

Testimony of
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Before the
Committee of Science and Technology
United States House of Representatives
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Mr. Chairman and Members, I appreciate your invitation to present my assessments on the new NASA plan based on the President's 2011 Budget Submittal.

I am, admittedly, an aerospace enthusiast, having spent 17 years at NASA and its predecessor agency, NACA, prior to joining a university faculty to teach aerospace engineering. I was a member of the National Commission on Space and Vice Chairman of the Presidential Commission on the Space Shuttle Challenger Accident. I finished my active career in a company manufacturing a wide variety of highly engineered aerospace products and, more recently, served on the NASA Advisory Council. I still get excited about great new ideas.

If one of the goals of government is to motivate its citizenry to 'be the best that they can be', few government agencies will surpass NASA in that function. I have met countless now middle aged adults who credit NASA's human space programs for inspiring them to study hard in order to master and excel in their chosen field. And they are not just in aerospace, but in education, astronomy, computer science, medicine, and engineering

The motivating quality of NASA programs and people is, I believe, due to its success in achieving leadership status in space travel and exploration, and to its enduring tenacity in exploring the frontiers of the cosmos. That is one reason why maintaining that leadership

position is so important to our country. But it is certainly not the only reason. Success in expanding our understanding of the universe that surrounds us, and sharing that information with others around the globe, engenders respect and admiration from people and governments around the world. Discoveries and developments at technology's edge produce new theories, new products, new systems, and ultimately, new ways of living. Who, at the time of Sputnik, would have suspected that, two generations later, golfers would be determining their distance to the flagstick using a Satellite based GPS ? Or that we could measure the rate at which the moon is moving away from Earth (currently about 1.5 inches/year)?

Management gurus have written endless analyses of push versus pull strategies. The applications are ubiquitous: marketing, advertising, manufacturing, development, etc. The new NASA plan includes technology push funding for research and the hope of 'breakthroughs' to hasten our success in developing craft to carry humans to distant cosmic destinations. Some have compared this approach to that of the National Advisory Committee for Aeronautics (NACA), the predecessor of NASA, whose only work was research and only product was reports. Some have assumed that NACA was completely a technology push agency.

As one of the small and ever diminishing number of NACA alumni, I can confirm that NACA did, in fact, conduct some technology push projects, such as the NACA airfoil series, the NACA engine cowl and supersonic boundary layer heat transfer. On the other hand, most research efforts were 'pull' projects, identified by the aeronautical industry and the military as problems that required solutions, and NACA help was requested. Examples are stability requirements for aircraft at supersonic speeds, understanding and solutions for transonic 'tuck', pitch-up, and roll coupling, practical variable sweep wings, and supersonic drogue chute development.

That work was exciting and fascinating. It was, day by day, perhaps the most genuinely satisfying work of my life. But it was not motivating to the general public. Rarely was the general public even

aware of the remarkable research work that was going on in the NACA laboratories and flight tests. My experience in both pull and push operations leads me to conclude that pull research attached to an operational space exploration program would be substantially more likely to produce usable results in a timely manner.

Project selection and budgeting in the new NASA plan appears to have been heavily dependent on the observations and options presented in *Seeking a Human Spaceflight Program Worthy of a Great Nation* (HSP), familiarly known as the *Augustine Committee report*. It is interesting to review the constraints under which the Augustine Committee operated, and the effects that those constraints imposed on their findings.

The committee was “asked to provide two options that fit within the 2010 budget profile” (HSP p.15). The two options selected were the “Constellation Program of record” and the “ISS and Lunar Exploration”. The funding available for Constellation under the 2010 Presidential Budget Submittal was more than \$1.5 billion per year below the 2009 Budget and about \$3 billion per year below the original funding plan based on the Exploration Systems Architecture Study. The Committee quite properly concluded that the program would be delayed and cost more and Ares and Orion would be too late to serve the International Space Station, scheduled for termination in 2015. They found that “human exploration beyond low Earth orbit is not viable under the FY 2010 budget guideline” (HSP p.96)

It is improper to conclude that Constellation was beyond help. Constellation managers believe they would have been in reasonable shape had NASA been provided the funding of the 2009 President’s Budget Submittal or even the 2011 Budget. Indeed, Mr. Augustine in his testimony to this committee last September said: “.....we believe that the existing program, given adequate funds, is executable and would carry out its objectives.”

In determining the reasonableness of competing concepts to be compared, the Aerospace Corporation (Aerospace) was engaged by the Augustine Committee to provide estimates on cost and schedule. Your Subcommittee on Space and Aeronautics, thoughtfully, saw fit to ask Aerospace to provide details of that process.

Aerospace projected the development costs for a 4 person commercial spacecraft with launch abort system at 12 billion 2009 dollars plus \$8 billion for the launch rocket. Similarly, costs for a 6 person spacecraft would be \$17 billion (spacecraft + LAS) plus \$10 billion (launcher) respectively. The Committee assumed NASA would contribute 3 billion dollars to this project, which Aerospace, using historical growth and other factors, raised to 5 billion dollars (HSF, p. 70). The contribution remaining for the commercial provider is a very substantial investment and, if accurate, raises questions about the ability and willingness of a public or private company to accept that financial risk. Aerospace stated their assumption was that three competitors would bid and two would be selected. They further assumed that NASA would need two flights per year to the ISS. A reasonable business case supporting this proposal is elusive.

Some question why America should return to the moon. "After all", they say, "we have already been there." I find that mystifying. It would be as if 16th century monarchs proclaimed that "we need not go to the New World, we have already been there." Or as if President Thomas Jefferson announced in 1808 that Americans "need not go west of the Mississippi, the Lewis and Clark expedition has already been there."

Americans have visited and examined 6 locations on Luna, varying in size from a suburban lot to a small township. That leaves more than 14 million square miles yet to explore. There is much to be learned on Luna, learning to survive in the lunar environment, investigating many science opportunities, determining the practicality of extracting Helium 3 from the lunar regolith, prospecting for palladium group metals, and meeting challenges not yet identified.

The lunar vicinity is an exceptional location to learn about traveling to more distant places. Largely removed from Earth gravity, and Earth's magnetosphere, it provides many of the challenges of flying far from Earth. But communication delays with Earth are less than 2 seconds permitting Mission Control on Earth to play an important and timely role in flight operations. In the case of a severe emergency, such as Jim Lovell's Apollo 13, Earth is only 3 days travel time away.

Learning how to fly to, and remain at, Earth-Moon Lagrangian points would be a superb precursor to flying to and remaining at, the much farther distant Earth-Sun Lagrangian points.

And flying to further away destinations from lunar orbit or Lunar Lagrangian points could have substantial advantages in flight time and/or propellant requirements as compared with departures from Earth orbit. And flying in the lunar vicinity would typically provide lower radiation exposures than those expected in interplanetary flight.

The long communication delays to destinations beyond the moon mandate new techniques and procedures for spacecraft operations. Mission Control cannot provide a Mars crew their normal helpful advice if the landing trajectory is 9 minutes long but the time delay of the radar, communication and telemetry back to Earth is 19 minutes. Flight experience at lunar distance can provide valuable insights into practical solutions for handling such challenges. I am persuaded that a return to the moon would be the most productive path to expanding the human presence in the Solar System.

Mr. Chairman, you asked that I present my priorities for the human space program. I suggest that:

- 1) We maintain American leadership
- 2) We guarantee American access
- 3) We continue to explore the Solar System.

Leadership, access, and exploration are my priorities.

This issue facing this meeting has produced substantial turmoil among space advocates. So many normally knowledgeable people were completely astounded by the President's proposal. Had the announcement been preceded by the typical review, analysis and discussion among the Executive branch, the agency, the congress, and all the other interested and knowledgeable parties, no member of this committee would have been surprised by the announcement of a new plan.

In this case, a normally collegial sector of society was split in many fragments, some focused on contracts and money, some on work force and jobs, some on technical choices. All because a few planners, with little or no space operations experience, attempted an end run on the normal process. It has been painful to watch.

Mr. Chairman, I sincerely hope the members of this Committee, and all the others involved in this process, will work openly together to provide a plan which will be the best choice for our country.