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Space Innovation and Development Center, "Unlocking the Potential"

Space Innovation is the Key to Providing Combat Power

SPACE INNOVATION

NASA's Innovative Partnerships Program: Matching Technology Needs with Technology Capabilities

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In the pursuit of mission objectives in aeronautics and space exploration, the National Aeronautics and Space Administration (NASA) is often pushing the boundaries of what has been done before, needing many technologies to either enhance current capabilities or enable new capabilities. NASA's administrator, Michael Griffin, told the World Economic Forum on 26 January 2007, that "Necessity is the mother of invention, and I believe that we are at our most creative when we embark on bold ventures like the space program."

As a result of the technical advances needed to achieve those ventures, NASA missions often generate technologies which have applications beyond aerospace and can provide important benefits to improve the quality of life for the American public. As NASA's deputy administrator, Shana Dale, said at the 2nd American Institute of Aeronautics and Astronautics Space Exploration Conference on 5 December 2006, "Of course, much of what we gain from exploring and settling the Moon will not be in what we find on it, or in the observations we make from it, but in the scientific and technological progress that will come in the process of doing it. And much of that will have direct economic and health benefits for those of us who remain behind on Earth."

NASA's Innovative Partnerships Program (IPP) is seeking to be a facilitator and catalyst for innovation in two directions:

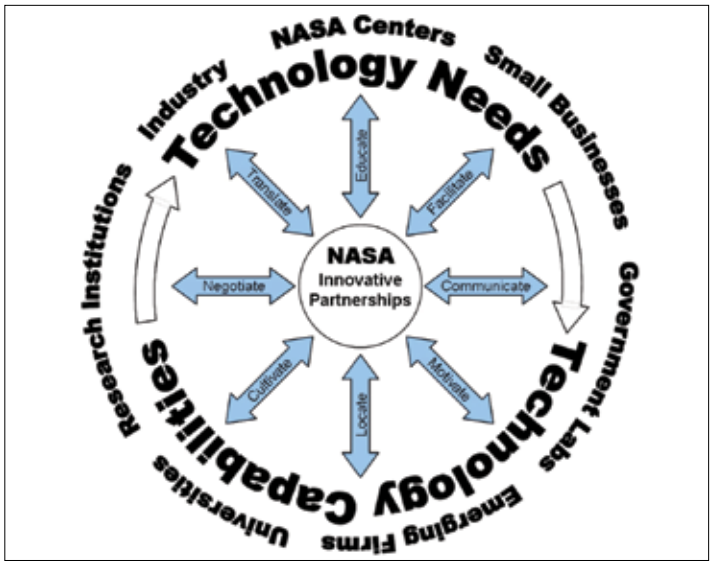


Figure 1. NASA's Innovative Partnerships Program is engaged in a dynamic process to match technology needs with capabilities.

technology infusion to provide technical solutions to some of the challenges being faced by NASA's programs and projects; and technology transfer—or spinoffs—to provide solutions to non-NASA technical challenges in the private sector or other government agencies with NASA-developed technology. IPP achieves these objectives through a network of offices at each of NASA's 10 field centers.

Innovation in this context is not a prescribed process, but rather an ongoing dynamic process with many simultaneous activities and organizations involved, seeking to match technology needs with technology capabilities, as shown in figure 1. In addition to the programs and projects at the 10 NASA field centers, organizations involved include small businesses, other government agencies and their laboratories, emerging firms seeking to address new markets including commercial space, universities and research institutions, and industry.

There are many activities undertaken to support this dynamic process. These activities are critical throughout the lifecycle of a partnership, from the initial state of identifying a need, locating potential sources of technology or innovation to address that need, facilitating the connection between potential partners and the negotiation that leads to an agreement. Once a partnership has been established, it must be cultivated with regular and ongoing communications, and success should be recognized and rewarded to create positive incentives that will continue to motivate innovation.

Communication is a critically important activity in this process. One of the premier tools NASA uses for communicating its technologies that are available for use outside of NASA is *Tech Briefs* magazine (figure 2), which is read by over 250,000 technology experts. Soon, *Tech Briefs* will also be used to feature some of NASA's current and future technology challenges in an effort to reach out to technologists who may have ideas or technologies available that can address those challenges.

Figure 2. Tech Briefs magazine provides access to NASA's latest technical innovations for over 250,000 advanced technology subscribers.

Communication is also important to convey success stories. This type of communication not only helps advise our stakeholders as to how well we are doing, but also provides important case

Figure 3. NASA's annual Spinoff publication has described more than 1,500 technologies that have been transferred to provide a broad range of societal benefits.

studies and lessons learned to help enable more successes in the future. *Spinoff* (figure 3) is NASA's annual publication featuring successfully commercialized NASA technology. For more than 40 years, IPP has facilitated the transfer of NASA technology to the private sector, improving the quality of life, contributing to US global competitiveness, and stimulating the national economy.

The broad spectrum of NASA technologies has relevance to an even broader range of industrial sectors. For example, successful transfer of NASA technology has led to the development of commercial products and services in the fields of health and medicine, industry, consumer goods, transportation, public health, computer technology, and environmental resources. Since 1976, *Spinoff* has annually featured 40 to 50 of these successfully transferred technologies.

Another important activity performed by IPP is *facilitation*—identifying technological needs, forming relationships and creating opportunities for making connections between sources that can fulfill those needs, through a number of venues. One particular facilitation activity that has been a big success for NASA is the TecFusion Forum. These forums actively reach out to large companies in various industry sectors to connect their needs with technologies developed by small businesses through federal funding, creating partnership and acquisition opportunities.

The *education* of NASA personnel as well as industry and others, regarding the opportunities and mechanisms for partnerships, is a very important element of the dynamic innovation process. An example of this is the authority for government agencies and their prime contractors to contract with small business innovative research (SBIR) firms for continued work on technologies they have developed with SBIR funding. Such contracts can be made on a sole-source basis without competition, enabling rapid access to technologies that may be very important to mission success. IPP also works with small businesses to help them mature their business processes and their ability to be successful.

By surveying the technology landscape inside and outside of NASA, the IPP professionals and their contractor support team are able to *locate* potential matches. To identify technology capabilities that NASA can offer, NASA inventors including civil servants and contractors, file New Technology Reports (NTRs) that describe their new technologies and what the potential applications may be. These NTRs form the basis for technologies that are communicated to a broad audience through the *Tech Briefs* publication described previously.

To identify NASA's technology needs, IPP works closely with NASA's Mission Directorates—the four NASA organizations responsible for investments in flight missions and technical projects to achieve the agencies goals in space exploration, space science, aeronautics and space operations. IPP communicates those needs through an annual solicitation for its SBIR/Small Business Technology Transfer (STTR) program, developed in close coordination with NASA's Mission Directorates, programs, projects and field centers. The annual solicitation is being structured such that SBIR/STTR investments will be integrated with and complementary to other Mission Directorate technology investments. In addition, there are industry workshops and focused activities conducted by the Mission Directorates to communicate their needs and challenges.

The IPP professionals who are seeking to make these connections between needs and capabilities often have to *translate* between different cultures and industrial sectors. Translation is a critical activity in order to avoid missed opportunities. Technologies in one sector may be described in different terms than in another, so it is important to have an understanding of the principles behind a particular technology to fully realize the potential for alternate applications.

In order for any partnership to succeed, getting to an agreement is just the start. It will take ongoing work from both sides in a partnership to *cultivate* the partnership to achieve its objectives.

Figure 4. NASA's Centennial Challenge program seeks non-traditional sources of innovation through prize competitions, such as the Lunar Lander Challenge.

NASA *motivates* the generation of technology by providing direct funding through contracts like SBIR and STTR, but also motivates innovation to achieve technical needs through prizes. Centennial Challenges (figure 4) is NASA's program of prize contests to stimulate innovation and competition in solar system exploration and ongoing NASA mission areas. By making awards based on actual achievements, instead of proposals, Centennial Challenges seeks novel solutions to NASA's mission challenges from non-traditional sources of innovation in academia, industry, and the public.

Another activity to motivate and technology solutions is the IPP Seed Fund—an annual solicitation from the IPP Office to enhance NASA's ability to meet Mission capability goals by providing leveraged funding to address technology barriers via cost-shared, joint-development partnerships. IPP works closely with the Mission Directorates to identify capability focus areas that

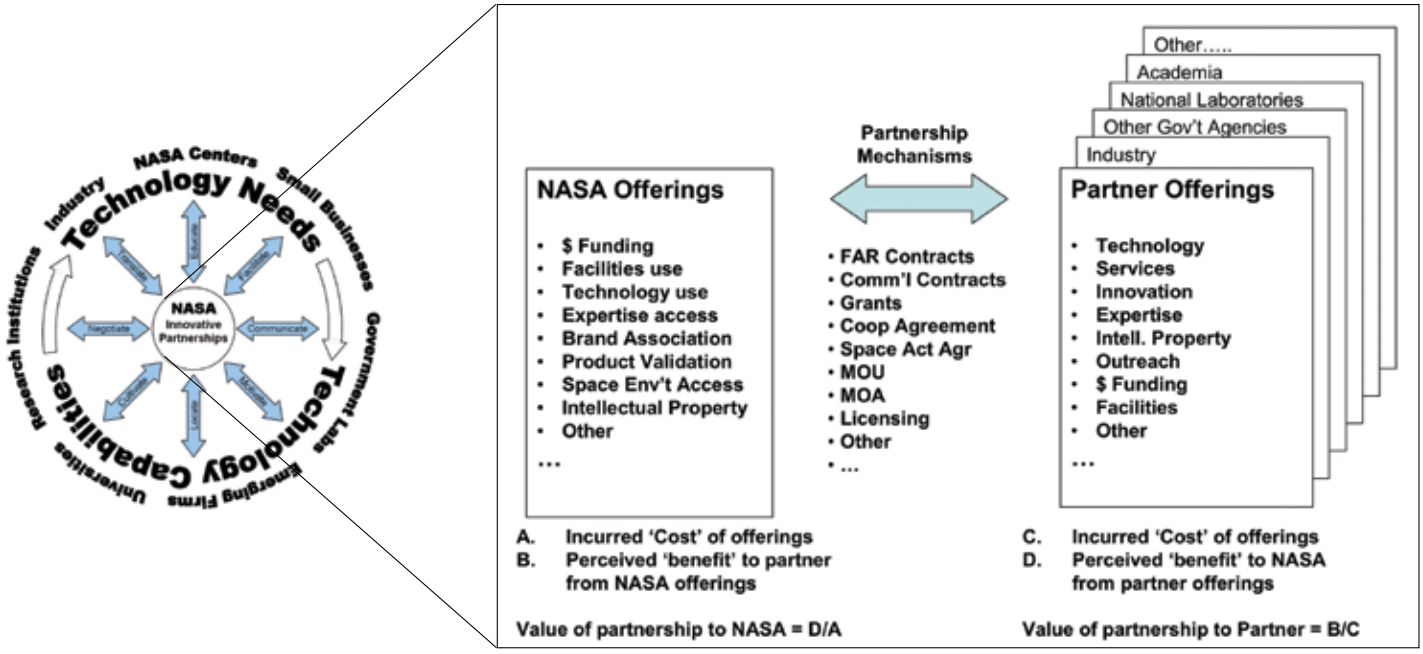


Figure 5. This generalized model of partnerships provides a useful construct for pursuit of partnerships, once the dynamic innovation process has identified potential matches of technology needs and capabilities.

technology investments such as SBIR/STTR, Centennial Challenges, and Seed Fund can address, in order to provide critical needs that are integral to their technology planning and investment strategy.

Creating positive incentives for achieving objectives can be very important to *motivate* success. One of the key mechanisms NASA has for achieving this is the Inventions and Contributions Board (ICB). The ICB, administered by the NASA chief engineer, is a major contributor in rewarding outstanding scientific or technical contributions sponsored, adopted, supported, or used by NASA which are significant to aeronautics and space activities. Over the past 48 years, the ICB has issued over 95,000 awards to NASA and its contractor employees, as well as to other government, university, and industry personnel.

A Generalized Partnership Model

When this dynamic process yields an opportunity for partnership such as a potential match established between a technology need and capability, it is important to *negotiate* an agreement based on the most appropriate mechanism. As part of this negotiation, it is important to understand the various facets of a potential partnership, and the perspectives of each partner. To do this, it is useful to consider a generalized partnership model, as shown in figure 5, that captures the type of offerings that NASA and its potential partners can make.

NASA's offerings could include technology, access to NASA facilities or expertise, and of course funding. Partner offerings could include technology, services, intellectual property, and so forth. There are numerous mechanisms that could be employed to effect a partnership, from licensing to contracts or grants, to space act agreements. NASA has unique authority for partnership agreements—known as Space Act Agreements—as part of the agency's enabling authorization under the NASA Space Act of 1958. This has given NASA a long history of collaboration as part of the agency's mandate.

For a partnership to be successful, each of the partners must

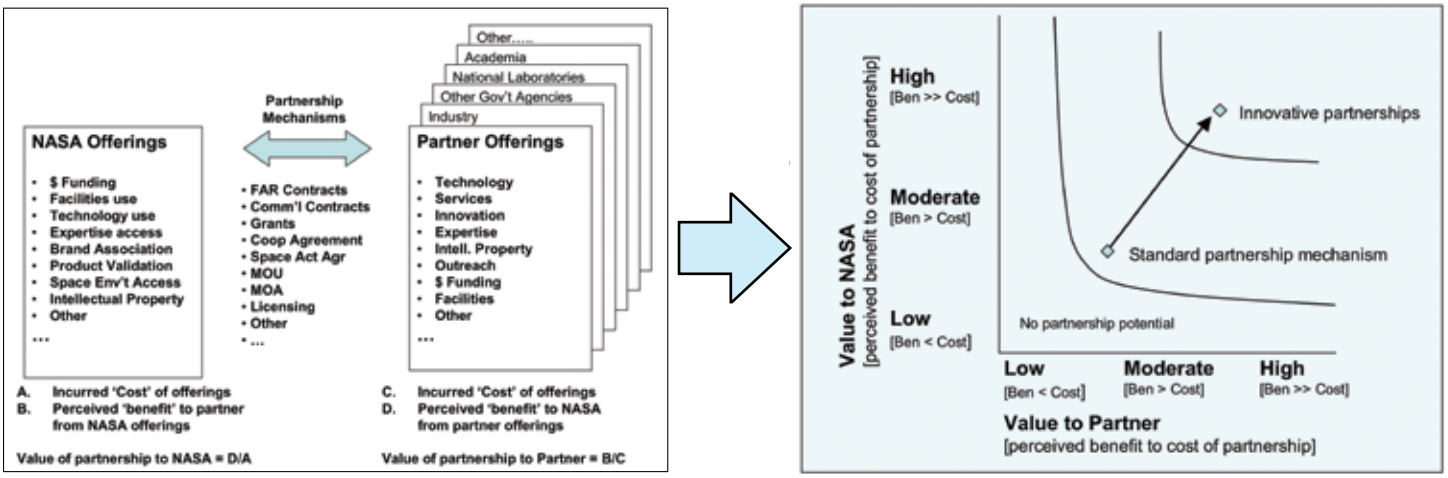


Figure 6. This conceptual value proposition is a useful construct to maximize value for both partners, when formulating a partnership.

perceive that the partnership provides good value, where the benefits derived from the partnership greatly exceed the costs of entering into the partnership. Perception is important here because although the cost of entering into a partnership may be quantifiable in dollar terms, the benefits to be derived from a partnership may not be easily quantifiable. An example could be a partner's interest in using a NASA facility with unique capabilities essential to meet their needs, or the benefit that NASA sees in positive outreach with the public resulting from a partnership.

The Value Proposition

The value proposition for a partnership (based on the partnership model previously discussed) is shown in figure 6. The objective of a partnership is for each partner to derive a high value as a result of the partnership. When putting a partnership in place, it is useful to consider the actions being taken and characteristics of the partnership, then relating those items to the value of the partnership.

It is in the best interest of both partners, for example, to avoid a lengthy and burdensome process of putting a partnership in place. Doing so adds to the cost of both partners, and creates delays that tend to reduce the benefits to be derived, both of which erode value.

Meeting NASA's Technology Needs

As a result of this dynamic innovation process, technology can flow in both directions—into and out of NASA. Technology flowing into NASA can be from a number of sources. One of the biggest sources that IPP is directly involved in is funded research through the SBIR/STTR program. There have been notable successes from this program, with technologies being infused into some of NASA's high profile missions and directly contributing to their success.

Some examples (figure 7) include the Mars Exploration Rovers using lithium ion batteries, ASCII chips and heat switches developed with SBIR funding, and the wireless sensors developed with SBIR funding that are now placed in the leading edge of the Space Shuttle wings to detect possible damage during ascent, as part of the Shuttle return to flight modifications after the Columbia disaster. This latter technology, known as Sensor Control and Acquisition Telecommunications wireless instrumentation systems, has also been used for multiple applications on the International Space Station (ISS) such as wireless vehicle health monitoring, wireless instrumentation and data recording, and for instrumentation of flight tests for developmental vehicles.

Transferring Technology to Benefit Society

Another key output of this process is transferring technologies from NASA for use in new applications that improve the quality of life for the American public. Two examples are given below, and thousands of other examples can be found on the NASA Web site references provided at the end of this article.

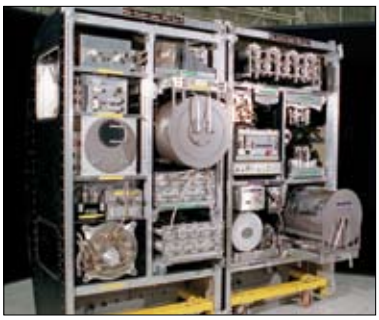


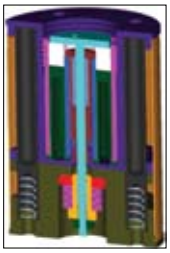
Figure 8. NASA's regenerative ECLSS for the ISS, shown here, has led to devices for turning wastewater into safe, affordable drinking water

First, a water filtration system (figure 8) providing safe, affordable drinking water around the world is the result of work done by NASA's Marshall Space Flight Center engineers who are creating the regenerative Environmental Control and Life Support System (ECLSS). This is a complex system of devices intended to sustain the astronauts living on the ISS. A derivative of this device is available through Water Security Corporation Inc., of Sparks, Nevada, and makes use of the available resources by turning wastewater into drinkable water.

A second example comes from an SBIR partnership between NASA's Johnson Space Center and private industry to develop technology for autonomous rendezvous and docking of space vehicles to service satellites. This partnership resulted in a new eye-tracking device for LASIK surgery, called LADARTracker. Eye-tracking devices must be able to sample the eye's position at a rate of at least 1,000 times per second to keep up with sac-

Figure 7. Numerous NASA missions, including high profile examples like the Mars Exploration Rovers (MER) and the Space Shuttle return to flight have infused SBIR technologies providing important contributions to mission success.

Maxwell Technologies of San Diego, California *fabricated and tested an ASCII chip with single event latch up protection technology. Innovation enables the use of commercial chip technology in space missions, providing higher performance at a lower cost. Supplying A to D converter for Mars 2003 Rovers.*



Starsys Research of Boulder, Colorado *developed several paraffin based heat switches that function autonomously. Heat switches control radiator for electronics package on Mars 2003 Rovers.*

Yardney Technical Products of Pawtucket, Connecticut *developed lithium ion batteries with specific energy of >100Wh/kg and energy density of 240 Wh/l and long cycle life. Subsequently, they won a large Air Force/NASA contract to develop batteries for space applications. They are supplying the batteries for the 2003 Mars Rovers.*

cadic movements, which do not stop during LASIK surgery. LADARTracker measures eye movements at a rate of 4,000 times per second—four times the established safety margin. The device is manufactured by Alcon Laboratories, of Fort Worth, Texas, and is used in conjunction with the company's LADARVision 4000 system for LASIK surgery, which is being used by eye surgeons across the country.

Figure 9. LASIK eye surgery, as shown here, is now safer due to the use of technology from a NASA partnership.

Summary

The dynamic process described herein provides an illustration of how NASA applies innovation through eight activities, to achieve the dual objectives of matching technology needs and technology capabilities in two directions—infusion into NASA and transfer out of NASA. These eight activities—communicate, motivate, locate, cultivate, negotiate, translate, educate, and facilitate—can be thought of as IPP's innovate eight, or 'innov8'. To learn more about NASA's Innovative Partnerships Program, or to explore potential areas of interest for partnership with NASA, please refer to the following Web sites:

- NASA: www.nasa.gov
- Innovative Partnerships Program: ipp.nasa.gov
- Tech Briefs: www.techbrief.com
- Spinoff: www.sti.nasa.gov/tto
- Centennial Challenges: centennialchallenges.nasa.gov/

IPP Overview

The Innovative Partnerships Program Office (IPPO) provides needed technology and capabilities for NASA's Mission Directorates, Programs, and Projects through investments and partnerships with industry, academia, government agencies and national laboratories. As one of NASA's Mission Support Offices, IPPO supports all Mission Directorates and has program offices at each of the NASA field centers. In addition to leveraged technology investments, dual-use technology-related partnerships, and technology solutions for NASA, IPP enables cost avoidance, and accelerates technology maturation.

IPP consists of the following program elements: Technology Infusion which includes the SBIR/STTR programs and the IPP Seed Fund; Innovation Incubator which includes Centennial Challenges and new efforts such as facilitating the purchase of services from the emerging commercial space sector; and Partnership Development which includes Intellectual Property management and Technology Transfer, and new innovative partnerships. Together these program elements increase NASA's connection to emerging technologies in external communities, enable targeted positioning of NASA's technology portfolio in selected areas, and secure NASA's intellectual property to provide fair access and to support NASA's strategic goals. Technology transfer through dual-use partnerships and licensing also creates many important socio-economic benefits within the broader community.

During fiscal year 2006, the IPP facilitated many partnerships and agreements, including over 200 partnerships with the private sector, federal and state government, academia, and other entities for dual use technology development and reimbursable use of NASA facilities, over 50 license agreements with private entities for commercial and quality of life applications of NASA developed technology, reporting of more than 750 new technologies developed by NASA civil servants and contractors, and evaluation for patent protection, more than 400 agreements for commercial application of software developed by NASA.

Mr. Douglas A. Comstock (BS, Mechanical Engineering, BA, Architecture, University of Washington; MS, Aeronautics and Astronautics, MS, Technology and Policy, MIT) is director, Innovative Partnerships Program (IPP) at the National Aeronautics and Space Administration (NASA) Headquarters, Washington, DC. The Innovative Partnerships Program provides leveraged technology for NASA's mission directorates, programs and projects through investments and technology partnerships with industry, academia, government agencies, and national laboratories.

Mr. Comstock is responsible for directing the IPP portfolio of technology investments and partnering mechanisms including Small Business Innovative Research, Small Business Technology Transfer Research, NASA's prize program of Centennial Challenges, and the Innovative Partnerships Seed Fund. He is also responsible for intellectual property management and technology transfer that will provide broad societal benefits from the nation's investment in NASA's space and aeronautics missions, and for encouraging and facilitating partnerships with the emerging commercial space sector including the agency's purchase of emerging commercial services.

Mr. Comstock previously served as the NASA comptroller, responsible for the preparation, tracking, presentation, and defense of NASA's budget to the White House Office of Management and Budget and the Congress. As the founding director of NASA's Strategic Investments Division, he was responsible for integrating NASA's strategic planning and program analysis supporting budget decisions into a single organization. Under his leadership, NASA was the first agency to achieve GREEN status as part of the President's Management Agenda for Budget and Performance Integration and NASA received its first honorable mention for the President's Quality Award.

Before coming to NASA, Mr. Comstock spent four years as a program examiner in the White House Office of Management and Budget, with responsibility for NASA's human space flight activities, biological and physical research, and personnel. Prior to his government service, Mr. Comstock was director of engineering with the Futron Corporation, a Bethesda, Maryland-based technology consulting firm, and began his career with General Dynamics Space Systems Division in San Diego, California, conducting preliminary design and systems analysis for numerous aerospace systems, from strategic defense to advanced space transportation.