and affordable and it is going to take leadership from

within the Government and cooperation with the industry to achieve that objective. In addition, one of the main Goals that you mentioned, we believe it will excite students. It already has excited the students who have gone to the websites and looked at the Mars rover data base that is coming back from that and I think it will continue to do that and bring the necessary qualified talent into the Government and industry that we know we so desperately need. In addition, it is going to sustain the workforce at large and obviously will strengthen the industrial base, which has been notably concerned about programs and future commitments from the Government for financial health. So, with that, we think that this overall is enthusiastic and we are looking forward to joining in this program. If I can have the next slide, I wanted to just briefly talk about what the AIA has been doing over the past several years before this plan became public. We supported these kinds of activities from the Space Council itself and then at AIA at large. Starting primarily back in the mid 2002 time frame, when the White House began an initiative to update some of the space transportation policies, particularly the space transportation policy, we energized the group and came on board fairly hard with some program recommendations and plans and particularly covered these four areas. We primarily wanted to see if we could get some near-term focus on some of the issues that were facing the country with respect to the infrastructure of the Shuttle, the Space Station, and identify some of those critical issues that were important to understanding when those programs were going to be phased out, what the objectives of those programs were going to be, and how we in the industry could get on board with new programs and initiatives to support those activities.

It also recognized and we were outlining some mid-term and long-term goals specifically recognizing that if we were going to move past the lower orbit syndrome we needed get some clear definition on were we going back to the Moon or send people to Mars in the near around far-term time frames. It also laid out a recommendation for a strong road map identifying some specific objectives and measurable goals and likewise also asked for industry participation so that we could be involved in the regular updates and course corrections for these kinds of activities as were necessary throughout the years. Again these activities even in 2002 now are fully supported by the President's initiative and we are delighted with that. A couple of other initiatives on the next slide that were not specifically rated to the space transportation policy per se, but were also generic in support of a plan of this nature.

We went on various white paper distribution lists and went over to Congress particularly on a regular basis either through direct member contacts or with Munchkins talking directly to the constituents about increasing the space science and technology budgets. We felt that we were very successful in using a lot of the historical database that was available, talking about the small investment that the country makes in necessary underpinning science and technology for the space programs and felt that it was necessary to increase those budgets in order to maintain U.S. leadership in space exploration. In addition, as I mentioned earlier, we were always concerned about the U.S. space workforce and the industrial base and we were particularly at that time talking about maintaining the number of scientific missions that were in work at NASA and, of course, we are seeing the fruit of those benefits again with the Mars missions as well.

We also were outlining some recommendations for stronger procurement strategies. Not necessarily saying that the majority of the contractors who work for NASA don't have firm contracts for the larger flagship programs like the Space Station and the Shuttle program, but

there are member companies that have only an Indefinite Delivery/Indefinite Quantity (**IDIQ**) type of contract where it did not provide some adequate necessary specificity for numbers of hardware commitments or contract arrangements in that regard. So, again all four of these initiatives that we had underway are now clearly defined in the President's initiative and we are supporting this as well.

If I can go to the next slide, we also, in the mid part of 2003, were lining two issues that the AIA takes on every year, and that is, we identify sort of the overall top arching goals or top 10 issues that the agency is going to take on and press for issues and resolutions in the year 2004. One of those top ten issues was specifically focused on developing a strategy for the next generation of human space flight. This was primarily aligned with NASA's Space Launch Initiative (SLI) efforts at the time and the movement toward an orbital space plane activity and development that was going on at that time frame. In addition, the AIA also prepares a very rigorous list of issues for the election candidates across the country and identifies more than 10, but a numerous number of goals and objectives for those election officials. One of those issues there was to commit to replacing the Space Shuttle with a more modern, human transportation system and again not necessarily identifying the specific time frame for when the Shuttle was to be retired but also just as the normal DoD Air Force Fighter Program where a development effort is started before you retire an airplane type system and bring that on way ahead of time.

So again, these two initiatives that we were pushing for are again now defined and definitized in the President's plan and we are delighted about that. If I could have the next slide please. These are the areas that really address some of the issues that we would like to present as an industry as a whole and have some concerns. One of the things is we feel obviously that the U.S. Government must utilize the enormous leverage of U.S. technology and investment In our companies that we have made over the years and although we encourage international participation in the endeavor, but we are also encouraging to make sure our foreign partners bring adequate investments along with those so again it doesn't jeopardize any industrial based concerns we have as a whole.

In addition, it was mentioned that there was a potential gap if the Shuttle is retired in 2010 and the Crew Exploration Vehicle is not brought on line until 2014 there will be a gap in capability to support the Space Station. We feel the U.S. companies have a capability to support that activity as opposed to just going directly to our foreign partners and suppliers. We feel that we have been working with NASA and other Government agencies with respect to support of the Space Station for cargo and for other services as required and that we think that we have some capabilities and technologies that could be provided either in a prime or backup situation in that regard. Likewise, we should certainly want the Commission to recognize and country to recognize that the enormous investments in the U.S. space transportation assets particularly with the EELV Program and the Government and industry investments that were made there, as well as the enormous investment in the Space Shuttle as a whole in terms of the infrastructure there, to look to those and understand as the space transportation requirements mature to support this initiative that we first look to those U.S. assets for those kinds of transportation requirements.

Lastly but certainly not least, we want to maintain the emphasis and balance that was identified in the plan relating to robotic and human missions. Several of our member companies obviously

support the robotic technologies and spacecraft efforts and they certainly don't want those to be overshadowed by the human aspect of the space transportation initiative. In addition, we feel that the other enterprises at NASA are equally important and obviously our member companies are supporting the Earth sciences and other sciences missions and the aeronautics program and we feel there should be a balance maintained to continue to study the Earth and the benefits that we obtain from those initiatives as well and hopefully the funding for those programs will continue to go on as well.

Lastly but not least, I think that NASA and the Government can benefit from the cooperation with other Government agencies in the pursuit of this activity, specifically with respect to, again, leveraging the numerous numbers of technologies and common technologies and infrastructure areas that I mentioned earlier certainly will be a benefit as a whole and lower the cost to the Government for these types of initiatives. So, again if I can have the last chart. In conclusion, we are delighted and we think that this is obviously what the country needs in the space exploration type initiative for a long-term endeavor that obviously can excite the nation. It also can reap the benefits of what we all know has been a benefit from the space transportation programs and the space exploration programs in the past. We have had numerous spinoffs from those that we have all shared and enjoyed. We also feel that of course, that this initiative provides the necessary foundation and justification for long-term investments in the technology and people and infrastructure that are going to be needed to support this initiative. We believe that this will help the industry to align its IR&D and investment programs to support this kind of activity and will obviously inspire, I think, the students and public support that this kind of exploration provides.

So, in summary, I think that we, the AIA, look forward to continuing to work with you over the time period that you have allotted, Pete, and that we support you and will support NASA and will support Congress in this effort and do everything we can to support the President.

PETE ALDRIDGE

Thank you, Ray. You made a comment earlier about stimulating the public interest. We had a fact finding meeting yesterday in which the deputy administrator of NASA commented on the fact that the Opportunity and Spirit missions, there's a webpage that people can go to get information and they had five billion, billion with a b, hits on that website from very young people to very old people. So, it does have a certain amount of interesting appeal. I have a question, then we will open it up for the rest of the Commissioners. Has the AIA looked at any unique management ideas as to how to make this project sustainable over the long term? It doesn't appear that this kind of system of capabilities can't necessarily be managed as business as usual. Is there any thought being given from the industry of how they might advise NASA how to better manage such a large scale effort?

RAY ERNST

We haven't really begun a discussion of any detail in that regard, Pete. But I can say that we would welcome the insertion of industry ahead of time in this deliberation as to how this initiative unfolds. And I know that we have been in talking with both Congress and NASA as an AIA organization and have been particularly pushing for the fact that we want to have industry

being involved in the level zero and level one requirements developments so that we can make certainly some of the architectural recommendations as well as some of the managerial recommendations you are talking about. So I think that it is an excellent point, and I believe if you do allow either through AIA or directly from gathering information from industry in those regards, I'm sure we can come up with some innovative and new and exciting programs and plans in management structures to work that.

PETE ALDRIDGE

Well, I would encourage you if in some future meeting if you could develop some ideas along these lines we certainly would entertain them as part of our deliberation.

RAY ERNST

We will take that as an action and work it with the committee.

PETE ALDRIDGE

Les, did you have a question.

LES LYLES

As a follow-up to the same subject, knowing how AIA works it would be very helpful if you could poll your constituents and provide us some thoughts on the management structure just as Pete mentioned. I think you can do that in very short order in time to feed into some of the deliberations that this body is going to portray. I don't mean to give you a tasking, but that would be very helpful.

RAY ERNST

No, no. We accept these kind of taskings and like those. I just failed to mention that obviously the membership is tied very directly into our CEO's and we can obviously energize the highest levels of our companies to make those kind of recommendations, which I think you will find very hard hitting and helpful.

LES LYLES

In addition Ray, you mentioned the comprehensive Space Transportation Plan of 2002 seems to have been very much in sync with the President's Vision. Are there any gaps? Anything that you covered in that plan that you think perhaps has not been addressed by the Vision. Any areas of omission from your perspective?

RAY ERNST

We really didn't. I mean at the time we didn't have the benefit of this Vision. But we were particularly just generically talking about a lot of the things that are now being brought out with

more measure and specificity and more goal directives. So everything is in a line. But we found nothing that pretty much is glaring as an omission in at least the planned updates to the policies that you talked about. So, we are planning to obviously be on board.

Right now we understand the White House is, now that the CAIB (Columbia Accident Investigation Board) report is over and the Commission, or this initiative has been announced we understand they want to bring the Space Transportation Policy back out and update that. It hasn't been updated since 1994. So the AIA had provided a position paper into that before they put it on the shelf and we plan to be putting in a position here shortly to help them with the final rewrite of that plan.

LES LYLES

It may be helpful to the Commission members if – and I'm sure we have it in our reference library but just in case – your plans, particularly the short-term and long-term goals and a road map might be very helpful to see.

RAY ERNST

Bruce can provide you the specific inputs that we have given to them and I'm sure that you are going to hear from the other associations and they were as well involved in that and we even coordinated with the other agencies and associations around town to make sure that we were sending in the right messages and that we didn't look disjointed in that regard. So that is a good tasking.

PETE ALDRIDGE

Any other... Yeah, Bob.

BOB WALKER

Ray. It seems to me that one of the real strengths of the President's Vision is the fact that it is long-term and something you identified in your remarks. Also one of the problems with the President's Vision is that it is long-term in terms of sustaining the funding and all of the things that will be necessary. When you say that AIA is 100percent on board, does that mean that AIA is prepared over a period of 15 to 20 years to keep the same kind of focus that the President is basically demanding inside the space program?

LES LYLES

I think speaking on behalf of all of our companies we would be delighted with this kind of focus and I think that obviously it is going to take cooperative leadership between the Government, the industry, academia at large and I think we would like to be involved on a regular basis in these kinds of course corrections. We mentioned earlier that at the time back we were recommending an annual review at least of the Space Transportation Policies as an initiative. But certainly I'm sure there are going to be many opportunities for reviews as we move forward and course

corrections as the architectures get understood and changed. So I think we are delighted for that. I think it is going to take some good solid leadership and cooperation and forcefulness to maintain the financial commitments both on the Congress and the Government at large. So, I think we are delighted to get on board and support that.

BOB WALKER

As you and the organization are well aware, the problem on Capitol Hill is the budget process is now broken pretty badly and we have come to rely upon 1-year appropriations bills to do all of the policy making and everything else. And the question really becomes one of how do you, in 1-year segments, maintain this sense of continuity of going forward. AIA can certainly be a very, very good instrumentality from the standpoint of keeping that focus and making certain that as we go year to year that we don't get off track. So I thank you for your comments

RAY ERNST

And we plan to continue to develop the constituency and the cooperation of all of the Washington associations together. We are already starting to work together. We are also talking about the kinds of support from all of our constituent members which all of the constituent bases in their districts for the Congressional support. So we like that kind of tasking and we can energize all of our companies to make sure they regularly visit their member constituent bases on the Hill or in their states and support this initiative. So I think it is one of the pseudo kind of grassroots efforts that we can take on.

BOB WALKER

That was the appropriators calling.

RAY ERNST

I was just going to say. Do you have to go vote?

PETE ALDRIDGE

Yes, Neil.

NEIL TYSON

Could you comment broadly on the relative value to you -- you are the whole industry now for the point of this conversation -- could you comment on the relative value between legacy management and the sort of the experience from the history of sort of systems engineering brings to senior management, versus the value that sort of the fresh thinking might bring from a next generation of engineers that might enter the workforce? I ask this because, if I remember my numbers from my service on the Aerospace Commission your industry lost a half million jobs over the past decade and a half or two decades and it is tough in that climate to say come and be an aerospace engineer to the next generation of students. So, given that that might experience a

turnaround going forward, are you inclined to go back to the laid off or the retired set and say come back in, we need you. Or are you prepared to sort of reinvent what is necessary going forward with this Vision? Or some combination of the two? I would just like some insight into how you would manage the personnel issue going forward.

RAY ERNST

I think we currently have a very well trained and energized and committed workforce. Yes, it has come down over the years and I think most of you are aware of all if that as well as we in the industry are aware of that. But I believe that what was lacking is one of the, again one of the focuses that you are going to work on, is what excites the students to go into the science and engineering fields. Certainly I think that there has been a sort of a lack of real enthusiasm on that part and that is why we have seen the decline in enrollments in those regards. So I think industry has gotten a lot better with technology, computers, the information age, the World Wide Web. I think that this is a better trained and more educated workforce. So I guess I am going to say I think its going to be a balance of both. I think that we are ready and the industrial base is there and I think that the concern is to maintain that and not let it further erode without the Vision that we have been seeing. And if we were just going to continue to idle and step to the right it may have continued to erode into other types of industries where not only the students but the leadership as a whole would be going to. But this way I think that we can get back to the excitement that was there for the initial early phases in the 60's and 70's for the space exploration activity and do the kind of jobs that I think the President and the country needs in this regard. So, I guess I'm kind of thinking that it is a little of both.

NEIL TYSON

Of course this next generation becomes your senior managers 20 years from now. So that's really important.

RAY ERNST

Right. So it is fundamental we get them excited now.

PETE ALDRIDGE

This is a long-term program obviously and it is going to be running for 40 years. I think Tom Stafford said something about 100 years. But some of the senior people who will be working in the later phases of this Vision are not even born yet. And so hopefully we will have some kind of incentive for these people when they get to the point of choosing their career They have an incentive to enter the science and math and engineering fields that are going to be necessary to sustain the talent base.

NEIL TYSON

Engineering kindergarten. Is that what you mean?

PETE ALDRIDGE

Great idea.

RAY ERNST

Bruce just passed me a note to remind me that AIA has taken on a fairly national rocket launch contest and I know they had a very successful one last year and this year's date I believe is May 22nd. So AIA is trying to energize the youth and is doing it through several means. But that is one and had fairly successful participation in that. So, if there's any, you know, young people listening that enjoyed that rocket launch contest, the next one is on May 22.

PETE ALDRIDGE

Very good. Yes, Maria.

MARIA ZUBER

You made the comment that other NASA missions were important and that it was, there was an importance to having stable funding in areas of Earth science and aeronautics. Do you see this as being part of the President's focused Vision, or do you see that as on some parallel path?

RAY ERNST

I think that the Earth sciences that were talked about and the aeronautic sciences were not directly part of the President's initiative because I think initiative as again, as your Commission's title is, it was mostly focused on exploration of the Moon and Mars and beyond. But I think as I mentioned the synergism between the Enterprises and how it has pulled the NASA Enterprises together, I think that it does sort of underpin the fact that we shouldn't forget the Earth and necessary science that comes from that as well as the space exploration activity. So there's benefits and spinoffs that occur from that that are available to the public from understanding and knowing more about our Earth and our systems and it needs to continue.

PETE ALDRIDGE

Yeah. Laurie.

LAURIE LESHIN

I'm a scientist but I'm coming up the curve -- and I'm interested in expanding a little bit on what Pete mentioned earlier about getting some examples of lessons learned from the partnership between industry and NASA on things like Shuttle and Station and capturing lessons learned on the robotics side as well. Can you articulate for us, what does AIA gather that in a reasonably distilled form or is that something that could be done in short order?

RAY ERNST

I'm not an expert on those programs so I might ask if Bruce would comment on those activities At large and maybe you can help me.

BRUCE MAHONE

We, as an association can gather any kind of information you want. Usually when it gets down into the programmatic area each company that has a contract will deal with the Government directly as their customer and we as an association tend to work the bigger picture policy issues. So it's not something we have gathered to date. But knowing the time frame you are on and the responsibilities you have we can get with our members and try to expedite gathering general principles That all our companies have learned from their various missions they have worked on to perhaps give you some suggestions. So we would be happy to do that.

LAURIE LESHIN

You were asking about management.

BRUCE MAHONE

We would be happy to do that and expedite and try to get you something in the next 30 days so you would have time to consider it.

PETE ALDRIDGE

Yes, Les.

LES LYLES

Along those same lines. The IR&D (Independent Research and Development) budgets of industry will be important in this particular endeavor both from long-term and even short-term. I think that we all know that while Government research and development dollars go a long way to help us develop various programs we are also very much dependent on industry's commitment and resources and R&D and science and technology. It would be helpful for us to get a feel for some of the broad numbers, the percentages of dollars you have associated in IR&D that may be helpful toward this long-term Vision. And, any comments on whether there is a commitment on the part of industry in the future to increase some of those independent research and development funding and in what specific areas. That might be helpful for us to understand.

RAY ERNST

Absolutely. I can only speak for only 1/35th of that operation so I won't try to characterize it as a whole. But as you know we particularly do focus our IR&D's for near-term returns and identify for long-term initiatives. So we will take that one as an action item to see if we can't gather from all of the members Certainly what kinds of commitments or investments or just focus areas we

can identify that might help align up on those things. Of course, I think that working together with NASA and other agencies and particularly how we have been supporting the DoD, supporting other agencies on their technology road map plans we have again been intimately involved with them in trying to align with that increase in the space science and research I talked about. That the leverage of all of those technologies pulling together and sharing investments is always a better answer than trying to duplicate efforts as a whole. So we will take that as an action to see if we can help to define that a little better and get our members coordinated to gather that information as well.

PETE ALDRIDGE

That is an excellent point. Sometimes when you are in an agency you focus on the activities there even though there's a lot of coordination between NASA and DoD and Department of Energy and other places. Really, industry sees that better than anybody else because they have to deal with multiple customers. And when the industries work in a technology activity, they probably have more, a better understanding of the application of that technology to multiple missions, perhaps than even the missions do. And it does raise the issue of whether, in polling your industry on these technology questions, it may be helpful to see when there's a technology being worked by the Department of Defense -- and I know a lot is going on in the Defense Advance Research Project Agency (DARPA) within the industry -- having industry identify that is a technology that might be applicable to this Moon-Mars mission and call that attention to NASA and to the Commission. It may be quite helpful because NASA may not know that DARPA is working on this particular technology but you would see it as clearly application to this new mission.

RAY ERNST

We have seen that in the past and we recognize that and we have been asked in the past to try to provide those comments and recommendations. We will be glad to do that and take that as another action item. I will only say that in the past it has been a little bit limited to be able to only do that at the very top levels because, of course, our member industries always try to protect sort of specific IR&D and proprietary technology. Therefore, I might recommend that you certainly would want to either visit or ask industry to come in specifically in a one-on-one environment where you can begin to see that. Again, that takes time from your standpoint doing that in serial fashion. But we will do the best we can but because of the proprietary nature of data we have been limited to provide top level overview.

PETE ALDRIDGE

I think in 120 days we won't have time to delve into very much depth but we are interested in those enabling technologies, those that make a difference of whether you can achieve the mission. Long-term life support areas would be one.

RAY ERNST

Clearly we can give you that input.

PETE ALDRIDGE

So I think focusing on those enabling technologies may be able to give us some indication of making sure we have adequate work going on in those areas if we were to be successful.

BOB WALKER

Along those same lines, has AIA yet had a chance to look at the Challenge Program included in the NASA budget and decide whether it may inspire industry to look for innovative ideas?

BRUCE MAHONE

I would say from everything we have seen it is very positive. We haven't been able to have time to discuss it as a whole to see if it is everything that is needed. But everybody I have talked to says it is a very positive move to have those kinds of incentives there. So, we will encourage that and support NASA on that. As time moves on we may ask them to increase that program.

BOB WALKER

I for one would be particularly interested in getting feedback on that to see whether or not an expansion of that kind of effort may be in line with some of the innovation that will have to be brought into moving the President's Vision forward. So, if you have those discussions and can give us some guidance it would be helpful.

BRUCE MAHONE

Glad to do it.

PETE ALDRIDGE

Anybody else? Ray, thank you very much. You have some homework to do. We will certainly appreciate all of the inputs you have. Any ideas, we are open to hearing them.

RAY ERNST

We look forward to working with you and know you have a major task and we will try to be timely in our responses.

PETE ALDRIDGE

Thank you very much. We have another witness. I hope he is here. Mark Bitterman. Susan is going to get him, I believe. Mark Bitterman is with the U.S. Chamber of Commerce and The Space Enterprise Council. I'm sure he will have input for us on the impact that this initiative has on the Chamber's Activities. Mark, thank you for coming. We appreciate your testimony and making time available for us. We will go ahead and proceed with your testimony.

MARK BITTERMAN

Thank you. It may take a moment to get the view graphs up.

PETE ALDRIDGE

Ok.

MARK BITTERMAN

There we go. Chairman Aldridge, other distinguished members of the Commission, I want to thank you very much for this very unique opportunity to testify before you today. It is an honor to be representing the U.S. Chamber of Commerce Space Enterprise Council before this esteemed panel. I believe President Bush chose wisely in bringing together some of the best minds with diverse experience to implement his Vision for a renewed spirit of discovery and his NASA budget submission for fiscal year 2005. First, a few words about the Space Enterprise Council. As a vital component of the U.S. Chamber of Commerce, a national organization representing over 3 million businesses and 800 business associations, the Space Enterprise Council is uniquely qualified to address space issues from the full spectrum of American industry. Manufacturers, service, and data providers, IT companies, engineering and professional services firms, and law firms. What our members have in common is a dedication to the promotion of commercial activities in space and on the ground that make possible the extraordinary human successes outside of Earth's atmosphere. Although not our main reason for testifying before you today, we do want to state for the record that the Space Enterprise Council strongly supports President Bush's Vision for space exploration. Tom Donahue, CEO of the U.S. Chamber of Commerce, in a letter to Vice President Cheney dated December 9, 2003, called upon the Administration to articulate a space Vision for the nation. Vice President Cheney's personal involvement in the development of a national space Vision was obviously key to getting space back on the national agenda.

Our membership could not have been more pleased when on January 14, 2004, President Bush laid out his space Vision in a major speech at NASA Headquarters in Washington. The organization will help build support by assisting the business community, Congress, and American people in understanding the economic benefits of space exploration. Over the last 40 years the space program has yielded significant economic benefits. These benefits also illustrate how space systems and technologies directly touch people in communities across the country and around the world. For example, we have 25 million U.S. subscribers of direct to home or d.t.h. teleVision, 10 million global positioning system users and two million users of satellite radio. Most dramatically demonstrated in recent weeks, benefits of space reach into our homes, schools, and businesses by way of excitement about new discoveries. Over 6 billion hits were made on the NASA website since the landing of the Mars rovers last month and the billions of hits recorded on Hubble Space Telescope images reflect an underlying fascination with space among mainstream Americans. It is this flow of excitement that can be tapped and sustained if we are skilled at implementing this new Vision. Today's kids in elementary, middle, and high schools are, after all, tomorrow's aerospace engineers, scientists, and astronauts. Their

motivation to stay on this path will depend on how well we, your Commission, NASA, the space business community, execute on commitments to Plorings being made today.

Where all the interest will lead us is often impossible to predict. The lesson of history outside the space sector is that exploration has led to economic growth in many unanticipated ways. When Columbus was tasked by the Queen to seek spices in the new world little did she know a new continent would be discovered and economic benefits would flow from that decision to explore the unknown. President Bush got it right when he cited Thomas Jefferson's decision to send Lewis and Clark to explore the west. Those responsible for investing in and authorizing the journey could never have anticipated the expansion of America into the west and the many scientific and economic discoveries that would follow.

More predictable and certain is the positive impact of the new exploration policy on the aerospace industrial base. We welcome more interest in and excitement about the math and science curricula that ultimately produce the engineers and managers our industry requires to remain competitive. We welcome the increased investor confidence in the sector the potentially higher profit margins and stock price appreciation. Our businesses recognize however that these are but by-product, not a goal of the policies and programs.

Less obvious and less self-serving are those benefits accruing to those industries outside the aerospace sector. Continued progress of the human robotic endeavor in space has positively impacted a large segment of industries such as medicine, computer technology, and public safety. Industrial competitiveness of the United States abroad has also benefited in no small measure from space-related technological advances that kept U.S. businesses in the lead across many market segments. Today U.S. firms completely dominate the worldwide market for high-resolution commercial imagery. Our information technology sector is second to none. The routine use of DoD's GPS satellites at the consumer level has been a remarkable achievement.

These successes have been great but challenges abound. Other nations continue to eye space as a vehicle to gain a competitive edge and this Vision provides an opportunity to solidify long-term U.S. leadership in space congress. As this Commission ponders implementation of the policy, we believe it critical that you remain cognizant of the multidimensional nature of the space enterprise. Looking at this fairly simplistic pie chart on the view graph in front of you -- I hope it will come up. I'm not sure you can see it clearly. But looking at this, one can clearly discern that NASA’s investment in space represents a mere 15percent of the total annual global space expenditures of approximately $100 billion. Commercial satellite services represent the lion's share of global economic activity at $40 billion. U.S. national security spending is next at $30 billion followed by user equipment such as GPS units at $5 billion. The international marketplace has the rest of the share at about $10 billion.

Space is indeed a vacuum, but however NASA chooses to implement the President's policy steps should be crafted in the context of worldwide space activity and how NASA's programs benefit from and impact the other slices of the space pie. Just as space enterprise is multidimensional the full range of American business must similarly be mobilized and act to achieve common space goals. None of this will be easy. Then again barriers are nothing new to the space community. On a technological level many of the technologies necessary to fully implement this

space exploration policy do not currently exist. The effects of long duration space flight must be mitigated. The question of whether a new launch vehicle will be necessary for replacing the Crew Exploration Vehicle (CEV) on a course for the Moon, Mars, and beyond has yet to be addressed. Economic barriers are high. Concerns about the cost of fighting the war on terror, deficits, fiscal effects of the coming wave of baby boomer retirements all weigh heavily on the minds of citizens and their elected representatives.

Compounding the problem is the knowledge that the ultimate costs of large new Government programs are often poorly understood. By definition a large Government program brings with it all of the familiar political barriers. Allies and coalitions are absolutely essential to the success of such programs and yet we live in a town, Washington, where most often the only friend you can count on is your own dog. After all, this is a Presidential Vision and by its very nature a target for partisan political attacks. So for this policy and programs to be successful we will require a multi-administration, multi-decade implementation strategy. Assuming the appropriate strong coalitions can be formed to sustain support throughout this journey, there is absolutely no room for the parochialism of the traditional NASA Center-centric politics. This Commission and NASA has asked for assistance of commentary on what could be another barrier to success, management. Popular support and confidence in NASA has waned, ebbing and flowing with the turn of events. Several major NASA initiatives have yielded very little at significant cost. The efforts that began in the mid 1990's, for example, fell flat after fits and starts and tremendous investment. One key reason was the inability to arrive at validated set of requirements. Over the past three decades NASA has had little experience with large DoD-like programs. Execution of a program as large and complex as the exploration initiative will require at the very least mind set and acquisition process changes. NASA is already demonstrating by way of adoption of practices such as spiral development and DoD's JROC (Joint Requirements Oversight Council) like process for developing requirements and by attracting the expertise from experienced agencies. In this way it can penetrate many of management barriers. Federal Government management of the exploration policy certainly requires the day-to-day expertise only NASA can provide. But only explicit policy responsibility centered in the executive office of the President will keep the exploration policy and program sold nationwide.

In conclusion, let me reiterate that this is indeed the right time for a national space Vision. And our association is certainly pleased and excited about this new Vision. America stands only to reap economic gain from successful implementation both domestically and internationally. Successful implementation of the Vision will in large measure be the responsibility of U.S. industry and we heartily accept that challenge. The Space Enterprise Council, speaking on behalf of a broad cross section of the American business community, supports the U.S. exploration policy because it will fuel economic growth through application of space-related technologies in domestic and world markets. We stand ready to assist this Commission today and in the coming weeks. Thank you very much.

PETE ALDRIDGE

Mark, thank you very much. A very interesting presentation. Your comment about the sustainability and of course that is one of the issues that we want to address, how do we sustain this. This is -- we are sitting on a program that is 40 to 100 years into the future. If it is 40 years,

that is 10 Presidential Administrations, so the bipartisan nature of the program has to be there. But it means every year as you go through the budget process and Congress or every 4 years as we address the Presidential Administration we have to have a way to convince the taxpayers, American people and political types that we want to sustain this program. How do you do that? What is the mechanism for ensuring the sustainment? Do you have any ideas as to how to convince people that this is the right thing to stay on course and not jump and start every year or so?

MARK BITTERMAN

I think an excellent beginning would be to try to understand better this very recent phenomenon that included all of these website hits related to rover and Hubble. Clearly there is excitement. Some will say space has become ho-hum. That is not necessarily true. Perhaps if you watch NASA Select every day maybe you tend to see a lot of the same things. But there's a lot of excitement out there. I think that once these new discoveries begin to become clear, the possibility of the new discoveries becomes clear and they are discussed in the schools, kids get excited about it, that is what I think will really matter. I have teenage daughters and for the first time since I can remember, since they witnessed their first Shuttle launch at the Cape, they have actually been very excited about jumping on the computer and checking out the latest rover images. I'm not sure what we take from that, but I think it needs to be explored. Why is it that we have had 6 billion hits on the website.

PETE ALDRIDGE

Yes – Neil.

NEIL TYSON

All right. I have a little bit of insight into that and I want to turn that into a question. First, my reading of the success of the rover and even of Hubble, of the hits that the web sites are getting, I think we need to remember that while the Hubble cost was initially debated mildly in various circles, the Spirit and rover probes are basically happening under sort of the funding radar. When they were launched, no one -- it didn't trigger extreme debates in Congress. It was $800 million, we have done this before. If we are going to ultimately put people on Mars, that increment in the perceived cost whether it happens within the NASA budget or from future increases, it brings on a whole other kind of debate that goes beyond a successful mission that happens for less than a billion dollars. And so my question to you or my accusation, if I will, is either I or you or both of us are failing at something very important here, and that is, half of your presentation was something that most of us in this room and certainly the entire aerospace industry knows that this enterprise feeds our economy. Not only through direct spin-offs, but from the fact that when you attract scientists and engineers into -- when you track students to become scientists and engineers, whether or not they go into aerospace, they go into some industry and end up inventing something to make tomorrow come. Because tomorrow is invented on the intellectual capital of that next generation. And half the time I'm interviewed, I get asked, why are we spending money in space and not here? Which means the interviewer, as some mouthpiece of the public, does not know the actual impact on their lives. Even though

you can list it just as you did on that chart, some kind of information is not actually reaching the public. And yes, the lower orbit stuff is easier to communicate because many people have a satellite radar and you know someone that does, but once you go out of lower Earth orbit, it becomes more challenging. I want to ask you as a whole agency, what can you do to get this out to the public? I'm trying, but you are a bigger agency than I am, and so I look forward to what we can then depend on going down the decades in support of how the public then sees this whole enterprise and its cost.

MARK BITTERMAN

Well, I can respond in a couple of ways. First of all, of the creation of the Space Enterprise Council within the U.S. Chamber was a recognition by this very large association that space and really what excited folks at the Chamber initially was the whole nature of space exploration and how commercial ventures might fit into that paradigm. It took a long time -- probably quite late in terms of getting space established within the three million business association. But it is there now. And I think growing and I think it is safe to say that our Council is on the mind of Tom Donahue, the CEO of the U.S. Chamber. I think that's terrific. But a lot of cynicism has developed about the applications of space. People have been hearing about everything from Tang to Velcro to Tempurpedic mattresses. Things they have heard so many times or don't believe about why space is so important.

But I think if people really grasp this is a journey and an exciting journey that we can't predict exactly what we're going to get, but the mere fact that we don't know much about the origins of this planet and we might actually learn something by this ultimate deep space exploration. I think that's going to be very important. If people think this is all about just going to the Moon, possibly exploiting resources on the Moon, or establishing a settlement on Moon, I don't think that's going to sustain this across Administrations, Congresses, across the decades. We're going to need to explain it in a way that I think most people I talk to are quite curious about whether or not there are other Earth-like bodies. There might be life similar to ours.

NEIL TYSON

Can you track the economic impact of the enterprise given the Space Enterprise Council's -- is that in the charge of the Space Enterprise Council to track the total economic impact on America?

MARK BITTERMAN

It is not one of our charges. We certainly do it. We're more in the promotion business, if you will, in trying to encourage more space commerce, more interest in space commerce. And I think that as the Association grows and right now we're just about 20 members, we will be getting our arms around this and trying to -- trying to articulate it and get the management, the upper management of the U.S. Chamber of Commerce, to articulate it in a way to all these businesses and all these associations about why space is relevant.

BOB WALKER

Mr. Chairman?

PETE ALDRIDGE

Yeah, go ahead, Bob.

BOB WALKER

Mark, if I could build off something that Neil started here. I, too, looked at your charts and they are a fascinating picture of just exactly how much space plays a role in our economy. And from personal experience, I now have a car that's tracked by three different space constellations all the time. Most Americans, to have that impact in their life, the financial system is absolutely dependent Upon GPS and so on. None of that seems to get reflected in Wall Street. The analysts and others don't seem to see space as being the place where they encourage people to make investments. And what I'm wondering is whether or not the Enterprise Council has taken a look at that, whether there is anything that you can do to help us understand how we might be able to leverage investment beyond the investments that the Government is going to make in this effort. And it seems to me that that involves Wall Street, maybe even some of the rest of the world's financial markets, because that's where the real money is. And ultimately, if we could figure out a way to leverage that into this enterprise, it would make certain we could sustain it over 20, 40, or 100 years.

MARK BITTERMAN

I totally agree, and in fact, the Space Enterprise Council is on that path. We are going to be building our membership with financial institutions. In the past we have had Bank of America as a member. And if you look at our membership, we do have some of the companies that have been fledgling commercial space venturers, like the Digital Globes of the world or the Space Imagings of the world. Those are companies that had to go to Wall Street and convince investors that these companies made sense. Cisco is a member because they see the relevance of space to what they do in computer technology. I think that is where our association can help the most is by tying that all together. Because in the aftermath of the failure of some of the big and little LEO systems – Veridium, Global Star, Oracle Sciences' own Orbcom System, much cynicism set in about the ability of companies to go out and do this on their own.

And so we see that as a very high priority for us is to be able to put that picture together. As I mentioned in my testimony, if all we do is talk about our own industrial days and how great this is for jobs and bottom line, I don't think this mission gets furthered in any way.

PETE ALDRIDGE

Mark, you have mentioned -- and I'm not sure I got from your testimony that in order for this Vision to be sustained, it must be run essentially out of a Presidential-like office. Did I get that right?

MARK BITTERMAN

What I was referring to there, Mr. Chairman, was really the sustained advocacy for what the President said in January. It was great to hear him articulate the speech. The Vice President did a wonderful job by going to the Hill and touching base with key members. But I think the expectation is, both in Congress and in industry, that the White House -- and we certainly don't expect the President to be mentioning this at every press conference or every visit -- but that the White House still has to be on point as this new initiative hoes forward. After all, this is a tremendous endeavor in terms of investment as well as scope. NASA's a great agency, but I don't think NASA will be able to do it on its own and it is unfair really to ask NASA to carry the entire advocacy load, if you will.

PETE ALDRIDGE

That implies, though the advocacy load must be sustained through multiple Presidential Administrations.

MARK BITTERMAN

That's correct.

PETE ALDRIDGE

And yet, I don't think there exists a mechanism to do that. And not only is it presidential, but it's also -- it's a national objective. And it has to be multi-agency involvement in this, I believe.

MARK BITTERMAN

It does. I can express my own personal bias. We did have a Space Council in the White House for a number of years. I thought it was very effective, especially in bringing together the various agency viewpoints and ideas on the subject. You can see in the ensuing years since the dissolution of the Space Council, the difficulty in getting policy developed on space matters. So I personally believe -- and I haven't asked my members about this -- but I personally believe a re-establishment of the Space Council within the Executive Office of the President would be a very effective way of sustaining this across Administrations.

PETE ALDRIDGE

Well, maybe there is a homework assignment we could provide to the Space Enterprise Council that it would be helpful if you could poll and give us an idea of whether or not something like -- I don't know if it will be national space council or some other -- it's a mechanism for interagency interaction under a high level leadership is what you are striving for, I think.

MARK BITTERMAN

Yes.

PETE ALDRIDGE

It would be helpful to have that input –

MARK BITTERMAN

Be more than pleased to take that on.

PETE ALDRIDGE

Since I am handing out homework assignments right and left this morning, any other ideas that you might have on the sustainment issue that you could provide to the Commission would be very helpful. I think there are some very good ideas here about why, and I think we are quite interested in understanding the why as it relates to our charter, which is sustainment. Because if you can't continue to say why, you can't sustain a program. Something will start and stop. So anything along those lines would be helpful as well.

MARK BITTERMAN

I will get back to you on that as well.

PETE ALDRIDGE

Ok. Maria?

MARIA ZUBER

You mentioned a number of things in your presentation that would lead you to believe would contribute to the success of the Endeavor. There's economic development, there's startups of new space ventures, various other things, more people going into science and engineering, the thrill of scientific discovery that your children see. Sort of, what kind of time frame do you need these things happening that you know you are on the right track? If we land a person on Mars, obviously we stop and we have a parade, but this is the journey of 1,000 miles, ok. I think something that's quite important here is to know that you are on the right trajectory. And so there are going to have to be things that are occurring on certain time frames that people realize you are headed in the right direction. And they don't necessarily have to be big things, but there have to be some things that lead people to believe you are on the right track. Do you have any ideas about what sorts of things those could be and the sort of time frames you would need to occur? A number of the things I can think of happen on cycles that are longer than Washington political cycles.

MARK BITTERMAN

Yes. At the risk of repeating myself, I would like to refer again to the success of the rover missions. These should not be discrete events. We should be trying to tie them today as best we can to what we are trying to do later. Clearly, there will be discoveries made on Mars by the

rovers and analyzed by folks on the ground that will play into this overall initiative. So I think we need to strike while the iron is hot. Otherwise, after the rovers are done, yes, we will still have a space telescope up there and we'll have a follow-on successor to the Hubble, but those gaps are very, very dangerous. Focus dissipates very quickly. And these are not stunts. We're doing real research up there today. I think given that we're in this first budget year of the new program and we're lucky enough -- we're fortunate enough to have a Vision from the White House and the successes, both with the rovers and with the telescopes, we need to use that as best we can.

This may sound a little goofy, but if you look back at the movie "Apollo 13" and all the attention that it received, I think Hollywood could have a large role to play here, too. After all, for better or worse, it's a major focus of the American people. I think the space community, whether it's Government or industry, both should be able to partner in some way with Hollywood. Because, after all, we're talking about doing things here about which movies were made not too long ago. We're talking about landing humans on Mars within the next few decades.

PETE ALDRIDGE

Any other comments? Questions? I have heard several times people say, well, I have my GPS receiver and I have my Direct TV, I don't need space. Ok. And if there are not any other questions, Mark, thank you very much for coming. Very interesting presentation. And we look forward to receiving your homework assignment. As quickly as possible.

MARK BITTERMAN

Thank you, Mr. Chairman. We'll try to get in it early. I would like to request to submit my written statement as well as Mr. Donahue's letter to the Vice President.

PETE ALDRIDGE

Terrific. That would be very helpful for our reference library. Thank you. Thank you very much. We are running fantastically early, and our next speaker had not planned to be here until 11:00, I believe. It's a very important one. Norm Augustine, who was the chair of the commission that met back in 1991 on the future of the U.S. space program, which is along the lines of what we are interested in. Why don't we take a break and we will reconvene when Norm arrives. At that point, we'll look forward to hearing his testimony. Thank you.

PETE ALDRIDGE

Could we get started, please? I'd like to introduce our next speaker, Mr. Norm Augustine, who was the chairman of the study called the Advisory Committee on the Future of the U.S. Space Program. Even though you are here in 2004, I believe this report was written in the year 1990. But many of the recommendations are very pertinent to today's deliberations. Norm, welcome, and we look forward to your testimony.

NORM AUGUSTINE

Thank you very much, Mr. Chairman, and members of the Commission, and I particularly thank you for giving me the opportunity to visit with you this morning. I am particularly pleased that your group has been established. I think you have an opportunity to impact what hopefully could be a space program that will endure and that Americans can take great pride in. I need to begin by apologizing for not providing a copy of my statement according to your rules in advance. I have just returned from photographing wolves up in Yellowstone, and the communications were rather limited -- even with satellites around. So I did provide a copy just this morning, but I do apologize. Nonetheless, I am very glad to be here.

As your chairman said, I have been asked to speak about the findings of the Committee on the Future of the U.S. Space Program, which was established about 14 years ago by then-President Bush. And I will try to summarize rather briefly some of our findings, and with your permission, I would like to close with four very brief observations of my own, of a more personal nature, given the perspective of the past decade.

It certainly goes without saying that a great deal has changed since our Commission, which your chairman was a very important member -- since our Commission conducted its work. And today, for example, there is, of course, no Soviet Union carrying on a strong space program, which at the time we met or just prior to that time, had provided a major impetus, a competitive impetus for the U.S. Space Program. And in fact, the Soviets today, rather than being adversaries in space, I might observe that the company that it was my privilege to recently serve, a company that is now in a partnership with the same people who are conducting the Soviet Space Program to launch commercial satellites. A rather successful and friendly partnership. There have been other significant changes that have affected America's Space Program during the period that's intervened. To cite just a few, china, of course, is now emerging as a major space participant, taking some rather significant steps only recently to have full membership in the space community.

Another observation would be that the United States never realized the 10percent annual growth in the space budget that was forecasted at the time we met. That was a forecast that was rather universally held throughout the Administration at the highest levels and on down, as well as in the leadership of the Congress. NASA's budget, as we all know, after our Commission met, continued to decline in real terms. Also, the commercial space business that seemed to hold such great hope and particularly I refer to constructing and launching spacecraft has in the intervening years being reduced to a commodity marketplace, and as such, at least from an economic standpoint, it's been a major disappointment to those firms that have participated in the market. America's space industrial base has shrunk from a relatively large number of healthy companies at the time we were meeting to today with relatively few companies that have broad space credentials. This being largely a consequence of the restructuring of the defense industrial base following the end of the cold war.

Further, it would be noted that there seems to be no consensus of what should be the long-term goals of our space program in the years ahead. On the other hand, a great deal has not changed. For example, your Commission, like ours, meets on the heels of a tragic failure with the Space

Shuttle, in our case the Challenger and in your case the Columbia. There also continues today to be, I think, a strong grassroots support for America's Space Program. At the same time, that support has not strongly evidenced itself in terms of budget impacts. There today, as when we met, remains a strong, important, budgetary demand for activities other than the Space Program to meet important needs of our nation. And the needs of the Cold War have by and large been replaced by the needs to support the war on terrorism. Also unchanging is the fact that the number of U.S. citizens studying engineering continues to be a worry and continues to be declining. This is even in the midst of the greatest technological explosion in history, a period when our economy and life style is changing to the extent never before witnessed, brought about largely by developments in science and engineering. America's K through 12 educational system remains in extremis and that is especially true in areas of science and technology and it seems that the Space Program more than anything else seems to inspire young people in terms of their interest in science and technology. There also remains a concern over the apparent loss by NASA of much of its innovativeness, of its management acumen, and systems engineering skills. At the same time, NASA, without question, remains the world's finest space organization and has produced some very remarkable accomplishments. And it has done so publicly to its great credit for all of the world to observe its successes and failures.

At the same time, I think very few people would confuse the NASA of today with the NASA of the Apollo era. Unfortunately, much of the public, and of even greater concern, parts of NASA, have come to accept our space activities as relatively routine and taken for granted. That is particularly true of much of the public. Dan Goldin, the former administrator of NASA, once shared an instant with me about a citizen who complained about the amount of money we were spending as a nation on meteorological satellites. This individual had said why do we need meteorological satellites? We have the weather channel. Indeed, we have come to take for granted much of our space success. Finally, as a somewhat gratuitous observation, I would note that the chairman of your Commission has been criticized for having conflicts of interest just as the chairman of our Commission. So, you have had company. I would like then to turn to some of our Commission's recommendations that may be relevant to your work. As I do this, I remind you that 14 years have passed since these recommendations were found.

First of all, we found a NASA that was badly overcommitted in terms of a mismatch of its goals and funding. Clearly the work NASA was trying to conduct seemed to surpass the money that was then available to carry them out. The Space Station and Shuttle were major consumers of funding, and in fact cost overruns in those two programs had major impacts on the smaller programs that NASA was trying to conduct. A major concern in our mind was the lack of adequate reserves in the programs that NASA conducted. Reserves in terms of money, in terms of schedule, in terms of technical alternatives, and in terms of leadership personnel.

Secondly, in the post-Apollo years we were addressing, there did seem to an lack of national consensus to get behind some specific goal for our space program. Some might even have said that America was lost in space. Our commission believed that under the circumstances that then existed -- and, editorially may exist today -- it would be inappropriate to set a firm date for some major goal as had President Kennedy so successfully a few years earlier. Instead we felt it was important to build a solid technological undertaking in terms of the technology that would support whatever long-term goal was chosen, and secondly that we conduct the program

on a go-as-you-pay basis. That was to make sure we didn't get a mismatch between funding and objectives.

Thirdly, we concluded that the Program should be a balanced Program, should include a manned human in space element and an element using robotic spacecraft. There were those who exclusively advocated robotics. Indeed, robotics play a major role. But it was our belief that public support for the overall program would diminish significantly if there were not a human element as part of that program. And, as we pointed out in our report, there does seem to be a difference between Hillary and Norgay reaching the top of Mount Everest and lobbing an instrument package from a rocket to the top of Mount Everest. Inspiration is a significant part of the human space program.

Fourth, we concluded that science should be the first priority of America's civil space program. That is because science, of course, is the basis of new knowledge, it forms the underpinning of technological progress as well as our educational pursuits in the relevant fields.

Fifth, there should be a mission to the planet Earth as well as from the planet Earth. The former should focus on the Earth's biosphere and protecting our planet from harmful activities that take place on Earth.

Sixth, space transportation was then and probably is now the primary impediment to conducting a healthy space program. It was concluded that we should not ask astronauts to serve as truck drivers. That humans in space should have a role limited in instances where humans in situ had a value added or could make a difference. In short, we urgently recommended steps to mitigate our dependence on the Space Shuttle.

Seventh and high priority, we felt developing a new unmanned but potentially man-rateable relatively heavy lift launch vehicle was very important. In that regard, as an economic move we recommended that the additional Space Shuttle vehicle that was being considered not be built.

Eighth, we noted that the operation of the Space Shuttle should not be viewed as had increasingly become the case as akin to operating an airline and pointed out that the Space Shuttle was at best a very advanced form of a research and development program that was operating in a very unforgiving environment and needed to be conducted as such.

Ninth, we noted that quite clearly it was not a matter of if we would lose another Shuttle, it was only a matter of when. This unfortunate conclusion was based on our belief that the reliability estimates that were then assigned to the Space Shuttle were grossly optimistic. In fact, we predicted that such a loss would probably occur -- and I quote – in the next several years. But we went on to note if America doesn't have the will to endure occasional losses in space, then having taken all reasonable steps to avoid them, then America probably doesn't belong in space. Space is an inherently dangerous and risky place, as you all know, and one that is very unforgiving of human failings of any type, whether on the ground or in space.

Tenth, we noted the need to proceed with dispatch in the development of some form of space rescue vehicle. A vehicle that could perform other important missions as well and the need to

develop the capability to continue to operate the Space Station in the absence of the availability of the Space Shuttle.

Eleventh, we noted that the Space Station program needed to be restructured to place it on a more conservative schedule, a more realistic financial basis and with a reduced number of objectives. And, importantly, that adequate reserves be provided.

Twelfth, we concluded that a human trip to Mars is the correct long-term goal for America's Space Program using the Moon as a valuable stepping stone along the way. We considered many other possible missions, including missions to the neutral gravity point in the Earth-Moon system that would provide a useful way station for deeper space travel, but is not a particularly interesting scientific location. We addressed more focus on Earth orbiting spacecraft but felt that the space station was handling that goal very adequately and was likely to become a dead-ended program in the long term. We considered missions to Fobos and Demos could be tied as part of a Mars mission. Missions to other space objects with humans appeared to be candidates but in the future. So a return to the Moon and then on to Mars seemed to be the correct answer to us.

Thirteenth and lastly, we observed that NASA's management and engineering approach needed to be reengineered itself. And, as with many very mature organizations, the drive for self-perpetuation seemed to be growing at a faster rate than the drive for innovativeness and creativity and undertaking new ways of doing things. At that time, the various Centers were often engaged in nonconstructive competition with one another and they seemed to be united only in their not infrequent assaults on NASA Headquarters. That summarizes what I think were the principal findings of our Commission.

With your permission I would like to take a few more minutes to offer four brief observations of my own not on behalf of our Commission but of a more personal nature. First, I believe that if NASA is to have a robust space program it is critical that we build a national consensus as to what that program should comprise. Absent that, I think we are unlikely to succeed. If, for example, we were to pursue a program that requires only -- and I use that word advisedly -- only 20 years to achieve, that implies we need to have the sustained support of five consecutive administrations, the support of 10 consecutive Congresses, 20 consecutive budgets, and that's no mean feat in its own right. This would seem to argue for a program that can be accomplished stepwise, where there are significant achievements that can be pointed to along the way and where the actual time scale to reach the final goal is left somewhat open ended.

Secondly, I think the exploration of space with humans offers many scientific, technological, and economic benefits. But, having said that, these tangible benefits, in my opinion, are probably not sufficient in themselves to justify the cost of the undertaking. To do that one has to assign value to intangibles, such as the excitement of exploring the unknown, the excitement of creating new knowledge, the excitement of inspiring young people, the opportunity to demonstrate to the world what America can do when it puts its mind to something. Critics, of course, will suggest that in these times, with so many legitimate competing demands for federal funding, that we can't afford intangible benefits. But if they are correct, I think we also have to ask ourselves, can we then afford football stadiums, Hollywood movies, rock concerts, golf courses, and a thousand other well-accepted pursuits.

Third, and I think this is extremely important, it would be a grave mistake to undertake a major new space objective on the cheap. To do so, in my opinion, would be an invitation to disaster. There's a tendency in any can-do organization, as the case I hope with much of NASA and with many of their contractors, to believe that they can operate with almost any budget that someone will make available. The fact is that trying to do so is a mistake. I'm not arguing for waste. I'm just pointing out that space activity is difficult. One might say it is rocket science, I suppose.

Finally, I would assert that one day humans will go to Mars. The only questions are when and who. And it is my hope that as we meet today the first Martian is in fourth grade somewhere in America and with those comments, Mr. Chairman and members of the Commission, I thank you for the chance to share our work with you and my own views.

PETE ALDRIDGE

Norm, thanks very much. I would observe that members of your commission seem to be Visionaries. A lot of what you had to say was very much pertinent to today's environment. It was a pleasure to be part of that Commission as a matter of fact. I know the report says something about mission from the planet Earth and mission to the planet Earth. And I have heard some concerns expressed by certain people that the President's Vision doesn't say much about mission to the planet Earth. Could you comment your views on that topic?

NORM AUGUSTINE

I would be glad to. I don't know the background that led the President to focus more on the mission from planet Earth, but it is my belief that the mission to planet Earth is continuing. I think it is generally understood what needs to be done and it has reasonable health. The important thing is that it not suffer as we take on the mission from the planet Earth. And, as you will recall, that was a major thrust of our comments. I think that probably the President would have addressed the mission from planet Earth because that seems to be the area of greatest confusion at this point and also the area of probably the greatest financial impact.

PETE ALDRIDGE

Yes, Neil?

NEIL TYSON

Thank you for your testimony. We have read the report. It was enlightening to hear a firsthand account of its substance. I have a question. If I ran my numbers accurately here, if you look at the total NASA budget from 1962 to 1972 and forward-value that to today, it turns out to have been less than the amount of money, the total budget of NASA of the past 10 years. And of course back then NASA basically its purpose was to get us to the Moon. So, every increment of growth, either in personnel or technological investment had that as a goal. Right now we have NASA sort of on the table as it is and now there's talk that to achieve this Vision may in the longer term require much, much more money. I would like for you to comment on the fact that at a $15 billion a year budget over 10 years that is $150 billion. That seems like a lot of money to most

people. Are you suggesting that that is not enough money to -- would you view that as, if it never went much above that, that that would be trying to get to Mars on the cheap, when we got to the Moon on somewhat less than that in inflated dollars.

NORM AUGUSTINE

It's a very good question. As I recall, and I probably should refresh the numbers, but I think the Apollo program and the kind of dollars at the time we were meeting was something like $100 billion undertaking think NASA's budget ran around a percent. 1 percent of the G.D.P. (Gross Domestic Product) or something like that. $150 billion not only sounds like it, but it is a huge sum of money. But there are enormous running costs within NASA that you have spoken about yourself that include operating at Centers, operating the space station and operating the Space Shuttle. And while those things, some of them, can perhaps be reduced over time, it will be over time, probably a long time. And, so there are other demands not only for the Space Program but the aeronautics program in the NASA budget. So, at best it will be some not insignificant fraction. The NASA budget could be devoted to an undertaking of this type. To begin the program without ample reserves, I think, is a mistake. We have traditionally underestimated the cost of programs of this type. We, collectively as a nation. And my answer is yes I would be concerned about undertaking a project of this scale with the current level of NASA's budget. To alleviate that in our Commission's case that kind of concern we said don't set a target date where everybody is racing around trying to get testing done by a certain date. Let's do it right no matter how long it takes. Does that answer your question fairly well?

NEIL TYSON

A little bit. I guess, you know, another way to think about it would be if there were no NASA today and this Vision were laid on the table and we had to create a NASA, are you suggesting that $150 billion over the next 10 years would not be enough? Everything created about it would be to the fulfillment of that mission, it wouldn't have the legacy of its infrastructure?

NORM AUGUSTINE

Frankly, I haven't done enough analysis that I would be confident to give an answer. But I guess if I had to bet, I would bet that it wouldn't be enough.

PETE ALDRIDGE

Yes – Les.

LES LYLES

Norm, continuing on the NASA theme, you made the statement that NASA is the world's finest space organization but the NASA of today is different from the NASA of Apollo and some of us have heard that many times. From your perspective or from the Commission perspective of some years ago, what do you think are the characteristics or attributes of the NASA of Apollo versus the NASA of now or even when did you your Commission that we should look to try to emulate?

NORM AUGUSTINE

Well, first I want to be careful trying to emulate. But the most obvious difference as I look back at the books I have from the Apollo days, at the people in the command Center, the control room, they were a bunch of kids. They were young people. They looked like silicon valley did a few years ago. Young, innovative, imaginative. Creative. They were not people of my generation for sure. And one can argue whether that is good or bad, but it sure served Apollo well. And I think NASA is aging. And that is a concern. And clearly there's great value to experience, great value. But there's also value to not accepting the status quo. I think NASA's personnel structure probably needs to be addressed. How do we induce young people to want to work for NASA? NASA was the employer of choice probably at the time I was in my youth, professional youth. Today it is probably, has more to do with the telecommunications industry, the biotechnology industries and so on. So, that would be of concern. Also, NASA's procedures, overhead structures, like any maturing organization, have grown, and most of those provisions were put there for a reason. But when taken collectively you don't start out with that clean sheet of paper that Neil referred to. And as you know from running large organizations, it is hard to change their course. It takes time and a lot of energy. So, those are, I think, a few of the things that I would be concerned about. I think also, in terms of systems engineering, NASA as well as our industry is probably not as strong as it ought to be. The government's hiring rules, not just for NASA but across the board, I think, tend to discourage dedicated, competent people from serving in Government, and that is tragic. Many dedicated, competent people do serve in government, but we need a lot more.

PETE ALDRIDGE

I was encouraged, Norm, just recently, in fact just within the last few weeks, a new personnel system was enacted for NASA much like that which has been enacted for the Department of Defense and for Department of Homeland Security in which we have instituted a pay for performance plan for civil servants that encourages high performance and reduces the red tape on the hiring and transfer of people within the agency. I have testified before Congress as this changed from a pay-for-attendance to a pay-for-performance and I applaud what the Congress has done and will help NASA a lot in rejuvenating the talent base that will be necessary for this type of Vision.

NORM AUGUSTINE

I, too, think that is terrific. And I guess I would just, having experience in this area as you all do, we need to watch how it is implemented. And, Pete, you will recall during our Commission there was a bonus system set up at NASA. It may still be there. I remember one of the speakers, when we pointed out how minuscule the amount of the bonus was compared to the base salaries, the speaker said yes, what we will have to do is one year we will give a third of the people the bonus, the next year the next third and the next year the other third. So, let's watch how this gets implemented.

PETE ALDRIDGE

I think that the process -- because I was running such a process in the acquisition corps in the Pentagon, and I saw how it worked. And it was terrific. The people who were the performers loved it. The people who didn't perform well didn't. For good reason. Because, if you didn't meet your goals set up in the beginning of the year, you didn't get a pay raise. It was zero. And a lot of people didn't like that and left. Ok. It achieved what it was supposed to do. I think that again, if it is implemented properly it does it very well. One of the things the President has done is challenged us to determine what it would take to successfully achieve this Vision in a sustainable and affordable way. They didn't lay out a 10percent per year increase but they have laid out roughly a 5percent per year increase for NASA. And I know that the President set dates to try to achieve those. I don't think they set dates firm, it was more of goals. You know, to have some kind of idea. About the year 2010 we would like to achieve. I think that, if I read that right, it is a pay-as-you-go type of plan. Maybe your observations of the Vision, do you share that same view?

NORM AUGUSTINE

Well, that was the way I read it. I think the risk of setting firm dates is that people do what they can to be there at that date and you may show up with an airplane with only one wing on it. And that is probably not a good idea.

PETE ALDRIDGE

Yes, Bob.

BOB WALKER

Let me put together a couple of things if I can, Norm, from your testimony and see whether or not you would respond to it or whether your Commission looked at it. You said that you had concerns about the fact that NASA was trying it manage too many things. And you also said that part of the concentration of NASA ought to be on the missions back to planet Earth. Is that an area or -- and are there other areas where we might look at the fact that NASA shouldn't be managing those programs any more and that they ought to go somewhere else with sufficient moneys to sustain them, but they ought to go somewhere else with sufficient money to sustain them so NASA's mission could be a far more focused mission in terms of the President's Vision?

NORM AUGUSTINE

We did look at that. And the question arose should NOAA (National Oceanic and Atmospheric Administration) have a bigger role. As a matter of fact one of the proposals that was seriously being promoted was that NASA be turned over to the Department of Defense. And we thought that might not be the best idea in the world. The NASA aeronautics program is an important part of NASA that is often overlooked and you have a lot of background in yourself. So, the answer is yes, we did look at these candidates. We found some and cited them. But candidly they were small relative to the magnitude of the problem. And NASA's budget, there's a lot of it that is

relatively fixed given NASA's overall structure and mission. And that is what leads me to believe that additional funding will be required. And hopefully we will include adequate reserves in whatever we do. I think that was one of the secrets to the success of the Apollo Program, was that we did it right.

BOB WALKER

But you also made the point that the one thing that seemed to unite the Centers for some time was when they attacked Headquarters. Is part of the issue here whether or not those Centers need to feel relevant? Kind of to programs other than -- I mean some of the Centers won't fit precisely inside what the President has outlined as his Vision. Would they end up being happier if they were somewhere else rather than on the outside of something that was defining the Agency?

NORM AUGUSTINE

Well, you point to a very significant problem that we also observed. One is that at that time -- and I don't know if it is true today -- there was a lot of overlap. You could name technologies that three or four Centers were performing similar work, with some coordination. But it probably would have been more efficiently done at one Center. Similarly, NASA Headquarters at that time was less strong than it is today. I think that has been an improvement over the years. I think we have needed strong leadership. But, for example, when the Space Station program was started every Center tried to carve out its piece of the Space Station program. That is not the ideal way to structure a major undertaking and certainly not for going to Mars. So, any Center, like a division of the company, doesn't like to be left out when the organization as a whole is charging up the mountain. And I think it is just a challenge for the management. You remind me as we talk about resources, we have talked a lot about money. Project managers. That is probably the most critical, under-available resource in the engineering world, at least in my experience. Good project managers are really hard to find. And not just one for the whole project, but the ones you need to run the major pieces. And that could prove to be a greater limitation than money.

BOB WALKER

That's a good point.

PETE ALDRIDGE

I know we both share the view that we don't have enough systems engineers in this business. It seems like for this type of project to be successful over the long term we've got to really focus on the system engineering skills and talent that exists within NASA to make all of these pieces fit together.

NORM AUGUSTINE

Without question.

PETE ALDRIDGE

I know we will be focusing on that in our Commission of how do we best do that. Yes – Laurie.

LAURIE LESHIN

Thank you so much for being here. It is a real pleasure to hear what you said. I was struck by your statement having taken all reasonable steps to avoid disaster. America has to accept that there is risk involved in this kind of exploration and I was hoping to get to you expand on that about what you see as how we can communicate that risk, the communications issue, how we can handle that more effectively. Because it can -- it's a critical one and it is easy to imagine a new program getting bogged down in attempting to just grapple with that particular issue and we are talking about sending humans beyond lower orbit for the first time in 30 years.

NORM AUGUSTINE

As I understand it, the speaker who will follow me will be able to address this question far better than I. But I, and Laurie I'm sure you, have never met an astronaut that didn't realize that what they were doing is a risky business. Your chairman was signed up to be an astronaut. It is a reality of life. At the same time, I think we cannot only communicate better that there is risk. We need to be sure that the benefits are worthy of that risk. Particularly when lives are involved. We also need to take steps to diminish that risk. When I was in my earlier part of my career, any new military aircraft expected to lose at least a handful of test pilots, and we did. Today it is very rare to lose a Test pilot. And the reason is we learned some lessons along the way of building redundant systems, of gradually moving out on the edge of the envelope, of much better Instrumentation, of the use of simulators to train pilots to Deal with dangerous situations, unexpected situations. So, I think not only can we take steps that will significantly reduce the risk, but it will never be zero. And that has to be communicated. And we tried hard to do that. The American public -- that sadly there will be losses. And it's a character of space. It is dangerous, hard business and we should do all we can.

LAURIE LESHIN

In terms of the evolution of this risk, it is clear in the aircraft business we have gained such a great base of experience but, I guess I am interested in your perspective on this from Apollo to now to Shuttle, of having accumulated that same experience base or striking out beyond lower orbit constitutes starting over in that experience base.

NORM AUGUSTINE

I would think that given the experience with the Space Station, with the Shuttle, and the experience the Soviets have had, much of which we have benefited from, there's reason to believe we should be able to do better. The problem is in space we deal with such small sample sizes. And also what we do happily is of great interest and concern to the public. I perhaps shouldn't bring this up but I will. You will recall that not long ago the institute of medicine, a highly regarded organization, indicated that America loses 50,000 to 100,000 people a year

through medical errors. Somehow we have decided that we need to march on and try to do better. I think we continue to perform surgery and hopefully can continue to pursue the benefits of space and recognize that there probably will be losses along the way.

LAURIE LESHIN

Thank you.

PETE ALDRIDGE

Remind you we lose roughly 50,000 people on the road in America and we don't stop driving automobiles.

NORM AUGUSTINE

That's true.

PETE ALDRIDGE

Yes – Maria.

MARIA ZUBER

I guess from my standpoint the implementation of this plan will be facilitated if there is a sensible road map. So I was interested in one of the results from your previous report where you indicated going to the Moon as a way station for going to Mars. I was wondering if you could amplify on that a little bit about what that buys you. Because we hear people who are interested in Mars say let's just go to Mars and why stop at the Moon and you have a diversity of opinion that says there's a lot of good reasons to go to the Moon. This could include resource development, testing new technologies and they can include just the operational idea of learning how to function on another planet. Do you have some thoughts about the value of going to the Moon as a way station for sending men to Mars?

NORM AUGUSTINE

I think you really stated it better than I could. But to follow on the points you made very well. In our Commission we did consider direct missions to Mars, and it is very easy to argue why go back to the Moon, we have done that, we have been there. Why will that inspire anyone. And I'm afraid if it were just mission to the Moon -- I say “just” unadvisedly -- but if it were a mission to the Moon, I suspect I wouldn't build great national support to go back. But if it is clearly portrayed as a sensible step toward going to Mars and we don't lose sight that our objective is Mars, I think that not only is it a sound engineering conclusion, I think it is a sound conclusion in terms of maintaining the support of the public. And the reason why I think it is a sound engineering conclusion and you cited them very well, there might be one additional one, but it does provide a means of operating on Mars from a body with obviously less gravitational field than the Earth. It provides a chance to get real-world experience operating with Humans

remotely but not so remotely that it takes you many months to get back and forth. It takes minutes to send a radio signal back and forth - many minutes to Mars. There is also the issue of exploiting the materials on the Moon to support the next step to Mars. And, finally, there are still useful things to be done on the Moon ranging from exploration to possibly setting up an observatory, to things that are worthwhile in their own right. But in my opinion would be hard to justify as an end point. So, our conclusion was that it makes more sense to go to the Moon first, then to Mars. Also, going back to the Moon, I don't know how quickly we could do it. I think it depends mostly on funding. But going to Mars will be a very long-term undertaking and it will be very hard to inspire people to say in 2025 let's go to Mars. My mother lived to be 105 and I'm looking forward to a long life but I don't think I will be here. So a lot of people would take that viewpoint. I think going to the Moon is a very sensible thing to do on the way to Mars.

PETE ALDRIDGE

Yes – Neil.

NEIL TYSON

I don't mean this question to sound blunt, but –

PETE ALDRIDGE

You never do.

NEIL TYSON

This commission exists because something failed in the recommendations of your Commission. I don't want our illustrious Chair to be sitting in that seat 10 years from now answering these same questions. So we want to know badly from you what went wrong.

NEIL TYSON

Why was it not adopted by the public? Is it a matter of public relations? Is it a matter of public resolve? Was it presidential leadership? What is it that we can put in our report so that we don't have a repeat of this 10 years from now?

NORM AUGUSTINE

It’s a terrific question, one that I thought a lot about. And my answers are disappointing. But you put your finger on probably the most important thing and that is presidential leadership. We have to have leadership at the top - sustained leadership at the top. Clearly a second factor that was very important was that the NASA budget didn't evolve the way we thought it would, and there are colleagues at your table that would answer this better than I, but I think one of the reasons was there was somewhat of a loss of faith in NASA as an organizational entity, whether it could spend the money usefully. And there are also huge demands that began to appear as we moved into the 1990's. You will recall at the time we were meeting, there was the euphoria that the cold

war was over and all these billions of dollars were going to be available. This huge peace dividend - there was a peace dividend - but it got eaten up by other things. I think, (1) the money has to be made available; (2) it takes very strong leadership to communicate why we are doing this; and (3) if the public is skeptical when you start out, my advice is don't start.

PETE ALDRIDGE

Norm, when we were doing the study that we had a council called the National Space Council under the leadership of Dan Quayle, do you think we need something like that to carry out such a program as the President has laid out?

NORM AUGUSTINE

I do, Pete. And you remember our commission recommended the strengthening of the National Space Council. And for those of you who perhaps aren't closely involved with it, its purpose was to provide the policy guidance and to be sure that resources were made available and that reasonable goals were set. And where it got it, I think, a little bit of trouble is when it tried to get it into operations, and it was much like a board of directors of a corporation, there's a big difference between governance and operations. And the National Space Council, I think, could be extremely valuable if constituted as a policy oversight board of directors rather than as another management layer.

PETE ALDRIDGE

The point I was raising is that if this is truly a national mission, the value added of other defense, other, not defense, but other agencies, Department of Education, Department of Energy, and DoD -- seemed like there's a lot of technology and leverage that can be made from these other agencies. Yet there's not a way for NASA to tap in directly into those other agencies without a leadership type of role much like a National Space Council. I don't know whether the council is the right answer but something that serves that function of interagency participation and leadership, I guess is the bottom line. So, just an observation, I was reminded as you were talking about the young engineers in mission control, at that time you and I looked just like those guys, by the way.

NORM AUGUSTINE

You still have hair.

PETE ALDRIDGE

Comments? Questions?

NEIL TYSON

Just an observation, one thing that I think we can look forward to in whatever is the next generation of NASA as a source of inspiration is, I am today, a scientist, not really because of

what NASA did in the 1960's but almost in spite of it. Because no one in that mission control looked like me. So it was not very inviting. It was a fascinating thing to observe almost the sociological thing, we are going to the Moon, but I didn't feel included. And I can't say that uniquely about NASA, it was true for so much of society of the day. But I know the profile of NASA today, the scientific community, the number of women represented. And so I move forward with some hope that that next generation is not—and uses the fully realized enfranchisement of all aspects of what we are as America today. That was just a comment.

NORM AUGUSTINE

Very good comment.

PETE ALDRIDGE

Norm, thanks a lot.

NORM AUGUSTINE

Thank you. It is a pleasure to be with you.

PETE ALDRIDGE

That concludes our morning session. We convene again at 1:00. We will hear from Tom Stafford, who obviously is going to have a lot to say about the Moon to Mars. And he has been there. Thank you. We will adjourn until 1:00. (please stand by)

PETE ALDRIDGE

Could we get started, please. Welcome back, everyone. We'll get started on the afternoon session of the commission. This afternoon, we are quite honored to have General Tom Stafford, U.S. Air Force Retired, with U.S. former astronaut, entrepreneurial person and quite an advocate for space. Tom, we are delighted to have you here today and to give us your insight to the views of the future space program. Tom, please proceed.

TOM STAFFORD

Thank you, Mr. Chairman, it's a real pleasure to be here and also to see so many old friends I've worked with, like yourself, General Les Lyles, Dr. Spudis who is a member of the Synthesis Group, and of course Chairman Bob Walker, who testified many times in front of Congress, and also the other members of the committee. We talked primarily about what we did on the Synthesis Group where the Vice President asked me to do that. I thought it would be interesting to go back just briefly in history to set the parameters. On July 20, 1989, President Bush said, on the 20th anniversary of the first lunar landing, that we ought to set our sights for space exploration for the 21st century this time to return to the Moon to stay and then go on to Mars, by 2019. He then reactivated the space council, with Vice President Quayle as the chairman. The Space Council then asked for a 90-day study of NASA and how they would carry out this Vision

of returning to the Moon and going on to Mars when this was completed. The space council reviewed it, and their thoughts were that it was not too innovative and it did not incorporate any new innovative ideas and it may have had a lot of problems in it. So they then wanted a very fast review and asked the research council to do that. Then they had a one-week intensive review of 13 people, which I was honored to be a part of, headed by Dr. Guy Stever. That was in January of 1990 and after reviewing the 90 day study we came to the same conclusion it was not innovative at all, so creative time - as kind of a morning, noon, and night, which a lot of us has been through - type of study. We had the Department of Defense come in with their ideas and other people, and so we said that there needed to be more ideas in this and how to go out and accomplish this Vision. From that, then the space council, the Vice President basically asked NASA to have an outreach program to go out to academia, to the Department of Defense, all the executive branches of government and individuals and industry firms, and bring in the ideas and put them together. Then I was asking -- from that, like the RAND Corporation had an 800 number the people would call in the Aerospace Industry Association (AIA) had all our people provide data to it, the Department of Defense, had data, the Department of Energy, NASA. I was then asked by the Vice President to put together a group and then lead them to re-synthesize this, hence the name the Synthesis Group, and say how should we go forward. Now, at the same time, Mr. Augustine, whom you heard from this morning was doing the future of America's space program, and so we had coordination with him, and you served on his committee. You were also a senior advisor on our committee. So we briefed Norm and his committee on several occasions, and he came over and briefed us on the progress of what we had there, but it was a large number of inputs, several thousand inputs, and we worked on this for about a year. And we started in June of 1990, concluded in June of 1991 when the Vice President and I had a joint press conference at the White House facilities.

At that time my instructions from the Vice President were to put together technology priorities required to carry out this Vision and produce two or more architectures that would take care of this. We had 143 people part time, ah – 43 part time, 150 people full time. And then from the DoD General Don Comber who a lot of you know, he gave us a lot of work and he pulled together all the activities from the DoD to support this effort. And this committee continued on. We came up with four different architectures, ten recommendations, and then the supporting technologies that would take us forward. And so at this time I would like to take you through the basic recommendations we have, if I could have the slide on that. Again, I got a call last Thursday night so I put this together real fast, Mr. Chairman.

PETE ALDRIDGE

You are used to working fast.

TOM STAFFORD

Well, the architectures we came up with were, the first one was, we take the minimum resources there, and that's the Mars exploration. And what this was, it was an exploration to go back to the Moon and then do their science and exploration, but also do the best simulation we could of going on to Mars, and I think Dr. Leshin asked the question or somebody this morning asked the question, why should we go back to the Moon? That question was asked among our groups. Why

should we go to the Moon, we've been there. But then as we continue into these months of deliberation, it was determined that the Moon made an ideal testing place. We can also do science there. You would take the type of habitat, the rovers, the spacecraft that you would have on Mars, you can test those on the Moon, it's only 3 days away. And it's operated in deep space. We have not been in deep space with humans since 1972. We then envisioned two exploration missions out to Mars. One's a short duration mission of 60 days, and the other one would go up to 500 days, in the second mission and that would take us to the year 2019. I don't know. Has your group been briefed on the trajectory on Mars?

PETE ALDRIDGE

Not yet.

TOM STAFFORD

Well, in about 15 seconds, Mars, we can have a window every 26 months, and the amount of energy it takes repeats itself in the sinusoid every 15 years. And 2003 happens to be the minimum energy year, and we saw these two rovers up there now, transited out to Mars in only 6 months, sometimes it takes well over a year to get out there. And so from the time we started the Synthesis Group we saw that 2018 will be an era of minimum energy and we would start down on that curve, starting with 2014 and going out there. But the exploratory part first would be done there on the Moon, and you would simulate what you were going to do on Mars and you could simulate the transit time. You go down to the Moon and work back, and you'd have a large safety factor because Mars with 38percent of the gravity of the Earth and the Moon, 16percent of the gravity, you have a good safety factor to work with and you would simulate then what you would do on Mars, on the Moon to take care of that.

The next one, science emphasis, this requires far more resources. You would look at areas like a large baseline interferometer telescopes looking into deep space where theoretically you could see planets around stars, you would then have also more on Mars. This is a far more ambitious type of architecture. The next one, the Moon to stay, this emphasized human presence this would be a build-up, we'd have initial operational capability and then we'd have follow-on operational capability and from that we'd then also have the Mars exploration similar to architecture one. And then the space resource utilization, that was what we called the wild card, far more resources required, but also could present a far better return back here to the Earth. And again, at the end of the one-year study, it's here, America at the threshold -- there were 80-some boxes of books presented to NASA behind that, but that's what we had. Next slide, please –

PETE ALDRIDGE

Tom, just a point of clarification. Option number one is more like the current Vision?

TOM STAFFORD

That's correct, Mr. Chairman, that required the minimum amount of resources. It was just to the Moon to do some minimum exploration and to verify, you know, that the equipment you had

would go on to Mars. And I was talking to Dr. Tyson at lunch time and he mentioned about how the Gemini and Apollo program built one on top of the other and this is built in the same way and here we had what came out. You see the explorations in sciences, one of them is the human presence. And then space resource development. So this was the first one, and then we had the second one. The Moon to stay was the third one I mentioned, and the fourth was the space resource development, but they all had that common theme of exploration and science, of human presence and space resource and development. So you could take various parts of them. And so I was requested for two and we came up with a total of four. Next, please. The recommendations. Now, again, my charter was only the two architectures and the technology priority. As we got into this, it became very obvious that what was going on in NASA at the time and the problems with the Space Station, that management was one of the key issues. Even though it was not my charter, my first four recommendations there was management, Mr. Chairman. And the first one as we got into it, I asked NASA, where was the long-range strategic plan, turns out they did not have a long-range strategic plan. They had some technology road maps varied between the Centers, and so the one thing that did come out of the synthesis group here was the fact that it was implemented in NASA the first long-range strategic plan, and that's continued on though you modify plans as we do in the DoD and industry.

So the next one, and you brought that up, Mr. Chairman, how do you work all these other technologies and capabilities? We said you need a national program office, a national program office that would be established by Executive Order from the President. And this is somewhat similar to what you have just recently that evolved with the NRO and space activities, that are there for the Air Force. You have a National Program Office. This is something that definitely needs to be done.

The NASA associate administrator, number three, is a program director. Now, this has probably changed. We did have an associate administrator for exploration, but now we have an associate administrator for exploration development, and also we have a human space flight. Now, how NASA source that out will be back to them, but the person would be located in NASA, but staffed heavily with people from the Department of Defense, Department of Energy, and other Executive Branch entities would be required there.

Number four, as we got into it, based on my experience, there's deputy chief of staff here of the Air Force. When we started the F-117A program. We flew that aircraft in 2 years and 8 months after we signed the contract to go do it, now I think that was somewhat of a record in modern day times, as General Lyles knows. We used the streamline acquisition management, which has been very effectively used in a lot of the classified programs in Department of Defense and I think it's very fortunate that the Commission has you and General Lyles there, you are both well versed in how this is done. I think it's Section 809 of Public Law 101510 worked at that time for the Department of Defense, and we recommended that Congress give approval for a pilot program in NASA for the space exploration initiative that they have streamlined acquisition and management and that the acquisition authority rests with the associate administrator in that program development.

So this is a change. Mr. Chairman, to carry out a program of this magnitude, you have got to not do business as usual. You have to use streamlined acquisition management and have it focused to

the nth degree, and this is outlined in the book, sir. The next one that came in was the space exploration initiative's requirements into the heavy lift program. This is somewhat modified as you know, because when the administration changed in the end of 1992, the space exploration initiative was pretty much zeroed out. The DoD continued on with expendable launch vehicle, with the evolved expendable launch vehicle, but they have capabilities that are somewhat limited as far as I think 40,000 to 50,000 pounds. And to do this and go back to the Moon and on to Mars, you need far more than that. We estimated in our recommendations that we have approximately 150 to 250 metric tons to low Earth orbit. I don't see that that's quite in the budget that you have today, but you do have some heavy lift capability there with the modifying and the Shuttle components. And again, it's up to your organization to make recommendations.
The one thing that has changed too is miniaturization has continued on with respect to electronics. The pay loads and the landing parts and material developments on the lunar surface of Mars has gotten slightly less, so therefore, you could do it with less lift into low Earth orbit. As we continued on, we used Jet Propulsion Laboratory running trajectories and simulations.

It became obvious, if you look at number six there, the nuclear thermal rocket technology development, we determined, was the only real practical way to go to Mars. For the Moon, chemical propulsion was perfectly acceptable as we did it. But to go to Mars and the amount of energy required, you basically would like for humans to have a nuclear thermal rocket. We had that capability developed in the United States in the late 1960's and the early 1970's with the NERVA program, it showed a specific impulse of 845 seconds, it was run continuously on one occasion for over an hour and did about 28 automatic start-ups and shut downs, but there was not a mission for it, so it was canceled. It was the opinion of the group after all the study that the nuclear thermal rocket technology needed to be developed for the mission to Mars.

The next one, space nuclear power technology based on SEI requirements - to do adequate work for in set to processing, for adequate work on both the Moon and particularly Mars, you needed space-based electrical nuclear power. This could also, we determined later on, be used for low-level propulsion – the trajectory - to speed you up using ion propulsion or -- magneto plasma dynamics. I also want to commend Sean O'Keefe, within the first 2 to 3 months of his administration, he put forth the NASA nuclear initiatives to start developing this type of technology.

Number eight, focused life science experiments - the biggest risk going out there, you know, if you assume that you've got your systems down where the systems failure would be very low is going to be radiation. I think this question was asked about risk, and we understand that fairly well. You have galactic cosmic radiation, very difficult to shield against however, it's not that hard. We understand that the main thing is the solar radiation, and it goes in a cycle. But also you can have a series of unpredicted flares. If you go back in history, we were good on Apollo, but we were also lucky. After Apollo 8, a large flare occurred. And then in the last year we did the last two Apollo missions, Apollo 16 was in April of 1972, Apollo 17, the last one was in December. On August of 1972, one of the largest solar flares ever recorder erupted instantly even though we are trying to track and predict it. And had those two crewmen been on the surface, they would have received possibly up to a lethal dose of radiation. They might have made it back to the lunar module and to orbit, but they would have a fairly short life span. It is a risk, but there are ways to shield against it, and we will discuss that in just a few minutes. But we

do understand about the risk to humans. And in focused life science experiments. The human body needs about 6 1/2 pounds of water a day, -- 2.5 pounds of oxygen and approximately 1.5 pounds of solid food, and most Americans get more than that.

<<[laughter]>>

TOM STAFFORD

At the Johnson Space Center, they did run closed life support to recycle oxygen and water, and for people up to 90 days, it worked very good, practically no loss of water or oxygen. This is one of the criteria to go out to the Moon and particularly to Mars. If you have to carry all that water and oxygen, it's very difficult to do that.

The next one, as we continued all the way through this deliberation, it became obvious we need a motivational factor, and the universities even down in through the K-12 and education should be a principal theme of the space exploration and a motivating factor for education and an integrated effort. We had a lot of that back in Apollo. Could I see the next one, number 10, could you get it up there?

Well, the last one, number 10, it's below the screen there, was to continue to expand the outreach program. We did get some good ideas from the outreach program. I will mention a couple of those in a minute. And now let's go into recommendations. That was the, as I mentioned earlier, the establishment in NASA a long-range strategic plan with space exploration as a centerpiece. NASA is going forward and I think it's up to this commission to review and see how your recommendations -- on how it's effective. Next. I mentioned this before, very briefly. The national program office, this would be staffed by the Department of Defense, Department of Energy and other applicable areas in the Government, even though the head of it would be at NASA and would be an associate administrator of it. It would take care of a lot of coordination. And the one thing, Mr. Chairman, we mentioned at that time that this type of effort would undoubtedly have international scope. So as you bring international partners in, which the President mentioned in his speech, this National Program Office would be the one to pull together all those just in the same way that the space station, but participation would be even far greater. Next.

Again, the associate administrator is a program officer for, you know, the National Program Office there. Next. Now, the streamlined acquisition authority, I covered most of this early on, just as I went through those, but I feel that this Commission can give a lot of guidance to NASA, in particular the experience of General Lyles and yourself, Mr. Chairman, on how to carry this out. Next.

The heavy lift program, the -- we've discussed that before. I probably discussed a lot of those just going through the iterative efforts and, today the Shuttle modified, I think it can take between 60 and 80 metric tons. It would take several of those together with a series of -- even though you want to keep the basic joining in space to a minimum, but it's advanced a lot in the past 12 years and it's amazing. Today with CAD, with the Internet, from Russia, Japan, from the European countries, we have put together a precise interface, and I've even been surprised how well the

Space Station has gone together and fitted real well. It's probably not as much as of a basic problem as we outlined at that time, so there's been some improvement. Next.

The nuclear thermal rocket we discussed. I think very definitely that this needs to be done, and we've got -- it will take a period of time, and this to me is the long pole in the tent going to Mars is that nuclear thermal rocket. Next.

The space nuclear power technology of -- that would go up to five megawatts, we estimated. And the minimum we would start with would be 100 kilowatts. And the Prometheus Program at NASA has now started up, but the program at which it's under – the Jupiter Icy Moon Orbit program – JIMO I'm concerned that this needs to really be focused and have adequate attention from management to get this nuclear development completed. Had a previous one on space – from NASA, as far as space nuclear power, and it was not too much of a success. I think it was the SP-100. Next.

These life science experiments -- this is ongoing also, and you need to have suits on, and lightweight pressure suits. Because if any of you have ever worn a pressure suit and not fitted right, it's like doing a penmanship contest using boxing gloves. It's very difficult. This was ongoing, but the program was cut back. Next.

Education, and I mentioned, it's very important and should be one of the central themes of the initiative that this Commission is looking at. Education is so important. And as I said, continue the outreach program. We got some very good ideas from the outreach program and really there are thousands of ideas that came in, so this should be continued in a controlled way. Next.

Let's go - I have the technology priorities. There. And again we have -- this was the order of priorities of the supporting technologies for this, and we have talked about -- but that was a priority. If you don't have heavy lift, it will be impossible to do this, nuclear thermal propulsion, extra power. Cryogenic transfer and long-term storage particularly on the Mars mission with liquid hydrogen. Even on the best installation, you lost close to 1 percent a day on boil-off. The installation and technology is better, but that's a problem. Russia has had automated docking from the Soyuz to the Mir and now the Space Station. It's an engineering problem, 50 to 100 tons of docking. It can be done with the right torque to inertia ratios. And that's something that needs to be completed. Next.

The radiation effects and the shielding. And Dr. Spudis can elaborate far more than I can on this, but I think, Paul, we came up with adequate shielding around 16 grams per centimeter squared of water. And the best thing to negate the radiation coming in is really the hydrogen atom, and from this, the best thing is really water. And with that, that would stop all the solar flare and any secondary radiation that would come forward. Telerobotics, very important point when you are on the Moon or Mars, that you could have a series of efforts there between both the human and the robotic-type spacecraft controlled by the flight crews. The closed life support systems, that was mentioned briefly, you have to close the loop for oxygen and for water. Now, we said it was not feasible to try to close the loop for food. Just in either the Moon or Mars missions that we looked at. And that would take us way out through past 2020. If you are really going to be there on that third architecture for a long time, the Moon to stay for a long time, you would look at

possibly recycling the food, but basically it did not make sense as far as the other missions. You could take that with you. You could afford the amount of payload in the low Earth orbit.

Number 11, human factors for long duration space missions, very definite requirement to be sure it's adequate. 12, lightweight structural materials and fabrication from Lawrence Livermore Laboratory and presented to us. First we had a lot of questions and doubts, but the more we got into it, it became more and more feasible and could have been one of the enabling technologies to get us out there. Nuclear electrical propulsion for follow-on cargo missions has evolved quite a bit. You have the hall thruster, a Russian development now being pursued in Lewis, now Glenn Laboratory, I think up to 25 Kilowatts. With a nuclear thermal rocket and electric propulsion to follow on, you can shorten the time out to Mars possibly to 40 or 50 days. And you have to start braking too, but this has come quite a ways in the 12 years since we did this study, and there's a variable impulse that's been done there, by Dr. Chang-Diaz and Marshall Space Flight Center. I'm not saying which is the right way to go, but definitely with electrical nuclear power, you can go along with this type of effort.

Number 14, in situ process that was primarily for architecture number three with humans to stay and some science exploration. Let's go to the next one. We put together a table; it's on page a-8, for those who don't have a Synthesis Group report. The legacies, the guidelines, this came from what were the things that worked so well in Apollo and Gemini, and what did not work so well. Establish crew safety is number one priority, no doubt, but sometimes, Mr. Chairman it gets kind of hazy out there, if you look at what happened on the Challenger mission and recently on the Columbia accident. Crew safety is number one priority, but the way it was approached, it became a gray area, and all of these events that lead up to both the Challenger and Columbia were waived and all this. Well, yet, it was crew safety. It's still number one priority and you have to be sure everyone understands that. One thing about Apollo, Mr. Chairman that was clean lines all the way to Gen. Sam Phillips and the top. And for all elements of the program, ensuring that one organization -- if NASA is going to have enough sense of engineering to do that, or a prime contractor is in charge. This needs to be done. Next. Ok.

Realistic program milestones to clear entry and exit points, and useful capabilities at each step, and this is Dr. Tyson's question, and this was a real effort both in Gemini and Apollo, what were the entry and exits points and how to set technology in it. And be sure the Administration and Congress understand the technical and program list and the realistic cost. Because the one thing we have all been hammered on, and I worked for the Executive Branch of the Government, cost overruns, schedule overruns. So this needs to be done with the space exploration initiative, say here's what it will do. And I think a great example was the way the Apollo Program was started. Mr. Webb told the Vice President after one day's deliberation that they could go to the Moon and back in this decade, for $20 billion. And the final cost was $22.4 billion, starting from scratch. If you look up on the wrap-up on NASA back in the early 1960's. That was building the infrastructure, building the Johnson and Marshall Space Centers. And the Cape was strictly palmettos, rattlesnakes, and palm trees. In 6 years, that was built to the Vehicle Assembly Building (VAB), and we launched the first Saturn flag. And most of it was done with a slide rule too, sir. Next.

Simple interfaces between subsystems and modules: again, I will have to go back to Apollo. The Saturn V and Apollo were probably the simplest interface, like a meat cleaver and in the two spacecraft, just the thrust chamber pressures from the stages and tank pressures, lit up with I think two wires in case we had to take over and fly by hand the Saturn V, which we could do. That was it. It was the cleanest interface. When I worked on your commission, the last of the Bush senior Administration, we talked about having a clean interface for future in payloads and all that. And I guess the Evolved Expendable Launch Vehicle (EELV) evolved with that. This is just the same thing, simple interfaces. And the Space Shuttle is one of the most complex interfaces you will ever see. And all right, make use of modularity over the life of the program and flexibility, technology transparency and build capability for one mission after another to insert the new capability. And as technology is required, you saw it on the lunar module and the same with Gemini with upgrades on the computer we have done some of it on the Shuttle but not to the extent we did on Gemini and Apollo. Next.

Push the state of the art when required, very important. And be sure the outlines and technology we push have acceptable risks. Next one, optimum use of man-in-the-loop technology, don't burden a man where a robot or machinery can do better. In aviation we see it, the 727 started out, and three people in the 727? And now we are down to 777, with 2 people in the cockpit flying very safe. And that was a big debate if you will remember back in the 1980's, and also again on Apollo, the original one, the computer program, it was unbelievable, we wore out our fingers. Pete Conrad and I helped to rewrite the program after the tragic fire and the stand down for a period of time. So there's a lot of things that computers and machines can do, and let them do it and let the man be optimized in what they can do. Next.

Limit development time to no more than 10 years and actually the longer it takes, the cost goes up and you see that in DoD programs. You have seen it in NASA Programs and the Space Station is a prime example of this. Of course, it had to be redesigned. Focus technology development toward program lists. You can have a lot of technology development, but it's all for technology. And a lot of it probably should be put out to academia, let them work on it in the long term. You need a focused technology development toward many things. Next.

Minimize assembly and orbit requiring extravehicular activity. It's gotten slightly better but you want to minimize the amount of docking and your total reliability goes down. However, it's still better than when we studied this report, and actually minimize the mass to low Earth orbit because the heavier the mass you have, the more the -- actually the bigger the lift-off is going to be and the costs. And so that's just a given. Next.

Redundant and primary systems versus a big reliance on onboard inside maintenance. The Space Station has some of that, but out to the Moon it will be difficult, and Mars it will be tough to do anything on that one. The last one, hire good people, trust them, do not micromanage. If the people don't perform, the next action you get somebody else to do it. That was the positive. The pitfalls are next. Can we have that?

Now, establishment -- requirements, this is the thing that went wild on the Space Station. Establish requirements that is a wish list, and what was a wish list became a requirement, and it was unbelievable on the Space Station, particularly in software. Have a constituency on the Hill

and other places by promising too much to too many people and then you low ball the technical list and costs. This has to be realistic. I will refer back to Mr. Webb telling President Johnson. They said we could do it for $20 billion and we did it for $22.4 billion, starting from scratch. So you have to be realistic. And this is one of the main pitfalls. Next.

Do studies and more studies, have a technology demonstration and a firm commitment to do basic programming. And configuration controls need to be established as soon as possible with weight and electrical power requirements, and in other words have strict control on those requirements. And this is where again, Mr. Chairman, it comes back to the national program office. You have to have control of it real tight. Next.

Allowing software to run unchecked, becomes a constraint rather than support element. I think if you look at Apollo, one of the long poles in the tent was the software. Used to have black Saturdays all the time and we did not have that many words in the computer. And the same with the Space Shuttle, the software was one of the main constraints on getting that airborne, and also the software on the Space Station, unbelievable from the original lines of code to where it's set up now. Set up agreements for program elements, directing program management control this was under the original Space Station Alpha, what happened there again, the National Program Office should be able to solve that problem. Next.

The last one, when you are wrong, say you're wrong. We goofed up. We are going to do better, and here's where we are. And now a couple slides I was able to get a hold of yesterday, it will take a couple minutes -- a couple seconds, pardon me. That was a picture I shot on Apollo 10. We disproved the British Flat Earth Society. The Earth is round. >> [laughter]

TOM STAFFORD

During the period of time we finished this in 1991. There's been some efforts completed toward the going back to the Moon and on to Mars, and we have -- down at Johnson Space Center, we did several phases of this. They did a 90-day, four-person closed-loop study, and it was finished there in 1997. They completely closed the water loop and the oxygen loop and amount of water and oxygen loss was very minimal. So this type of technology needs to be put on board and demonstrated, and taken to the Moon and Mars, it drastically reduces your gross take-off weight. Next.

This Transhab came out of Lawrence Livermore Lab, an inflatable structure with a reentry vehicle on the far right. This is a habitation quarter, inflatable, very light weight. Turns out the way it was built, you see the gray areas at the top and bottom, this type of structure, it was demonstrated, it really has more micrometeorite protection than the Space Station does that's flying right now. And furthermore with water tanks around, it adequately shields you from radiation, from solar radiation and a little galactic cosmic radiation. Next.

This is -- they have built a prototype at the Johnson Space Center, deployed in a large vacuum chamber, hoping to have industry do that and work on the life support system. Unfortunately it was canceled. And that ends my formal presentation, sir.

PETE ALDRIDGE

Tom, thank you very much. I have a couple questions and we will open it up to the other Commissioners. I recall in your study and you hinted at it, enabling technology for the Mars mission was this nuclear thermal propulsion. And seems like I recalled, and said something like 240 days if you do chemical and 100 days or less if you do nuclear thermal propulsion. And the other piece was the significant savings in costs, billions of dollars if I recall correctly for that study?

TOM STAFFORD

You are correct. And the -- the fact -- take a look at these curves, those are all verified and run by JPL for us over a period of 6 months, and the blue ones are the nuclear thermal. With just a slight increase in that is on nuclear thermal, you can cut the transit time down from 240 days to 130. And if you have any electrical power propulsion, therefore ion propulsion, you can cut it down to about 60 days. Now, this drastically reduces your gross lift-off weight and directly relates to cost and staging and everything else, Mr. Chairman. And, yes.

PETE ALDRIDGE

Ok. It's interesting, just an observation. Any time this country, and I know this in DoD and you do as well -- wants something really badly and fast, we take it out of the normal acquisition cycle.

TOM STAFFORD

Yes, sir.

PETE ALDRIDGE

We specialize, and it says something about the acquisition system, means if we don't want something fast, indeed, we will put it in there. It's a little bit -- it's kind of backwards, it sounds like. One other issue, I noticed you had on there, and I was not familiar with it. You said something about an EVA suit?

TOM STAFFORD

The pressure suit you wear out in space, the life support suit.

PETE ALDRIDGE

What I wore in the SR-71.

TOM STAFFORD

Which was basically a Gemini suit. And it was fairly comfortable except when you pressurized, Mr. secretary, you were pressurized. When we started training underwater after my second mission, Gene lost 10 1/2 pounds in 2 hours outside and we had a tough time getting him back in. There needs to be a lot of development in pressure suits. Lighter weight, far more flexible, particularly in the gloves and dexterity. This was ongoing when it was canceled. There needs to be effort there, there has been lots of progress, but for a fairly small expenditure of money, a further improvement in those suits can be done. So you would like to have the same dexterity you have here at sea level, but I think it's probably going to be impossible, but you can get close to it. And most of those suits, we had 3.5 pounds per square inch pressure in Gemini, and Apollo about 4.1, and today on the Space Station about 4.3 pounds per square inch. The Russians have a unique system, and if you get into trouble, you can lower the pressure. We can't. That's how Leonov saved his life and got back on, it was risky, but you can lower the pressure. They have had the same problem with their pressure suits, but with adequate development, we can have some very effective suits. If you are going to live on the Moon for a long period of time or Mars, you will have to have the pressure suit that's very good and not tax so much of your strength.

LES LYLES

I put my previous hat on -- responsible for Air Force research and development and technology. With the exception of the EVA suit, everything you list are technologies that other agencies, in this case particularly the Air Force, are developing to some extent or another. It reinforces the notion for leveraging technologies and leveraging agencies to make sure they are working together. Because every one of these in some form or another is being touched on and there are dollars associated with it. From the Air Force and I'm sure many other organizations also, so that leveraging aspect is very, very important.

A question. You talked about management and NASA management etc., and you mentioned a couple different areas. And I don't know if you have had a chance to look at, but I would be interested or the Commission would be very interested if you could give us your comments, if not today but in the future, about the reorganization NASA is currently making within Headquarters to address some of the things you are talking about, particularly Code T, new exploratory systems, sort of an Air Force systems like command organization, to be responsible for addressing some of the concerns you expressed in your study. If you have not had a chance to look at it and give us your thoughts today, certainly would be interested in when you could get back to us.

TOM STAFFORD

I would like to come back with that. I know briefly and I'm all in favor that, Admiral Craig Steidle, has a lot of acquisition experience, bringing people in there with him. And we are more like -- Code M writes the requirements and the other people do the acquisition development like the Systems Command did. I think it's a wonderful way to go, but I only know some of the primary details. I would be glad to look into it and come back and report to the Commission.

LES LYLES

Very good, sir.

TOM STAFFORD

And the National Program Office would pull it all together because the Air Force has a lot of technology.

PETE ALDRIDGE

That would be helpful, give us a piece of paper and a phone call or whatever.

TOM STAFFORD

Sure, I'd be glad to.

PETE ALDRIDGE

Bob?

BOB WALKER

Tom, how far away are we from developing a nuclear thermal rocket?

TOM STAFFORD

Bob, I can't give you an answer today. I will take that down and try to give you a report on it. We had it at one time, in the early 1970's, had that specific impulse, ran it for an hour, and at approximately 250,000 pounds of thrust. And had a whole series of restarts, automatic shutdown starts, and to start where we are now, I don't know that answer, but it's an enabling technology. we have to have. And so I will get an answer back to you, sir.

BOB WALKER

Is that an enabling technology we should have on the way to the Moon as well as to Mars?

TOM STAFFORD

We said that to go back to the Moon, and for chemical propulsion was adequate as we did in Apollo. But to go beyond that, to Mars, like, I'm going from memory now, but to go from low Earth orbit to lunar orbit and back to landing, is around 5 kilometers a second. To go from low Earth orbit to Mars orbit, depending where you are, the 15-year sinusoid varies from about 8 kilometers per second to 24 kilometers per second, so that is a big amount of delta b. You have to add to get out there.

BOB WALKER

Going from your guidelines, I assume if you do nuclear propulsion, you would not assume on-orbit assembly –

TOM STAFFORD

No, sir. Well, on-orbit assembly as far as big masses together. But you would have the nuclear thermal rocket out here with the tank of hydrogen, docking neck mechanisms and guidance. So yes, you would have to have at least two or three dockings, but you would not go assemble the device at all. Also when I gave testimony on this, I think Ralph Hall was chairman of the Commission then, and the thermal rocket, until it's activated, is very quiescent. You can actually sit on top and you won't get any radiation. Only after you turn it on and that's in low Earth orbit.

BOB WALKER

The issue will be the political issue of launching a nuclear material, nuclear rockets, and so on. And, that's the reason I am asking the question, whether or not there's an on-orbit assembly to give the public some degree of comfort on whether or not you're launching something that is hot.

TOM STAFFORD

It can be perfectly safe in the way that you have all the safety factors with -- nuclear physics that in case for some reason it happens it doesn't go on, it's not going to give you any radio activity anywhere. The only time you have radio activity is when you pull the control rods and by then, you are in Earth's orbit headed out. So it's not going to affect anything here on Earth.

BOB WALKER

Thank you.

PETE ALDRIDGE

Maria.

MARIA ZUBER

I'm wondering if you would comment on the idea of acceptable risk. We calculate risks in doing robotic or human missions, and getting those last several percentages drives the cost of the schedule. How would you define acceptable risk in sending a person to Mars?

TOM STAFFORD

Well, I'll go back to Apollo. I said the number one priority is crew safety. In Apollo, it was 99.999 percent. Mission success was 0.90. And Apollo 13 was not a success in terms of finishing the mission. We were 0.99 out there as far as crew safety. Now, there's, you know, on any curve,

you have a capability versus the dollars. And I think you need to be up in the, at least the 98, 99 percent, this can be debated. Again, you know, it's not risk free. This has been well demonstrated. And also another thing that I have told NASA that, when they put the new crew expedition module on top of an expendable launch vehicle or whatever launch vehicle, it needs to be, quote, human rated. We used to call it man rated. And had that not happened on Gemini, besides the 17 astronauts, you would have had two more dead added to the list, and that was Schirra and Stafford. The fire broke out down below. But the emergency man rated on that Gemini took some savings, it was a close call. So you can't take this Crew Exploration Vehicle and, well, put it on this vehicle. But also you have to look at the escape -- like on the Challenger accident, had they been on an Apollo spacecraft, they would have been alive and well. The Russians have had a few experiences like that, and it has to be designed in from the start.

PETE ALDRIDGE

Neil.

NEIL TYSON

General, I share your sentiment about -- the tendency to raise an eyebrow when someone boasts of the complexity of the Shuttle. I remember a NASA engineer telling me with pride how complex it was. And as a scientist, I thought to myself, is that what we should be boasting of, given how many extra points of failure are introduced. What would we need to recommend to try to ensure that future creations of ours, hardware creations, don't have every possible last bit of technology just because -- just because it's available? And I get the feeling that people just want to load it up, because we can, without regard to -- because maybe it looks like you will accomplish more for having done so, when in the end you are just trying to get a simple job done. Can you comment on that?

TOM STAFFORD

Yes, sir, Dr. Tyson. I mentioned simple interfaces, and you only put technology in when it's necessary to accomplish a mission. Often they say, it will be great to do this and insert that, but that should be done in line, evaluating the risk and costs and all that. You have an objective, go do it.

NEIL TYSON

So we should surely reemphasize that fact in our report.

TOM STAFFORD

I think so. That brings up a good point on resources and that. I think you need to -- again, my viewpoint, what the Commission, one of the great things you can do is you oversee NASA, to see, you know, the resources required and everything. We built up during Apollo and things evolved out of that. You have never taken -- there have been several attempts to look at the resources and installations and all this. And I think you need to take a good, hard look at that, sir.

PETE ALDRIDGE

Let me make sure I understand. To take -- to take a look at this new mission, where we are going, you would recommend we stay, here's what it takes to accomplish this mission for the future –

TOM STAFFORD

That's right.

PETE ALDRIDGE

This is the interest infrastructure that exists within NASA today. How do we rationalize the infrastructure and the new mission, pluses and negatives.

TOM STAFFORD

That's right, pluses and negatives.

LAURIE LESHIN

I was going to ask a similar question, and I was struck by your description of earlier spacecraft versus the Shuttle. To make sure I understand, it comes down, sounds to me, in the writing of requirements of basically taking desires and making them requirements, is that what it comes down to in your view?

TOM STAFFORD

Yes, and again this National Program Office being very tough on requirements and review, and having simplicity between the stages, and the way the requirements were written, I headed the Synthesis Group. We had all the industry come in and talk to us over a period of time of this year, and the DoD and NASA. And I started asking questions because I have had several reviews, and I was on the NRC, and I was concerned about how the software kept going up and up on the Space Station. And finally an industrial firm is coming in, bragging about how many lines of software code is in there, bragging.

<<[laughter]>>

TOM STAFFORD

You volunteered to come here, I wanted an answer. He told me they had a big room with black boards all over, and everybody wrote down what they wanted, and that was the requirement. So you need to have a lot of discipline in the requirements. And that's what happened in the Space Station field.

PETE ALDRIDGE

Go ahead.

NEIL TYSON

You mentioned a 10-year limit, a realistic 10-year limit on a program. I presume that you came to that number through some analysis of -- the politics of decision making and of public interest, but 10 years is 6 Mars years doubling times and I would not be caught dead using a computer that's 10 years old.

TOM STAFFORD

No.

NEIL TYSON

I'm curious in the life cycle of any program that involves the creation of new technologies, at some point the technology is frozen onto some design and then it gets launched some years later. 10 years feels a little long to me given the rate at which things matter in such a mission. I'm wondering, is it unrealistic to believe that that could be reduced to 5 years given what we know of -- when I think of the Manhattan Project going from idea to bomb to 5 years, how come we don't have that turn around on technology today? What's wrong and how do we fix that?

TOM STAFFORD

As I mentioned, on the streamlined acquisition management, we said 10 years is the outer limit, and probably the long pole in that tent would be the nuclear part on that. But, you know, the basic part to get started for the initial operational capability, because you do have some elements that have some heavy lift with the Space Shuttle, you modify it and work from that. You could do that. But that would be the total. Again, I go back to the F-117A and yet you look at the Space Station and see how that's gone from the time President Reagan said in 1984 we'll go forward. And people have seen it, we've had reviews on it. I know Chairman Walker has seen it many times.

BOB WALKER

There's a rule of thumb I used to have on Capitol Hill that any program that sticks around on Capitol Hill for more than 6 years is in trouble.

TOM STAFFORD

That's right.

BOB WALKER

It's the election cycle. You're one full term for a Senator, and you've gone through three election terms for a house member in 6 years, and after that, members of Congress believe after they authorize programs they're immediately done. So, if you come back to them a couple years later and say we're still working on that --

PETE ALDRIDGE

And we need more money.

BOB WALKER

That's right, and we need more money.

TOM STAFFORD

Always. Well, one thing on the program, you could have some -- less than 10 years definitely. I think some demonstrations to get back to the Moon. Using some of the existing -- you know, type of capability with a lot of vibe, but there's certain technologies to use that could -- would definitely be there and in a demonstration. Now, this is going to take you for a long period of time, just like the space exploration issue. When you talk about Mars, you've got a sinusoid of 15 years for those 26-month windows, and the Moon is a complete different thing as far as yes, it's out there but you can go there any month of the year.

BOB WALKER

I think Norman R. Augustine's guidance earlier today about having goals and having the points, I mean, Congress will sit still if you're meet a series of goals within a certain time frame, so an important part of this program is to make certain you have the long view of it and some of those longer-term technologies, but mean time you're meeting goals which are definable on Capitol Hill.

NEIL TYSON

Indiscernible.

TOM STAFFORD

Right. Meet those early ones. Right.

PETE ALDRIDGE

Tom, we're running out of time. Just one more question.

TOM STAFFORD

Right.

PETE ALDRIDGE

I know the Synthesis Group focused on the technical solutions of things, but one of the things we have to address in our Commission is sustainability of these programs over this long period of time. You didn't talk very much about that, the leadership, the Presidential leadership, that's required to keep these things going.

TOM STAFFORD

Well, the basic Vision starts from the President down. And it starts there for leadership, and it's -- we have the opportunity now with President Bush -- what he's said and what happened before, we had the change of Administration and real fast it got zeroed out. So, again, you're talking an 8-year cycle, but you have to have a buy-in by both the Congress but also it come from the Executive Branch of the Government. And it has to be showing a compelling argument. Now, in here we outlined why the Moon, why Mars, and what are the compelling arguments for it and what is the benefit back here on the Earth and what it does for us.

PETE ALDRIDGE

Ok. Well, it's going to be a challenge for our commission because as we pointed out already, you know, this is a 40-year program. It's 10 Presidential Administrations. And it must be bipartisan. It cannot -- hopefully we'll do something that didn't happen to SEI that the next president thought -- had a different idea.

NEIL TYSON

The American people need to take ownership of it. And think of it as theirs, almost like a national right that we are in space, otherwise it will float away.

TOM STAFFORD

I agree completely, Dr. Tyson in that it has to be explained to them and say, you know, that you are the stakeholders in this. It's part of your Vision, and also I get back to one of the emphases on education, and if -- you know, if you can infuse that to the universities and back to the high schools and do it the right ways, I think this is a very positive thing which again feeds back up to the Administration.

PETE ALDRIDGE

Tom, thank you very much. And we look forward to your additional contributions. We talked about giving homework assignments to science people, and we did it again.

TOM STAFFORD

That's true. Thank you. It's been a real honor to be here.

PETE ALDRIDGE

Thank you. Ok. We have one more presentation. We have Cort Durocher, the executive director of the American Institute of Aeronautics & Astronautics (AIAA). I was privileged to work with him on several activities, several workshops that AIAA has been involved in in international cooperation and I'm sure Cort will tell us some good ideas that came from those workshops of how we can enhance and encourage international participation in the appropriate way into this new initiative. Cort? Welcome.

CORT DUROCHER

Thank you, sir. It's a pleasure to be here today. It's also great to follow General Stafford. And the remarks that I have to make today might make this thing a little more complicated because I'm going to recommend an international component to this activity, which what I think this will also help further develop the capability and the support for the program. If I could have the next slide, please.

These didn't come out very well, did they. Ok. First a commercial message about AIAA. The American Institute of Aeronautics and Astronautics usually goes by its acronym – AIAA. We were formed in 1963, through the merger of two societies which date back to the 1930's. Are your copies better than this?

PANEL

Yes.

CORT DUROCHER

I hope so. Ok. I guess I can't be accused of reading my own slides today. We are the largest professional society in aerospace. And we represent 35,000 members in over 90 countries as well as 50 corporate members. And our members are engineers, scientists, executives, and educators, leaders in the aerospace field from all levels of industry, academia, and Government. And I wasn't going to read our mission because it's on the chart there, but I would like to highlight the fact that our mission is to advance the art, science, and technology of aerospace and to nurture and promote the professionalism of those engaged in the aerospace profession. Next slide, please.

Our 35,000 members are formed into discipline-oriented technical groups and, in turn, a series of 66 technical committees, again, discipline oriented. We also have a regional orientation of 65 sections and 20 standing committees for our governance. Our areas of expertise include publications and conferences to include standards. We have a public policy program. And we have a very active international program, and in addition to the space cooperation workshops

which I'll talk about at the end of my presentation, I also wanted to mention an additional item that we're active in, and this is the India--United States Conference on Space Applications. And this follows because of President Bush's announced next step in the strategic partnership with India that came out on the 12th of January. It builds on previous statements by the President from 2001 and the next steps in implementing the shared Vision include a way to enhance cooperation in the peaceful uses of space technology. So, we've put together under the guidance of the Department of State a conference in Bangalore, India, in June of 2004, to review and evaluate current research and existing projects, to convene U.S. and Indian scientists, policymakers, and industry to expand current projects and to identify new areas of cooperation and commercial activity. This is more of a bilateral rather than a multilateral space cooperation endeavor. Next slide, please.

We applaud the President's Space Exploration Vision and are very excited about this activity and this panel. We believe that it finally provides a long-term focus for the civil space program, and we like the way it integrates robotic and human activity. We also feel that it will stimulate interest in pursuing careers in science and technology. This morning, I was at the Reagan Center. We had a panel of six industry CEO's and probably the only thing they had in common was the fact that the pipeline needs to be reinforced. And an exciting space exploration program would be a great step to improve the pipeline. We believe that this program is important as part of a balanced and comprehensive aeronautics and space program, and we wish to provide additional comments once further details have been elaborated. There are some who still believe that the U.S. should go it alone in pursuing the future of human space flight. And we believe those people to be wrong. We should not miss the chance to get the whole world together in taking the next important step in our march to the stars. Next slide, please.

I notice the slides are getting a little bit better as we go. The U.S. should encourage private sector involvement in this activity. Private sectors develop launch systems and service, can operate new communication satellites and ground systems, they could coordinate operation support, and they could stimulate new and innovative technologies. We also commend NASA on their recently announced Centennial Challenges Program to establish annual prizes for breakthrough accomplishments that enhance the solar system exploration. In addition, next slide, please, we believe that the U.S. should encourage international participation in this Vision. We have a very different world today than we had with Apollo, Space Shuttle, and when the International Space Station initiatives were launched. The cold war is over. We're in a world of asymmetrical threat. We have more experience in working with international partners, and we have a host of other countries who have expanded interest and capabilities which could be combined to those of the U.S. in order to undertake this human exploration initiative. Next slide.

Where would we be today if we didn't have Russian participation on the Space Station? In light of this situation, we believe that the U.S. should actively encourage other countries to join with us and play significant roles in the initiative through the development, launch, and operation of both robotic and human missions. Now, we recognize that countries wishing to play must also be prepared to commit a share and availability of resources. Although the international cooperation is written into the National Aeronautics and Space Act of 1958 that created NASA, our record in addressing that goal has been spotty to date. There have been many highs, most notably in robotics, space science, and exploration, and today ever increasingly in the

commercial space sector where international joint ventures have become the norm rather than the exception. But in considering the future of human space flight where the international flavor could perhaps be most effective, there is much more we can and should do. Next slide, please.

These are some of the benefits of international cooperation in our mind. We could enrich the character of the initiative. We could make it more affordable for the United States even though the total cost may increase with multiple partners. We could add redundancy or robustness through the use of parallel space transportation and orbital systems and provide access to launch facilities and other capabilities that might not be available. It also might give that compelling interest so that it would be a global political legitimacy rather than just a national one. We also believe there's a number of challenges including expert control, proliferation, and competitiveness issue, and we realize that the long-term commitments are really a challenge to any program. And I -- I'm glad you're already thinking about the schedule and what type of political commitment it's going to take. Next slide, please.

Our membership includes 5,000 international members and 10 international corporate members. And since 1992, we've started a series of international space cooperation workshops. I think it's going to be interesting when you see some information on the first one. We will be conducting our seventh workshop in Anchorage in May of this year. We invite the commission to participate in that activity in any way that they deem appropriate.

So, my next slide is the conclusion, and we believe that the Vision for space exploration focuses on exploring the origins of the solar system and searching for life beyond planet Earth. We believe this also provides us with a unique opportunity to cooperate with other countries in the pursuit of these objectives. May I have the next slide, please.

There's a second file. Fact sheet on international space cooperation. Maybe not. Do you have a second file? I'd like -- I do have some information on the past six workshops, who was the chair, what organizations cooperated with AIAA in that activity, and I think what you'll see is the -- although we had some continuity of chair, we had great growth in supporting organizations over the years. No. It's the second file. Well, look, you have it in front of you. Ok. Let me just cover it. The first workshop, slide three, learning from the past, planning for the future. We weren't exactly stupid. We went to Hawaii in December. And our chair was your chair. Pete Aldridge. Maybe that's why we went to Hawaii. I'm not sure. We looked at several different topics, very top-level. We had about 60 people from maybe 15 different countries. We had developed and developing countries represented.

Slide four, the second one, we went back to Hawaii in 1994. And your chair was joined by Richard Peterson, who was the AIAA vice president at the time, and we looked more in depth at certain systems, global space systems services, peacekeeping cooperation, robotic exploration of space, solar power.

The next slide, slide five, we move to Europe. We joined with the Confederation of European Aerospace Societies. We were hosted by the European Space Agency. We had an American and an Italian co-chair, Thomas Young, Tom Young the chair from our side, and it's interesting to

note -- I notice he's just registered for the seventh conference that we're going to do in Alaska. So, he's back. And we looked at some additional topics.

PETE ALDRIDGE

Cort, just to interrupt for a second.

CORT DUROCHER

No problem.

PETE ALDRIDGE

This first one, these criteria for international space cooperation I think would be of particular interest to this commission. We looked at the -- what makes sense, what's appropriate, and what's not appropriate for international. I think that one would be of particular interest. I know you're going to offer up the workshop reports.

CORT DUROCHER

Right.

PETE ALDRIDGE

And we'll put that in our reference library.

CORT DUROCHER

Ok. Yes. I've got a complete set of reports that I will leave with you, but, yes, that was the first time we developed criteria for international space cooperation. I've got a couple slides on that at the end here.

PETE ALDRIDGE

Ok.

CORT DUROCHER

But it's interest to note in the planning for the seventh workshop we decided months ago to take a look at that area again. So, we're either lucky or we're seeing the future happen to us. But we did establish criteria at that time. The fourth workshop, we move back to North America, and we added the Canadian Aeronautics and Space Institute as well as the European Society, General Cromer and Karl Deutsch were the co-chairs.

The fifth conference was solving global problems in Bermuda. And your chairman returned to co-chair that with --

PETE ALDRIDGE

Only in Hawaii and Bermuda would I --

CORT DUROCHER

There seems to be a pattern here. We also added the United Nations Office of Outer Space Affairs as one of our co-sponsors at the fifth conference. And the sixth one we did in Spain, again, with your chairman, co-chairing. We also -- we added the International Academy of Astronautics as a co-sponsor, and we covered such topics as space traffic management and international approach to detecting Earth-threatening asteroids, global navigation, space and the public, and the contribution space systems make to the development and implementation of multilateral environmental agreements.

Slide nine is the criteria for cooperation. And again these were developed at the 1996 workshop and it was realized that both domestic interests and materials benefits were of import to determining whether a project was right for international cooperation or not. We actually developed a checklist in the 1996 time frame, and we have decided to revisit that at our newest workshop. And the last slide, slide 10, is the title of the next workshop, number seven, is From Challenges to Solutions. It will be in Anchorage, Alaska. We are pre-qualifying people in order -- it's by invitation only, but if someone either on this Commission or someone in the audience is interested, if you'd contact AIAA, we'd be happy to discuss whether your organization is a good fit for the activity. This will be shared by Jean-Michelle content from the EADS and the French Society and our vice president for international, Jim Zimmerman, and we'll be talking about five topics, four plus the guidelines for international cooperation. So, that's the -- that's my presentation, and I'll leave this with Susan, and I'm ready to take any homework assignment or questions.

PETE ALDRIDGE

Cort, one of the things that would be of interest, this is going to be in May. Right?

CORT DUROCHER

Yeah.

PETE ALDRIDGE

Ok. Getting close to the end, but, you know, maybe a quick look at taking a look at the President's Vision and the criteria that you had established before might be a -- might be good for the AIAA to provide input to the Commission maybe on a quick-look basis with obviously a more thorough review maybe at the May workshop. What might you see as logical areas of cooperation in this new Vision? And as it fits its criteria.

CORT DUROCHER

Absolutely.

PETE ALDRIDGE

So, it would be helpful, I think, in the next weeks if you could provide that input to us. I think we'd be much appreciative.

CORT DUROCHER

We'll take basically -- the President's Vision with the old criteria, and we'll run that as a test case, and obviously we'll see what that gives us.

PETE ALDRIDGE

Ok.

LES LYLES

Cort, one of the strength areas of expertise for AIAA is our student programs. And obviously, a part of this Vision is intended to address stimulating or re-stimulating interests in space, and science and math for our young people for the future. As an enabler and really for the future in many different aspects. Can you give us any ideas or thoughts on perhaps things that could be addressed either in your programs that you have or other areas that we might sort of take into examples of how this might be addressed?

CORT DUROCHER

Well, I -- yes. I think first of all, this would be a great opportunity because you need a compelling Vision and you need a compelling program to really get people excited about this. And I think this would -- we have programs for students, undergraduate and graduate, we have a K-12 program, other technical organizations have the same or have similar programs. But you need a lightning rod to really get people excited about it. And I really think this could be it. It's certainly more exciting than a NASA without a Vision, which is what we've had for the past few administrations.

PETE ALDRIDGE

I'll put a plug in for AIAA. A program just finished called The Evolution of Flight, which is the 100th anniversary of the Wright brothers' flight. And that was a lightning rod which had a tremendous amount of student participation that had learned to fly, scholarships, there was -- what is it -- the ambassadors that went around all over the country to various aerospace places, aerospace corporations because it was focused on the 100th anniversary. And this seems like a logical step to the next series of stimulants for this kind of thing, the new space exploration activity. So, maybe AIAA ought to think about that.

CORT DUROCHER

Yeah. That was a -- actually, I think it was started on -- when Pete was our president, and the program manager for that, Mary Scott, I believe, is in the room back here. And --

PETE ALDRIDGE

Give Mary another job.

CORT DUROCHER

That was a very exciting program, and it pretty much culminated in another one -- when another one of the Commissioners got involved this summer in July. It seemed that our final banquet, which is being held in Dayton this year, a certain individual was being honored at that banquet and he wanted to fly his own personal 707 and land it at Wright-Patterson Air Force Base, so we called the general running the base, and he and his wife were glad to welcome John Travolta to Wright-Patterson.

NEIL TYSON

And my twin daughters. Thank you for -- this is quite enlightening to see the breadth and depth of activities that the AIAA is engaged in and how that might plug into our deliberations. I have a question regarding the international cooperation. I think the fact that on the Moon there's an American flag is a point to pride to many Americans. And even though, of course, on the plaque it says, "we came for all mankind," it doesn't say we came for America, still an American flag was put on the Moon. I think most people, most sensible people, I believe, would not argue against international cooperation. I think it's just sensible, particularly given that economically the world is a much smaller place than it ever has been. So, I'm not here to argue against that, but I want to put up a -- I want you to comment on a possibility that the space program remains a point of pride in America and that it may be that there's more money to do it alone than there is to do it in partnership. Because when it's in partnership, there's sort of a dilution of the American dimension of the plan. And I have no doubt that some subset of Americans feel this way. And so, we're wealthy enough so that whatever moneys are brought in by partners, that's not going to make or break whether we would have afforded the thing to begin with. It's not a factor of 10 difference even if it’s as much as a factor of two. Could you comment, for lack of a better word, on sort of the nationalistic flavor that space travel has as perhaps part of its baggage?

CORT DUROCHER

Right.

NEIL TYSON

Rather than as a shining point.

CORT DUROCHER

Well, I guess there's a couple points I'd like to make. The first is we, in this country, cannot force another country to be part of this initiative. I mean, they would have to come forward to do that. I guess I'm assuming that if we were willing to have them join us, that they would – they would like to do this. As recently as October of this last year, at the last International Astronautical Federation Congress, the ESA has put forward a program, I believe they call it Aurora, and that program is essentially very, very, very similar to the President's Vision. It involves the Moon, it involves Mars, it involves robotics, it involves people, Ok. So, and actually the time frame is not too inconsistent. I see the doctor is aware of it. The time frame is not too inconsistent. So, theoretically, the European Space Agency might be willing to come forward. Now, that doesn't address your concern as far as, you know, maybe we should just do it -- you know, keep all this for America. We might have more consensus here. It's very interesting to note we have some international astronauts that have flown on the Space Shuttle. I've been with them when they've returned to their countries after they've flown.

NEIL TYSON

Local heroes.

CORT DUROCHER

And they are -- I mean, it's like being the -- winning 20 gold medals at the Olympics. I mean, it's really a compelling thing. So, although on the one hand as an American I feel that it would be great, we could do this without international participation, but should we? You know, shouldn't we try to take everything -- other people along with us? The meeting I was at yesterday, we were talking about coalition warfare. You know, we don't really want to go into a defensive situation or war or any kind of police action. We would like it to be a coalition rather than a -- us being the only ones there. I think the same thing applies. I think the total value of the program would increase if we had significant and appropriate international participation.

NEIL TYSON

I heard that President Kennedy was, by one of his advisors, recommended -- was recommended to present to Congress a joint mission to the Moon with Russia, but another one of his advisors strongly recommended against it, that it would be dead in the water the moment it came on to the House floor. So, I was just curious -- I mean, so, if you were around back then, you would have been tugging on his --

CORT DUROCHER

I was around back then.

NEIL TYSON

Ok. Around making this point is my -- and it would have been unheeded.

CORT DUROCHER

Well, but, again, the world has changed quite a bit. That's also the same President that had the Cuban Missile Crisis to deal with. So, you know, I think today is a little bit different than the 1960's.

PETE ALDRIDGE

The point being we are now dependent upon the Russians for support to the Space Station.

NEIL TYSON

Right.

PETE ALDRIDGE

And I think we're glad we are. At this point in time. But Cort makes a good point. We can't force anybody to come and join us, and, in fact, we probably have to lay out a program under the assumption that it will be U.S. only, but if people come and say we want to join you, then you have to assess the pros and the cons, I believe, in that discussion. That's why I think these criteria that were developed internationally would be very useful to see because there may be cases that in some critical path we may not want to have -- be dependent on participation but on some redundant missions and supporting missions, we might be quite willing to have somebody. Anyway, I don't know the answer at this point in time, but it's a question that we as a Commission will have to address before the --

NEIL TYSON

Right. Because the political baggage can be insurmountable. China wasn't exactly invited into the Space Station, for example, so to the extent that we address the scientific and technological value of multiple partners, especially given the heightened technological talents in the rest of the world that was not the case 40 years ago versus whatever is the politics of the moment in the week's headline in "the Washington Post."

PETE ALDRIDGE

And the politics of the moment change drastically over 40 years.

NEIL TYSON

Yes. As they already have.

PETE ALDRIDGE

As they already have.

CORT DUROCHER

I guess -- I was around during the debate about, you know, do we want to let the Russians into the Space Station or not, and there were people on each side of that. We went the way we did. The Administration chose to include them, and then the debate was over, well, we don't want to give them anything that's supercritical in case they, you know, mess it up. Well, here we are. There's one way up and one way down right now. All's well that ends well, I guess.

LAURIE LESHIN

A very interesting topic to me as well. I'm curious if you have taken a stab at correlating the international cooperation and here with the Space Station we have an example of international cooperation. Have you done the exercise of taking those criteria and matching them against how it came to be on space stations and --

CORT DUROCHER

See if it fails or not?

LAURIE LESHIN

Yes. Would it have passed the test of criteria?

CORT DUROCHER

I believe so, because the people that actually developed This was pretty much the same people.

LAURIE LESHIN

Ok. So, they took those lessons learned.

CORT DUROCHER

Yes. And the participants for each of these -- as a matter of fact, the next one includes somebody from the Department of State, somebody from NASA, and somebody from the Department of Commerce, I know.

PETE ALDRIDGE

Anybody else? Cort, thank you very much. We appreciate your input and your look to the future. To get your homework assignment in, on time. We promise not to grade it, though. Thanks, Cort. That ends the formal presentation. And we'll adjourn the Commission. We do have an opportunity for a press conference at this point In time. Those of you who do not want to participate in the press conference, you're free to depart. Those who do are free to stay. It'll be a series of questions and answers to myself and the other members of the Commission for about a

half-hour or so. I think that's the schedule. Ok. Oh. The press conference starts at 3:30 right here. Ok. Then we will adjourn until 3:30. Thank you.