Statement of

Kathryn C. Thornton
Professor and Associate Dean
School of Engineering and Applied Science
University of Virginia

before the

Committee on Science and Technology
Subcommittee on Space and Aeronautics
U.S. House of Representatives

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Chairman Udall, Ranking Member Feeney, and members of the subcommittee, thank you for inviting me to appear before you today. My name is Kathryn Thornton and I am a Professor and Associate Dean in the School of Engineering and Applied Science at the University of Virginia. I appear here this morning not in my faculty role but as an organizer and co-chair of an independent workshop entitled *Examining the Vision: Balancing Exploration and Science* held last February at Stanford University. The workshop was co-hosted by Stanford University Department of Aeronautics and Astronautics, and The Planetary Society. Other organizers were co-chair Professor G. Scott Hubbard from Stanford University, Dr. Louis Friedman of The Planetary Society, and Dr. Wesley T. Huntress, Jr., of the Carnegie Institution of Washington. The post-workshop joint communiqué and a partial list of participants are attached.

The intent of the workshop was to critically examine the current implementation of the *Vision for Space Exploration* as announced by President Bush in January 2004, especially to help prepare for a new Administration's consideration of its broad space program goals and plans. The *Vision for Space Exploration* in its original plan was a major redirection of the human space flight program with an accompanying emphasis on scientific exploration. Whatever changes might be made in its implementation in the next Administration, we wanted to identify, highlight and support the best parts of the current concept. Our goal was to create a report intended to be useful in the next stage of policy planning, and potentially to define follow-on studies of the issues.

The *Vision for Space Exploration* provided specific targets, defined human and robotic exploration objectives and set timetables. The *Vision* as originally put forth was rich in scientific goals aimed at finding life elsewhere in the Universe. In addition, the *Vision* continually pointed toward Mars as the ultimate target for human exploration and couched exploration of the moon in those terms. Four years later, implementation of the *Vision* has focused on a small subset of the original concept: finishing the International Space Station (ISS) for international partners, retiring the Space Shuttle by 2010 and

developing new launch vehicles (Ares I and V) and a new crew vehicle (Orion), and the moon as the near term goal of human exploration.

With the fixed requirements, fixed schedule and NASA's flat budget, funding to meet the *Vision* has come from science, aeronautics and technology. Aeronautics has been reduced radically, life sciences have been largely eliminated, the entire crosscutting technology budget has been redirected, and more than $3B over 5 years was taken from the space and Earth science budget. Much of the originally planned funding for the human exploration mandates has not materialized, while the cost of returning the Space Shuttle to flight and its impeding retirement has risen.

With these concerns as the motivation, the workshop was planned as a two-day, behind-closed-doors discussion of the goals and implementation of the Presidential directive, and the issue of balance between exploration and science. Organizers sought to bring together scientists, astronauts, engineers, policy analysts, and industry executives in a single conversation where insights across traditional boundaries could occur.

The discussions were organized around the following topics:

1. *Scientific Exploration of the Universe*, in particular the role of a Mars Sample Return mission as a major milestone in scientific and robotic exploration as well as a precursor for human exploration.
2. *The Earth Science and Climate Change:* What should the US be doing to provide policy makers with the best available information.
3. *Access to Low-Earth Orbit (LEO) and Beyond:* Plans for and capabilities of the Constellation system
4. *The Role of Lunar Exploration* in the human exploration strategy
5. *Human Missions to Mars*
6. *Alternative Destinations for Human Exploration*
7. *Humans and Robots in Exploration:* when is a human the tool of choice for solar system exploration
8. *The Role of the Emerging Entrepreneurial Space Industry*
9. *International Collaboration in Space Exploration*

Invitations were extended to individuals whom the organizers felt would bring great diversity of thought, as well as expertise, on those topics. Each participant was invited to take off his or her corporate, institutional or advocate hat, and engage in discussion that will help this nation have the best possible space exploration program. To the extent that the outcome might be critical of the current plans, progress or goals, criticism was

intended to be constructive and consistent with strong support for space exploration. As expected, lively discussions ensued.

Pre-workshop reporting predicted that the outcome of the workshop would be a repudiation of at least some of major the goals of the *Vision*. There was some doubt that fifty individuals, selected specifically for their differing specialties and divergent views, could reach a consensus on the goals and directions for America's space exploration program over the course of a two day workshop. Therefore there was no predetermined workshop report or product, but rather the expectation that these discussion would lead to further study and output in some form. Nevertheless, workshop participants did reach consensus on the following statements which in essence endorse the *Vision* as announced in 2004.

- It is time to go beyond Low Earth Orbit (LEO) with people as explorers. The purpose of sustained human exploration is to go to Mars and beyond. The significance of the moon and other intermediate destinations is to serve as steppingstones on the path to that goal.
- Human space exploration is undertaken to serve national and international interests. It provides important opportunities to advance science, but science is not the primary motivation.
- Sustained human exploration requires enhanced international collaboration and offers the United States an opportunity for global leadership.
- NASA has not received the budget increases to support the mandated human exploration program as well as other vital parts of the NASA portfolio, including space science, aeronautics, technology requirements, and especially Earth observations, given the urgency of global climate change.

These statements represent consensus among all workshop participants. I would like to expand on them from my own perspective.

It is time for humans to go beyond low-earth orbit. The post-Apollo space program traded exploration for utilization; exploration on the moon was exchanged for the prospect of a permanent laboratory, factory, and satellite repair station orbiting within a few hundred miles of the Earth's surface. The resulting quest for a permanent presence and routine access to space resulted in the Space Shuttle and later in the International Space Station (ISS). While both are remarkable technological achievements, neither has quite lived up to its promise, and just as the Space Shuttle today bears only a slight resemblance to early concepts for a fully reusable spacecraft, the ISS we have now is not the station that was envisioned more than two decades ago. To be sure, the ISS must be completed in order to fulfill obligations to our international partners. But in the longer term the Space Shuttle and the ISS serve to anchor humans in low-earth orbit, and orbiting the Earth, as thrilling as it is, is not exploring space. This nation must move forward with the development of a space transportation system that will do more than just orbit the Earth, but will enable humans to explore in space.

Mars and beyond is the goal of human exploration. Although "Mars and beyond" as the goal is a consensus of workshop participants, the question of intermediate steps was debated at length without overall agreement. A steppingstone approach to Mars might include some or all of the following intermediate steps: sorties to the moon and the Sun-Earth Lagrange points (L2) as the first step out of LEO; longer missions of perhaps a year's duration to a near Earth asteroid as the first step out of the Earth's gravity well; and expeditions to the Martian moons, Phobos and Deimos, which would be of similar duration to Mars missions but without the need for complex and risky landing and launch systems. The important point is that each of the steppingstones, whichever they may be, should advance the science and technology needed for the next, more ambitious objective and for the eventual human exploration of Mars, and none should be considered as permanent outposts that would again anchor us in place for decades.

Exploration should be goal driven, not schedule driven. The exploration goal has been repeatedly found to be the basis of public excitement and interest in the space program. In the aftermath of the tragic loss of Columbia and her crew, this was forcefully reasserted in the discussions of why human space flight is worth the cost and the risk. Indeed it was in that aftermath that the *Vision for Space Exploration* was born. Exploration is open-ended, it has no limits. But it has interim objectives and those also should be publicly engaging and seen as milestones on a longer road. Practical engineering for meeting milestones is bound by three major constraints: budget, schedule and requirements. If you change one of these three, the other two must change accordingly. Particularly if the budget is over-constrained, either schedule or requirements must give – and that is what is happening today. As a result, the "gap years" in which there will be no US human space launch capability stretch to or beyond the middle of the next decade. At the same time human missions to the moon by the year 2020, as specified in the *Vision*, are exceedingly unlikely. I strongly believe the goals of the *Vision* are valid, but recognize that budget difficulties will remain. It is important to remain focused on the goals, not the schedule, and proceed as efficiently and safely as technology and budget will allow.

Science is enabled by human exploration, but is not the goal of exploration. To be sure, there are compelling science objectives at each of the intermediate destinations en route to Mars, and important scientific questions that must be answered before humans can venture beyond LEO. But the motivations for science and human exploration are different, even as they are synergistic. Science seeks to answer questions of the origin of the universe and of ourselves, and the processes that govern nature. Motivation for human exploration is largely derived from innate human characteristics such as curiosity, imagination and the desire not just to understand but to experience, the drive to compete and more recently the need to cooperate. Geopolitical influences shape our exploration goals as much now as they did in the 1960s.

One of the questions posed in the workshop was, "When is a human the tool of choice for solar system exploration," to which one participant responded, "as soon as possible when exploration has transitioned from *reconnaissance* to *meaning*." Humans solve puzzles and find meaning in data, albeit at a higher cost than our robotic surrogates. We could

debate the relative value of humans versus robots at great length but, in fact, we would be missing the point. Humans are explorers. Whether deep under the ocean, on the frigid plateaus of Antarctica, or above the atmosphere, humans are programmed to indulge our unquenchable thirst for knowledge - not only scientific data but human experiences. We are unwilling to surrender those domains solely to robotic surrogates and forego the human experience of adventure and discovery.

We must balance science and exploration, and manage expectations as we move forward. NASA's portfolio includes Earth and space science, aeronautics, and technology as well as exploration, and a healthy balance must be maintained among the sciences, and between science and exploration. Science is of enormous benefit and interest to the public and to our future generations – the inspiration derived from Hubble and the Mars rovers are but two examples, the 2006 Nobel Prize in physics for work that was based on measurements from COBE is yet another. The science budget should not be used to compensate for the underfunding of the *Vision* goals.

Furthermore, science programs are not just budget lines, they are people. They cannot be turned on and off without consequence. As NASA's aging workforce reaches retirement, how are we going to attract the next generation of scientists and engineers who will continue exploring the universe? I believe we must pull rather than push; pull students into science and engineering with the promise of interesting work and a fulfilling career. What more powerful pull can there be than the opportunity to explore the universe? When budgets are redirected and the very programs that attracted young scientists are summarily terminated, they are forced to retool, retrain and reeducate themselves for other careers. They are in all likelihood lost to the NASA workforce forever and we are all poorer for it.

The entire field of microgravity science was based on the expectation of a space station for long term experimentation. Drop towers, zero-G flights and even two week flights on the Space Shuttle were just warms up for the permanent laboratory in space. Young scientists built their careers on that promise. Even as ISS grew in orbit, opportunities for its use as a world class laboratory for microgravity science were shrinking. Microgravity science, born in the 1980s, was effectively killed in 2004.

As we execute the *Vision for Space Exploration*, it is important to be realistic about the goals, funding and timeline for science and exploration. Should we cast a net widely within the science community to find all possibilities for exploration and research that could be accomplished on the moon, and therefore solicit the broadest possible support within the science communities for a lunar program, or should we focus from the outset on science objectives that support the next step in the overall exploration strategy? Let's not repeat the microgravity science experience on the moon

Sustained human exploration requires international collaboration. From the very beginning, human exploration has been driven by geopolitical factors, in the US as well as in the Soviet Union then and in Russia now. As we make plans to explore beyond

Earth, it is appropriate that those political forces have led to cooperation rather than competition.

The US is the unquestioned leader in space exploration, a position that we are unwilling relinquish. International collaborative exploration initiatives offer the United States an opportunity to maintain global leadership in a cooperative environment. Collaboration with international partners provides opportunities for countries who may be competitors in global political or economic arenas to work together to increase human knowledge and promote peaceful utilization of the solar system.

The road to Mars will be a very long one, and any architecture must survive many one-year budget cycles and 4-year administrations. After several near death experiences, the ISS is still alive and will be completed because of our international commitments. The overriding importance of multi-national cooperation justifies the risk and cost of continuing the Space Shuttle program long enough to satisfy our obligations.

We can debate the value of science objectives or exploration goals, but the value of international cooperation in space ventures over the past decade cannot be challenged. Inviting meaningful international participation in the exploration architecture may reduce cost, accelerate the timeline, provide additional capability, bring a measure of stability through numerous budget cycles and administrations, while engaging rivals and allies in a shared commitment to extend the boundaries of humankind into new domains.

The role of entrepreneurial space ventures should be to help NASA get out of the business of routine transportation to LEO for cargo and crews as soon as practical. Non-government entities have transported cargo to space for decades, but only NASA and the Russian Space Agency transport humans to the ISS. As we have seen over the past two decades, our space transportation system has at times left us stuck on the ground. US flights were suspended for almost three years after Challenger, more than two years after the Columbia accident and will be suspended for some number of years after the retirement of the Space Shuttle in 2010. Shorter downtimes of months to one year have resulted from problems with helium leaks and external tank insulation shedding. As long as NASA is the owner, operator and sole customer of transportation services to LEO in this country, there is no competition for services and limited access to space.

The emerging entrepreneurial space industry projects growing demand for access to space by foreign governments who want to get into the space business, from multinational corporations and from tourists. NASA is investing in commercial space transportation services through the Commercial Orbital Transportation Services project (COTS) for cargo to the ISS, and eventually crew transport as well. Bigelow Aerospace and Lockheed Martin Commercial Launch Services are engaged in discussions on the Atlas 5 as the launch vehicle to provide crew and cargo transportation services to a Bigelow-built space complex in the near term.

As NASA refocuses on exploration, commercial ventures that will replace NASA as the sole US human space transportation system should be encouraged and incentivized by NASA and by Congress. Assurances that NASA will become a customer, not a competitor, in LEO would strengthen the business case for companies who are investing in this venture.

NASA has not received budget increases to support the mandates of the *Vision for Space Exploration* and the other elements of its portfolio even in the most optimistic scenarios. Each year since 2004 when the *Vision* was announced, the NASA budget has fallen short of that required to achieve the mandated exploration goals and milestones. Science, aeronautics and technology have suffered severely to compensate for the shortfall. Costs associated with the Space Shuttle retirement are not budgeted. The gap between Space Shuttle retirement and Orion crew exploration vehicle (CEV) initial operational capability is widening. In short, there is a mismatch between aspirations and appropriations that no amount of spin can disguise.

Faced with inadequate budgets, the other two elements of the budget – schedule – requirements triad must be reassessed. Again I urge that we focus on the goals of the *Vision*, not the schedule, and proceed in the most efficient, cost-effective and safe manner possible.

Is the Constellation system a vehicle for science as well as human exploration? I was asked to address potential advantages of using Constellation systems for science exploration missions, a question not considered at the workshop, but is the subject of an on-going NRC study. Constellation systems being designed primarily to achieve human exploration goals would enable larger, heavier and more capable spacecraft as well as human servicing options to meet science objectives that are synergistic with or independent of *Vision* goals. The Ares V launch vehicle, as envisioned, would offer significant increases in payload volume and payload mass *at a significantly higher cost* when compared with Delta and Atlas families of launch vehicles available today. In general, the advantages of launching "flagship"-class science missions on an Ares V are:

- Larger diameter payload fairing would allow larger optics (mirrors) for a significant improvement in high resolution imaging. The proposed Ares V 10-m (8.8-m useable) diameter payload fairing is roughly twice the diameter of the largest fairings available on the Atlas 5 or Delta IV (collectively referred to as EELV).
- Larger payload volume could lower complexity and mission risk by reducing the number of deployment mechanisms required to fit a spacecraft into a EELV-sized payload fairing. Larger payload volume may also reduce or eliminate the need for in-space robotic assembly of larger spacecraft.
- Larger payload mass would allow for redundant components for longer service life, and additional instruments, propulsion elements and propellant. Mission concepts that require multiple EELV launches could be consolidated into a single Ares V launch with integration of as much hardware as possible prior to launch.

- Future derivatives of the Orion crew capsule that include provisions for extra vehicular activities (EVA) could enable astronauts to assemble, service, repair and modernize science spacecraft outside of LEO, for instance at Sun-Earth L2 which is the proposed location for several large astronomical instruments and a potential steppingstone destination on the path to Mars. In the same way that the Hubble Space Telescope has been rejuvenated four times over its 18 year life, human servicing capability at L2 could greatly extend the useful life of spacecraft and instruments.

I am not aware of any reliable cost estimates for an Ares V launch, but it seems reasonable to assume that the incremental cost of a launch vehicle capable of putting 140 MT into LEO would be several times the cost of a 25 MT-capable launcher. Similarly, the cost of a science payload that requires such lift capability or would take advantage of the payload volume of the Ares V would be considerably more costly than "flagship" missions currently being developed for launch on EELV.

If Ares V launch vehicles were available for science missions in 2025 or later, there would undoubtedly be a number of mission concepts that would enable a qualitative new approach to the important scientific questions in fields such as astronomy, astrophysics, heliophysics, Earth science, or planetary science to name a few. However, the greatly increased payload capability promised by Ares V would also result in more costly science payloads and significantly more expensive launch vehicles. One billion dollar "flagship" class missions could well be superseded by $5B to $10B "super flagship" missions.

Unless the space science budget grows as the launcher capability grows, science missions that take full advantage of the capabilities of the Ares V cannot reasonably be flown on a routine basis.

Two post-workshop follow-on activities are in progress at this time. Workshop organizers are in the process of writing a detailed summary of the presentations and discussions that led to the consensus statements. Not seeking a consensus of all workshop participants, the intention is to represent the nuances of the discussions and various points of view, and to provide recommendations for the next Administration's consideration. The Planetary Society, a co-host of the workshop, is conducting a series of "town hall meetings" at several cities around the country to gain an understanding of public opinion on topics addressed at the workshop. The Society will use the results of these discussions to produce a roadmap for space exploration for the next Administration and Congress. The roadmap will cover robotic missions of exploration, human space flight, international activities, and public interests. The first of the town hall meetings was held on March 29 in Brookline, MA.

In summary, it is time to go beyond LEO with humans as explorers. To do so, we must have a space transportation system that will enable humans to travel to the moon, Mars and beyond; without it any debate of destinations and goals for human space exploration is pointless. We will explore with multi-national partners to serve our own national and international interests, as well as to advance knowledge. With the goals clearly in focus,

budgets and schedules must be balanced for an affordable, sustainable and successful space exploration program.

Mr. Chairman, I thank you and the Committee for your staunch support of the space exploration program and the opportunity to express my views today. I would be happy to answer any questions.

[THE JOINT COMMUNIQUE ISSUED REPRESENTING THE CONSENSUS VIEW OF THE WORKSHOP]

STATEMENT

The Planetary Society
65 N. Catalina Avenue, Pasadena, CA 91106-2301
(626) 793-5100 Fax (626) 793-5528
E-mail: tps@planetary.org
Web: http://planetary.org

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Contact: Susan Lendroth, 626-793-5100 or
David Orenstein, 650-736-2245

Space Experts Say: Restore Funding and Enhance International Outreach to Put Humans on Mars While Sustaining NASA's Science Mission

STANFORD, CA — NASA's program for human exploration must lead to Mars and beyond, and achieving that goal will require future presidents to embrace international collaboration and to fund NASA at a level that will also sustain its vital science programs, stated the organizers of a space exploration workshop today after intensive discussions Feb 12 and 13.

"This workshop achieved a consensus that NASA's resources have not been commensurate with its mandated missions of exploration and science," said G. Scott Hubbard, former director of NASA's Ames Research Laboratory in Mountain View, California, and a consulting professor of Aeronautics and Astronautics at Stanford.

"The next administration should make the human spaceflight goal an international venture focused on Mars—both to bring in more public support and to sustain the program politically," added Louis Friedman, Executive Director of The Planetary Society in Pasadena, California.

Friedman; Hubbard; Kathryn Thornton, a former astronaut and current professor in the School of Engineering and Applied Science at the University of Virginia; and Wesley T. Huntress, Geophysical Laboratory, Carnegie Institution of Washington co-organized the workshop.

The Workshop Joint Communiqué

In particular the attendees agreed to the following set of six statements:

- It is time to go beyond LEO with people as explorers. The purpose of sustained human exploration is to go to Mars and beyond. The significance of the moon and other intermediate destinations is to serve as steppingstones on the path to that goal.
- Bringing together scientists, astronauts, engineers, policy analysts, and industry executives in a single conversation created an environment where insights across traditional boundaries occurred.

- Human space exploration is undertaken to serve national and international interests. It provides important opportunities to advance science, but science is not the primary motivation.
- Sustained human exploration requires enhanced international collaboration and offers the United States an opportunity for global leadership.
- NASA has not received the budget increases to support the mandated human exploration program as well as other vital parts of the NASA portfolio, including space science, aeronautics, technology requirements, and especially Earth observations, given the urgency of global climate change.
- Additional recommendations will be provided by the organizers and participants in this workshop.

About the workshop

The two-day workshop, co-sponsored by The Planetary Society and the Department of Aeronautics and Astronautics at Stanford University, was an invitation-only meeting of 45 space exploration experts, including top scientists, former NASA officials, and leading aerospace industry executives. Eight of the attendees were former astronauts (for the agenda and attendees see http://soe.stanford.edu/research/evlist.html or http://www.planetary.org/programs/projects/space_advocacy/examining_the_vision.pdf).

The group gathered privately to engage in a frank, wide-ranging discussion of the Bush administration's vision for space exploration and the policy options facing the new administration that will take office in January 2009.

Topics discussed by the attendees in a series of 90-minute panels included scientific exploration; Earth science and climate change; lunar exploration; sending humans to Mars; alternate human exploration destinations; humans versus robots for exploration; vehicles for accessing low-earth orbits and beyond; emerging entrepreneurial space activity; and international collaboration.

"The Space Shuttle has been an incredible workhorse in low-earth orbit for more than 25 years, but now it is time for humans to move out into the solar system," Thornton said.

Contact:
David Orenstein
Communications and PR Manager
Stanford School of Engineering
davidjo@stanford.edu
(650) 736-2245

Susan Lendroth
The Planetary Society
tps.sl@planetary.org
626-793-5100 ext 237

Examining the Vision Workshop:
http://www.planetary.org/programs/projects/space_advocacy/2008_workshop.html

Examining the Vision: Balancing Science and Exploration

February 12-13, 2008

Workshop Attendees (partial list)

Buzz Aldrin	StarBuzz Enterprises LLC
Jim Bell	Cornell University
Ron Birk	Northrop-Grumman Corp
David Black	University Space Research Association (Ret.)
Jim Cantrell	Strategic Space
Brian Cantwell	Stanford University
Bill Clancey	Institute for Human and Machine Cognition
Nancy Colleton	Institute for Global Environmental Strategies
Pau Eckertl	Boeing
Bob Farquhar	National Air and Space Museum
Chris Field	Stanford University
Len Fisk	University of Michigan
Peter Friedland	Technology Consultant
Louis Friedman	The Planetary Society
Lori Garver	Capital Space
Noel Hinners	Aerospace Consultant
Scott Horowitz	Doc's Aerospace
Scott Hubbard	Stanford University
Russ Kerschman	NASA Ames Research Center
John M Klineberg.	Consultant
Pascal Lee	Mars Institute
Lon Levin	SkySeven Ventures
John Logsdon	George Washington University
Stephen Mackwell	University Space Research Association LPI
Mike McCulley	United Space Alliance
Chris McKay	Ames Research Center
Brian K. Muirhead	JPL
Tom Pierson	CEO, SETI Institute
Jeff Plescia	Applied Physics Lab / Johns Hopkins University
Charlie Precourt	ATK Launch Systems
Harold Reitsma	Ball Aerospace
Ken Reightler	Lockheed Martin
Joe Rothenberg	Universal Space Network
Steve Schneider	Stanford University
Russell L. Schweickart	B612 Foundation
Marijean Seelbach	Lockheed Martin Space Systems Company
Mark Sirangelo	Space Dev
Doug Stetson	Jet Propulsion Laboratory
Kathy Thornton	University of Virginia
Neil De Grasse Tyson	Hayden Planetarium
Jim Voss	Space Dev

Kathryn C. Thornton, Ph.D.
School of Engineering and Applied Science
University of Virginia
Charlottesville, Virginia

Kathryn C. Thornton is a Professor at the University of Virginia in the School of Engineering and Applied Science in the Department of Science, Technology and Society and Associate Dean for Graduate Programs in Engineering. She earned her Masters of Science and Ph.D. in physics from the University of Virginia in 1977 and 1979, respectively, and a Bachelors of Science in physics from Auburn University in 1974. From 1984 to 1996, Thornton was a NASA astronaut and is a veteran of four Space Shuttle missions. She has logged over 975 hours in space, including more than 21 hours of extravehicular activity (EVA).

Thornton was a mission specialist on the crew of STS-33 which launched at night from Kennedy Space Center, Florida, in 1989 aboard the Space Shuttle Discovery. The mission carried Department of Defense payloads and other secondary payloads. In 1992 on her second flight, Thornton served on the crew of STS-49 on board the maiden flight of the new Space Shuttle Endeavour. During the mission the crew performed four EVAs (space walks) to retrieve, repair and deploy the International Telecommunications Satellite (INTELSAT), and to demonstrate and evaluate numerous EVA tasks to be used for the assembly of Space Station Freedom. The following year Thornton was again a mission specialist EVA crew member aboard the Space Shuttle Endeavour on the STS-61 Hubble Space Telescope (HST) servicing and repair mission. During the 11-day flight, the HST was captured and restored to full capacity through a five space walks by four astronauts. On her final mission in 1995, Thornton served aboard Space Shuttle Columbia on STS-73, as the payload commander of the second United States Microgravity Laboratory mission. The mission focused on materials science, biotechnology, combustion science, the physics of fluids, and other scientific experiments housed in the pressurized Spacelab module.

Since leaving NASA, Thornton has served on several review committees and task groups, including the NASA Mars Program Independent Assessment Team and the Return to Flight Task Group which evaluated NASA's work in meeting goals set by the Columbia Accident Investigation Board prior to resumption of Space Shuttle flights. Dr Thornton also served on the NRC Aeronautics and Space Engineering Board, the Committee for Technological Literacy, and the Committee on Meeting the Workforce Needs for the National Vision for Space Exploration, and is currently a member of an NRC Committee assessing science opportunities enabled by NASA's Constellation system. She also is a co-author on Pearson Scott Foresman's K-6 grade Science program. Prior to becoming an astronaut, Thornton was employed as a physicist at the U.S. Army Foreign Science and Technology Center in Charlottesville, VA.

Dr. Thornton is the recipient of numerous awards including NASA Space Flight Medals, the Explorer Club Lowell Thomas Award, the University of Virginia Distinguished Alumna Award, the Freedom Foundation Freedom Spirit Award, and the National Intelligence Medal of Achievement.