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Mr. Norman Augustine
Chairman, U.S. Human Space Flight Plans Committee

Dear Mr. Chairman,

I am writing today to provide some perspectives that your commission may find useful during its deliberations on the future of our nation's plans for its manned space flight program. To put them in context, I have taken the liberty of appending a brief biographical sketch to this note.

The United States faces a broad range of economic challenges today, and it is appropriate that we carefully evaluate the merits of all of our government's spending policies. With regard to NASA, this means that we must take a sober look at the mission of the agency and we must determine which of its many activities are essential to the success of that mission and which might be delayed or eliminated to save money. When I do this exercise, I keep returning to the notion that NASA, since its earliest days, has been most successful when it has emphasized *exploration* – not simply space operations, be they manned or unmanned.

As we enter a new era of space ventures when commercial enterprises are poised to serve many of the operational functions once only in the domain of NASA and its international counterparts, NASA should renew its focus on exploration. As a scientist, I recognize the scientific value of orbital laboratories like the International Space Station As an earth scientist especially, I feel that space sensor networks are powerful tools for monitoring the evolution of our home planet. But these activities, however important, rarely push the threshold of our engineering capabilities and could be managed by other government agencies, national or international, with the help of the private sector. NASA should be about constantly pushing the envelope; America should lead the world, through NASA, in inventing the future of manned and robotic space exploration.

At this juncture in the history of space exploration, the least "mission-critical" of NASA's manned space activities are operations in low Earth orbit. This implies to me that the current vision for space exploration, including phasing out of the Space Shuttle, is not fundamentally flawed but, rather, in need of some significant tweaking. For example, an exploration-focused approach to manned space flight means that the logic behind building Ares I is far less compelling than the logic behind building a heavy-lift vehicle such as Ares V. Should we not look to existing assets or to assets being designed by the private sector to serve our national, low Earth orbit needs and use the sparse resources of NASA instead to accelerate the development of Ares V?

I am sure that your commission will confront, at some point, the old chestnut of an argument (dating back at least to Jerry Wiesner's days in the Kennedy Administration) about the relative scientific merits of human vs. robotic space exploration. As my friend Bill Clancey (of NASA Ames Research Center) often reminds me, it's all human space exploration, but sometimes we employ teleoperated robotic tools. When you look at the argument that way, and you take into consideration cost and safety issues regarding human space exploration, it really comes down to a question of whether or not there is sufficient value added by conducting science directly. As was the case for Apollo and the Mars Exploration Rovers, the early stages of scientific exploration of a planetary surface is likely to focus on field geology. At juncture in the development of robotic tools, and for the immediate future, there is no doubt to me that the scientific return with geologists actively working on a planetary surface is vastly superior to the scientific return with robotic assets alone. (More effective still would be a collaborative effort among robotic assets and astronaut-explorers, and that is precisely what many of us are working toward in academia and various NASA research laboratories.) There definitely *is* a scientific motive for human space exploration.

Another perspective you will no doubt encounter is that the Moon is a poor – or, at least, unimaginative – target for the next phase of human space exploration and we should instead go directly to Mars or, perhaps, an asteroid. Issues of technology readiness notwithstanding, this is an ill-conceived notion. The Moon is a big place, and our first tentative exploratory forays there (Apollo, Luna, etc.) have left us with at least as many scientific questions regarding its evolution as we have answers. Most importantly, because the Moon never developed plate tectonics, it serves as our best archive of the early history of the inner Solar System, including Earth. It is even plausible that

the Moon maintains, through meteorites transferred from the early Earth, an archive of the earliest life in the Solar System. Unquestionably, Mars is a dynamic place and thus a compelling research target for many planetary geologists (including me!), but the relatively accessibility of the Moon makes it a better short-term target for human exploration. From a purely nationalistic perspective, cancelling our planned return to the Moon would be a profound mistake. It will take decades before we are ready technologically for human exploration of Mars; by then, we will have ceded our leadership in space exploration to the Chinese and possibly Europe, Japan, and India.

One lunar effort in our current plan for human exploration is, in my opinion, more debatable: the notion of a permanent lunar settlement. While I can understand the arguments, I do believe that we must keep our eyes on the prize of venturing to Mars and, quite plausibly, finding evidence there for past or present extraterrestrial life. I would focus only on developing the minimum capacity on the Moon to support Mars exploration, not the broad infrastructure necessary for permanent settlement. We need refueling and launch capabilities without doubt, and lunar research facilities may provide badly needed scientific grounding for the physical and psychological effects of long-term work in hypogravity. But the concept studies I have seen emphasize the concept of permanent outpost, not the sort of "frontier fort" – occupied for an undetermined time and abandoned when it has outlived its purpose – that has played such a critical role in Earth exploration.

Finally, I'll end with a simple observation based on my experiences in university, K-12, and informal education: human space exploration is a powerful catalyst for public interest in science and technology, much more so that exploration with robotic assets. Our nation faces a serious problem inasmuch as the best and brightest of our youngest generation are not as focused on science and technology as we need them to be. Without question, we need them to learn mathematics, physics, chemistry, biology, and geology, but we must also create learning environments that are inspirational. The 1960's prove the notion that human space exploration can provide such inspiration and attract students into science and engineering in large numbers. In fact, I can think of only a handful of cutting-edge activities that are as effective, particularly with very young students. (Imagine, for the moment, the inspirational impact of talking to elementary students about nanotechnology or genomics!) I trust that your committee will emphasize the profound educational value of human space flight as it prepares its recommendations.

Thank you for your time in considering these thoughts. I know the committee has a hard task before it, and I wish you well in your deliberations.

Sincerely,

Kip Hodges
Director, School of Earth and Space Exploration

Biographical Sketch – K.V. Hodges

Kip Hodges is Founding Director of the School of Earth and Space Exploration (SESE) at Arizona State University, a unique educational and research enterprise that integrates earth and space sciences with systems engineering of instrumentation for scientific exploration. His principal research foci have been the process interactions responsible for development of our planet's great mountain systems, particularly the Himalaya-Tibetan and Andean systems. Field research has taken him from the High Arctic, across the Tibetan Plateau, and to the jungles of South Asia. In the laboratory, he specializes in the development and deployment of new microanalytical strategies for studying the geochemical behavior of noble gasses in geologic materials and for high-precision 40Ar/39Ar and (U-Th)/He geochronology and thermochronology. In recent years, he has taken up the challenge of expeditionary planning for planetary exploration, with a special emphasis on planetary field geology. In this capacity, he has been collaborating with colleagues at various NASA facilities (ARC, JPL, and JSC) to design protocols for human-robot exploration, particularly lunar surface science operations. He is presently involved in designing field geology training curricula for the 2009 class of Astronaut Candidates. Prior to moving to ASU, Hodges was on the faculty of the Massachusetts Institute of Technology for 23 years. While there, he served (at various times) as Dean for Undergraduate Curriculum, as Co-Director of the Earth System Initiative, and as Co-Director of the special freshman learning program Terrascope. Throughout his career, Hodges has been active in the design and implementation of new strategies for K-12 and informal science and engineering education. A Fellow of both the Geological Society of America and the American Geophysical Union, he serves as a member of the Planetary Science Subcommittee of the NASA Advisory Council.