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NASA's Technology Transfer Process

April 15, 2019

Report No. IG-19-016

Office of Inspector General

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RESULTS IN BRIEF

NASA's Technology Transfer Process

April 15, 2019

IG-19-016 (A-18-011-00)

WHY WE PERFORMED THIS REVIEW

Throughout its 60-year existence, NASA has shared its inventions and scientific breakthroughs with the public, academia, and private industry. Memory foam pillows, cell phone cameras, high-definition video, and social media networks all have roots in NASA-developed technologies. This transfer of technology is consistent with the legislation that created NASA, which directs the Agency to provide for the "widest practicable and appropriate dissemination of information concerning its activities and the results thereof." Technology transfer can happen in a variety of ways, sometimes broadly and informally through the publishing of information, and other times more formally through partnerships or licensing of intellectual property. NASA's fiscal year (FY) 2018 budget to promote technology transfer was $18.2 million, which funds the administration—invention disclosure, commercialization assessments, portfolio management, marketing, software release, and infrastructure—of NASA's Technology Transfer Program, responsible for ensuring that NASA-funded inventions are distributed as broadly as practical for public benefit.

In a 2012 audit, we highlighted weaknesses in NASA's technology transfer processes and made five recommendations to strengthen policy, increase awareness of technology transfer requirements throughout the Agency, and maximize the potential of research and development efforts related to technology transfer. In this follow-up audit, we assessed NASA's management of its processes for transferring technology to the commercial sector. Specifically, we evaluated whether recommendations from our prior audit were implemented and working effectively and if NASA Centers were implementing the technology transfer process in accordance with Agency policy. We also looked at how NASA determines the commercial potential of a new technology innovation.

In the course of our audit work, we analyzed a random sample of 38 New Technology Reports (NTR), which NASA employees and contractors use to document the potential commercial applications of their innovations, and conducted 103 interviews with Agency personnel at NASA Headquarters and four NASA Centers. We also interviewed personnel from organizations that did not report any new technologies to obtain their perspectives on the Agency's technology transfer process.

WHAT WE FOUND

NASA's Technology Transfer Program Office and other personnel responsible for technology transfer at the Centers we reviewed during this audit—Glenn Research Center, Goddard Space Flight Center, Langley Research Center, and Marshall Space Flight Center—have made concerted efforts in recent years to improve the overall awareness of NASA's Technology Transfer Program through increased communication and outreach. In 2012, the Agency introduced the e-NTR as the preferred method of submitting NTRs, and in 2014 NASA's Office of Chief Technologist issued a new policy outlining responsibilities for the Agency's technology transfer activities. We found that the four Centers have greatly improved their communication and outreach efforts with NASA technical organizations. These efforts have resulted in a considerable increase in the numbers of NTRs submitted, patent applications filed, and licenses negotiated—effectively increasing NASA's overall commercialization efforts.

Goddard, however, is experiencing poor technology transfer performance outcomes when compared to the other three NASA Centers we reviewed, to include a lower percentage of licenses as well as delays in processing of NTRs and patent applications. We found Goddard's technology transfer process was hindered by a lack of adequate controls and poor collaboration between its Technology Transfer Office and the Office of Patent Counsel, leading to many instances where the Patent Counsel did not use the standard review process for determining commercial viability of a new technology. As a result, NASA lacks reasonable assurance that federally-funded, commercially-viable new technologies at Goddard are being effectively reviewed and disseminated to the widest extent practical to benefit the public and private sector.

WHAT WE RECOMMENDED

In order to improve the effectiveness of the Technology Transfer Program, we recommended that the NASA Technology Transfer Program Executive (1) examine Center-specific operations and enhancements to determine those that could be beneficial if implemented Agency-wide and (2) complete implementation of the two-party authentication system as soon as possible to minimize instances of offices bypassing patenting process requirements. In order to improve the efficiency and effectiveness in pursuing patents for inventions developed by NASA employees and licensing those technologies to commercial customers, we recommend that the Goddard Center Director (3) make needed changes in Goddard's technology transfer processes or personnel to improve the Center's overall performance and (4) establish firm completion dates for the 12 outstanding action items from a November 2017 Lean Six Sigma review. In response to a draft of this report, NASA management concurred with our recommendations and described corrective actions they plan to take. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon verification and completion of the proposed corrective actions.

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TABLE OF CONTENTS

Acronyms

CTTO	Center Technology Transfer Officer
e-NTR	electronic New Technology Reporting System
FY	fiscal year
JWST	James Webb Space Telescope
NICER	Neutron star Interior Composition Explorer
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NTR	New Technology Report
NTTS	NASA Technology Transfer System
OIG	Office of Inspector General

INTRODUCTION

Throughout its 60-year existence, NASA has shared its inventions and scientific breakthroughs with the public, academia, and private industry. Memory foam pillows, cell phone cameras, high-definition video, and social media networks all have roots in NASA-developed technologies. This transfer of technology is consistent with the National Aeronautics and Space Act—the legislation that created NASA—which directs the Agency to preserve "the role of the United States as a leader in aeronautical and space science and technology" and encourage "the fullest commercial use of space" by providing for the "widest practicable and appropriate dissemination of information concerning its activities and the results thereof."[1] NASA's fiscal year (FY) 2018 budget to promote technology transfer was $18.2 million, which funds the administration—invention disclosure, commercialization assessments, portfolio management, marketing, software release, and infrastructure—of NASA's Technology Transfer Program, responsible for ensuring that NASA-funded inventions are distributed as broadly as practical for public benefit.[2]

In 2012, we highlighted weaknesses in NASA's technology transfer processes and made recommendations to strengthen policy requirements; increase awareness of technology transfer requirements throughout the Agency; and maximize the potential of research and development efforts related to technology transfer.[3] In this follow-up audit, we assessed NASA's management of its processes for transferring technology to the commercial sector. Specifically, we evaluated whether recommendations from our prior audit were implemented and working effectively and if NASA Centers were implementing the technology transfer process in accordance with Agency policy. We also examined the processes and procedures used to determine the commercialization potential of new technology innovation. See Appendix A for details of the audit's scope and methodology.

Background

When NASA engineers faced the difficulty of locating a safe landing spot amidst the dust fields of the Moon, they developed a new scanning system that used high-frequency sound waves, magnets, and computers. This scanning technology subsequently translated into ultrasounds; magnetic resonance imaging, or MRI, machines; and computed axial tomography, or CAT-scans, all of which are widely used by doctors today. When NASA-funded researchers were asked to design a seat that would keep test pilots cushioned during flights, they developed temper foam. Now known and sold commercially as

[1] Title 51, USC, "National and Commercial Space Programs," December 18, 2010.

[2] A patent is a 20-year exclusive property right granted by the U.S. Patent and Trademark Office that protects the rights of inventors. A patent entitles the inventor to exclude others from making, using, or selling the invention. Licenses are contracts that transfer intellectual property rights from the owner of the rights (licensor) to a third party who wants to use them (licensee). They can be exclusive (rights are granted to only one licensee) or non-exclusive (rights can be granted to multiple licensees). A licensee typically pays the licensor a royalty in exchange for the right to use the intellectual property. Royalties are usually based on a percentage of the revenue the licensee generates from the sale of products using the licensed intellectual property rights.

[3] NASA Office of Inspector General (OIG), *Audit of NASA's Process for Transferring Technology to the Government and Private Sector* (IG-12-013, March 1, 2012).

memory foam, it is found in mattresses, pillows, and shoes as well as wheelchair seat cushions, hospital bed pillows, and padding for people suffering long-term pain or posture problems.

Aerodynamic advances made by NASA researchers led to the upturned tips of aircraft wings, known as "winglets," that are used by nearly all modern aircraft and have saved billions of dollars in fuel costs. Technology based on spacecraft electrical power systems led to the first rechargeable, long-life pacemaker battery. And, in more recent times, a number of contractor employees in Massachusetts drew from their NASA experiences—including the construction of a prototype Mars rover—to help develop the PackBot Tactile Mobile Robot used by U.S. troops in Iraq and Afghanistan to help clear caves and bunkers, search buildings, and cross minefields.

Polymer Fabric Protects Firefighters

NASA helped develop a line of polymer textiles for use in space suits and vehicles. Dubbed PBI, the heat and flame resistant fiber is now used in numerous firefighting, military, motor sports, and other applications.
Source: NASA.

NASA's Space Shuttle Program alone generated more than 100 technology spinoffs now used by medical, environmental, automotive, sports, and computer markets. Development of the James Webb Space Telescope (JWST) has led to a number of improvements in technology for measurement of human eyes, diagnosis of ocular diseases, and improved surgery. Further, technologies developed for JWST to minimize the effects of vibration during launch of the telescope have resulted in several new types of high-speed test devices utilizing pulsed lasers that are now benefitting a wide range of applications within the astronomy, aerospace, semiconductor, and medical industries.

NASA's Patent Portfolio

Technology transfer can happen in a variety of ways, sometimes broadly and informally through the publishing of information, and other times more formally through partnerships or the licensing of intellectual property.[4] To accomplish its technology transfer goals, as shown in Figure 1, NASA maintains a portfolio of patents that have commercial potential. Patents can be pursued for work by civil servants or for work funded by NASA and are made available to academia and industry through NASA's patent licensing program. Civil service employees developing an invention on which a patent application is filed may receive an initial monetary award, supplemental monetary awards, and royalties

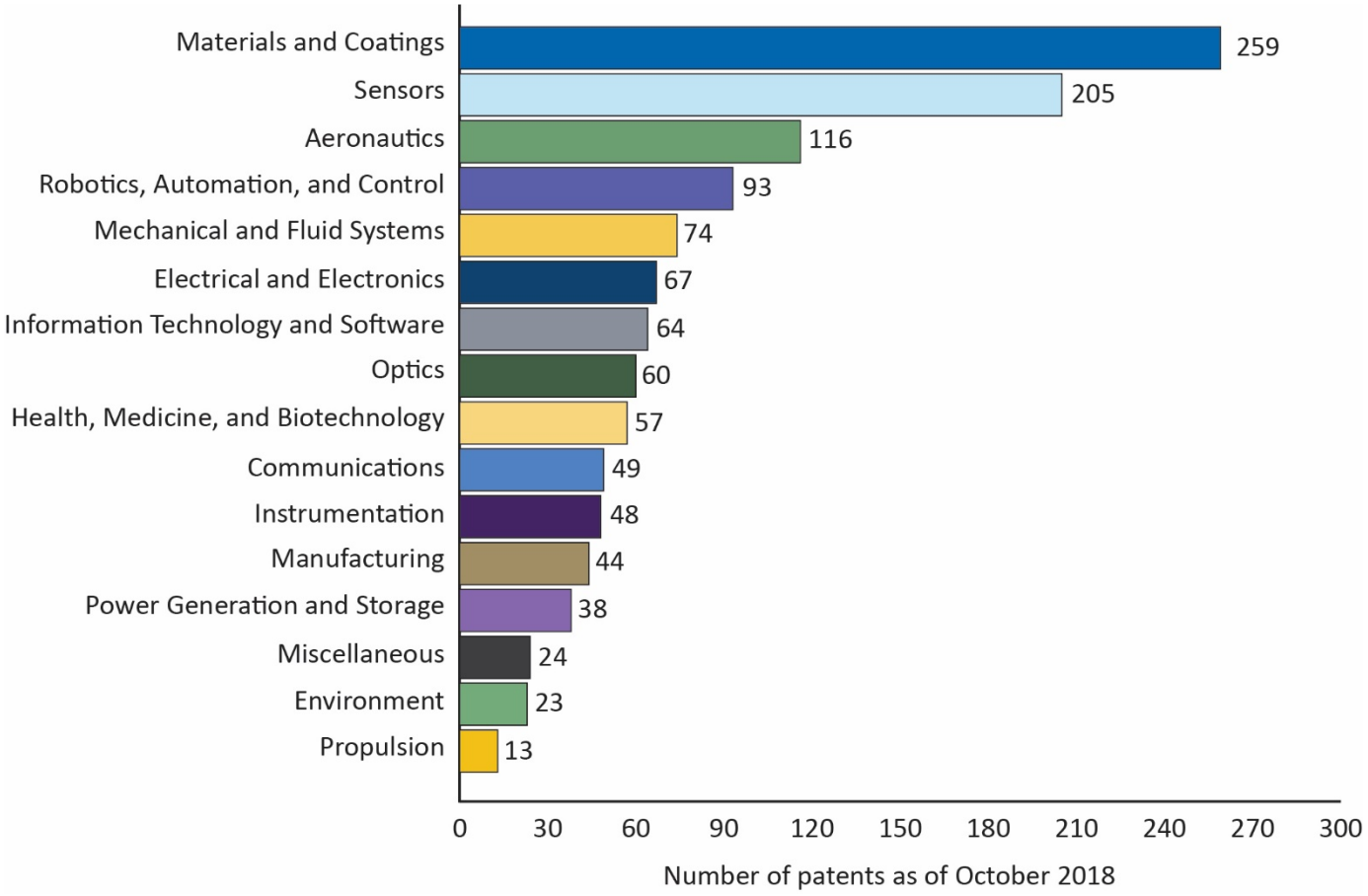
Noninvasive Ultrasound Detects Cardiovascular Disease

A NASA team adapted Agency-invented software, originally designed to handle imagery gathered by space probes, to assess ultrasound images of arteries for plaque buildup. The software is now part of a diagnostic system for accurately predicting heart health.
Source: NASA.

[4] Intellectual property refers to knowledge, creative ideas, or expressions of the human mind that have commercial value and are protectable under copyright, patent, servicemark, trademark, or trade secret laws from imitation, infringement, and dilution.

based both on the commercial application of the invention and its value in the conduct of aeronautical and space activities.[5] A NASA partner that makes an innovation in the performance of work conducted under a NASA-funded contract, grant, or cooperative agreement is responsible for reporting these innovations in accordance with the requirements of their contract, grant, or cooperative agreement.

Figure 1: NASA's Patent Portfolio (2018)



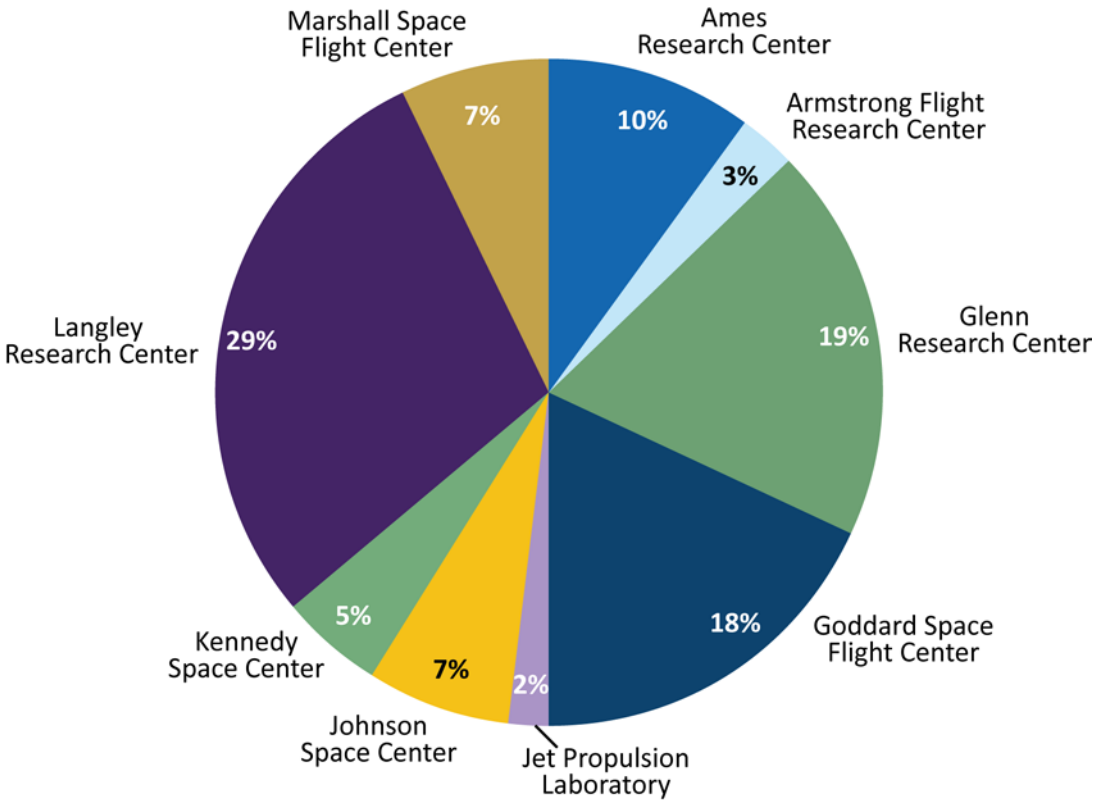
Source: NASA OIG presentation of Agency data.

The definition of a *NASA-developed innovation* is broad and includes any invention, discovery, improvement, or innovation that was made in the performance of the Agency's work. This includes, but is not limited to, new processes, machines, manufactures, and compositions of matter, and improvements to or new applications of existing processes, machines, manufactures, and compositions of matter. It also includes new computer programs and improvements to or new applications of existing computer programs.

[5] NASA Policy Directive (NPD) 2091.1C, *Inventions Made By Government Employees* (May 24, 2018). The initial and supplemental awards are paid through licensing fees received by NASA. Monetary awards are calculated and vary per license. For example, for an invention with one named inventor, the individual could receive $5,000 and may receive 25 percent of any royalties earned while the U.S. Treasury receives the other 75 percent.

Each NASA Center is responsible for technology transfer as it relates to that Center's programs and projects, and employs a process to review new technology innovations and analyze the patentability and marketability of each innovation proposed. As shown in Figure 2, in 2018 Langley Research Center (Langley) was NASA's leading contributor of patents.

Figure 2: Portfolio Patent Contribution by NASA Center (2018)



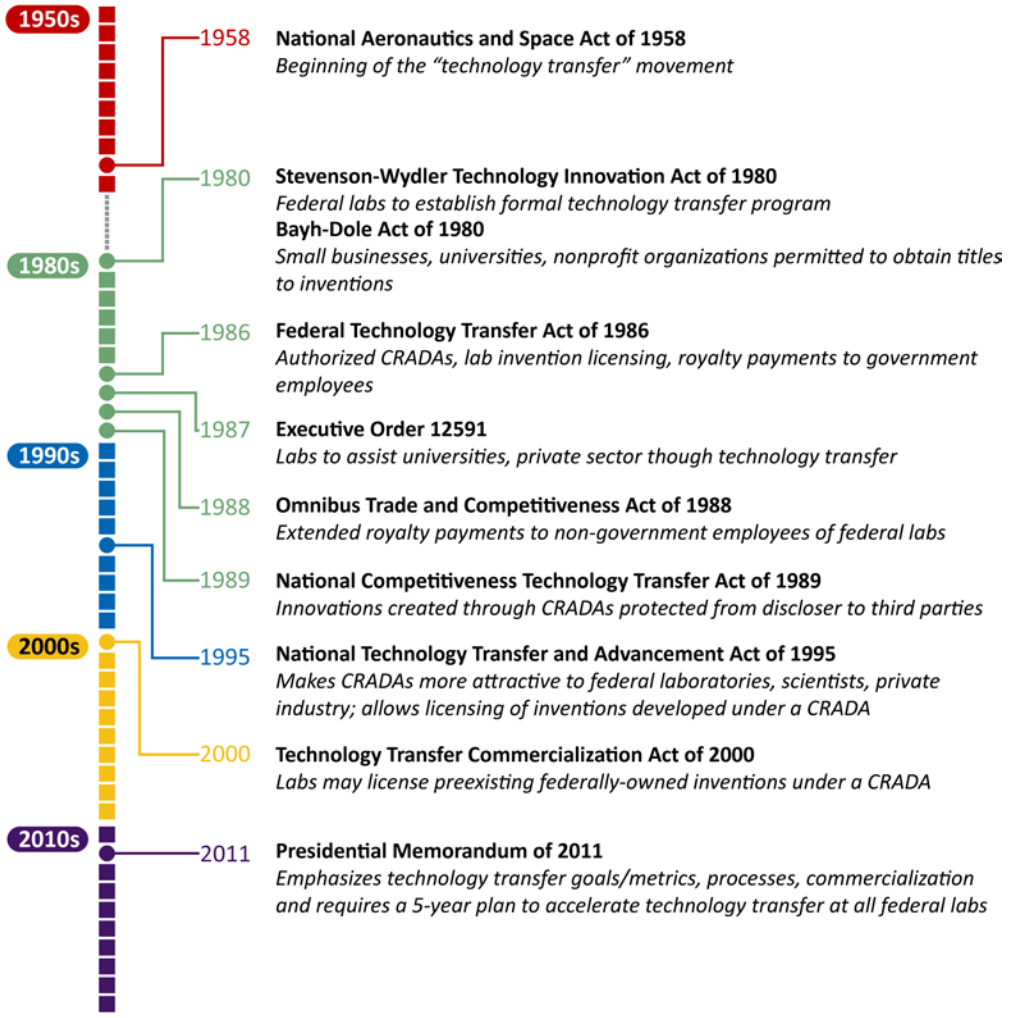
Source: NASA OIG presentation of Agency data.

Note: Stennis Space Center did not issue any patents in 2018.

Legislative Requirements and Agency Policy

NASA's technology transfer efforts began with the National Aeronautics and Space Act of 1958 and, as shown in Figure 3, has evolved as successive Presidents and Congresses enacted executive orders and laws to promote technology transfer and encourage the pooling of resources to develop commercial technologies.

Figure 3: Legislation and Executive Actions Related to Technology Transfer



Source: NASA OIG presentation of NASA graphic.

Note: CRADA is a cooperative research and development agreement.

The Bayh-Dole Act of 1980 gave universities, non-profits, and other small businesses the ability to obtain patents on inventions funded by the federal government.[6] Prior to this legislation, these entities had to sign over ownership of their inventions to the federal government in such cases. The change gave these entities an incentive to make new discoveries. Most recently, Presidential Memorandum of 2011 established goals and performance measures, streamlined administrative processes, and facilitated local and regional partnerships to accelerate technology transfer and support private sector commercialization.[7]

[6] Pub. L. 96-517, December 12, 1980.

[7] Presidential Memorandum, *Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses* (October 28, 2011).

NASA Policy

NASA's policy is to pursue intellectual property protection only on technologies with commercial potential for which NASA has an ownership interest to enable licensing. NASA policy provides guidance for implementing the processes, requirements, and responsibilities for Agency technology transfer.[8] In addition, NASA established a process for public disclosure of inventions and new technologies, and policies governing inventions by government employees, release of NASA software, and the distribution of royalties received by NASA.[9]

Technology Transfer Program

NASA's Technology Transfer Program, managed within the Space Technology Mission Directorate, seeks to ensure that technologies developed for exploration and discovery missions are broadly available to the public. The Program is responsible for promoting and supporting the development of new technologies and administering the Agency's technology transfer and commercialization process. Activities include collection and assessment of all NASA inventions, strategic management and marketing of intellectual property, negotiation and management of licenses, development of technology transfer-focused partnerships, and the tracking and reporting of metrics related to these activities (i.e., numbers of new inventions, patents, licenses, cooperative research and development agreements, and software use agreements).

Solar-Powered Refrigeration System

Innovators at Johnson Space Center patented a solar-powered refrigeration system that eliminates reliance on an electric grid, requires no batteries, and stores thermal energy for efficient use when sunlight is absent. It is particularly ideal for off-grid applications.

Source: NASA.

NASA Center Directors appoint Center Technology Transfer Officers (CTTO), who work with the Center's intellectual property lawyers (referred to hereafter as Patent Counsel) to ensure all Center technology transfer activities are conducted in compliance with legal requirements. The CTTO is responsible for contributing to the development and maintenance of a robust portfolio of NASA intellectual property assets with commercial potential to preserve NASA's ability to license inventions arising from NASA-funded research or development in which NASA has an ownership interest. This includes the disposition of all New Technology Reports (NTR) received (see Appendix B for an NTR example), addressing items such as ownership of rights, commercial potential, technology transfer plans, intellectual property protection, and NTR closure. The CTTO conducts commercialization and technical viability assessments for technologies that have potential for transfer to industry.

[8] NASA Procedural Requirements (NPR) 7500.2, *NASA Technology Transfer Requirements* (December 19, 2014).

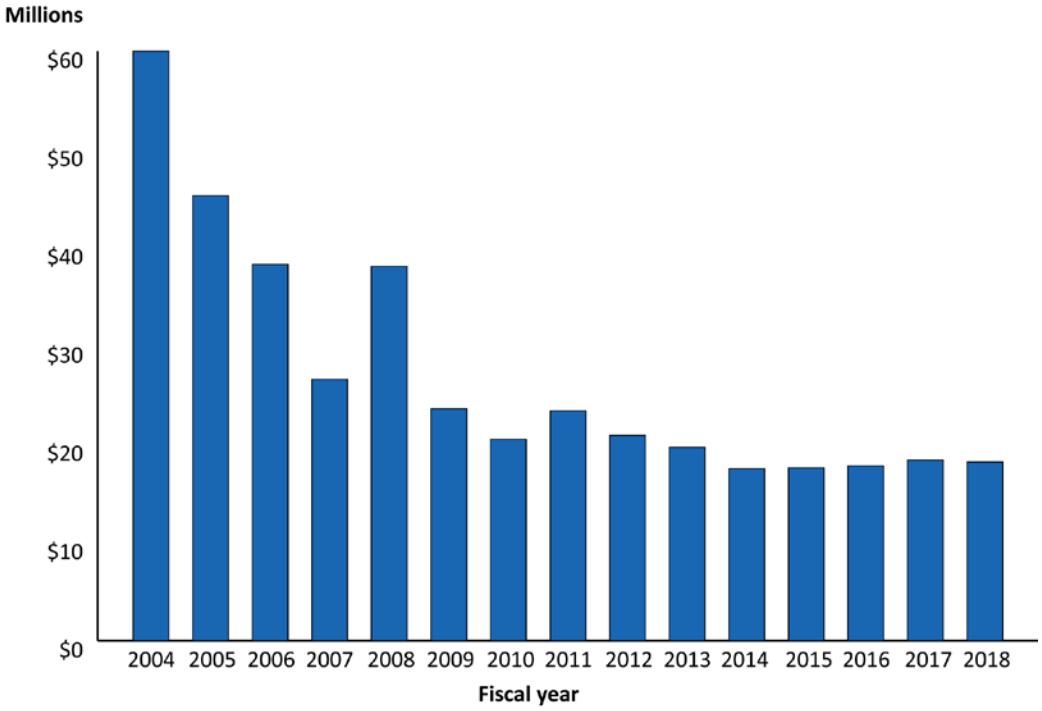
[9] NASA Form 1679, *Disclosure of Invention and New Technology (Including Software)* (November 2012); NPR 2092.1B, *Distribution of Royalties Received by NASA from the Licensing or Assignment of Inventions* (August 22, 2014); and NPR 2210.1C, *Release of NASA Software* (August 11, 2010).

The Patent Counsel is responsible for protecting Agency-level intellectual property assets, as well as those originating from their respective Centers. Center Patent Counsels make patentability assessments, including searches for prior patents or as recommended by the CTTO or their delegate. Additionally, they are responsible for timely filing and prosecution of patents on NASA-owned and jointly-owned intellectual property, based primarily on recommendations from the CTTO.

Technology Transfer Program Budget

As shown in Figure 4, the FY 2018 Technology Transfer Program budget has fallen to 30 percent of its FY 2004 funding level. Despite the declining budgets, since FY 2011 there has been a 341 percent increase in patent licensing. However in 2018, patent licenses declined 9 percent while software licenses declined 40 percent from the previous year. This outcome discontinues the trend of increased licenses that had been underway over the prior 6 years.

Figure 4: Technology Transfer Program Budget History



Source: NASA OIG presentation of Agency data.

In July 2018, the Office of Management and Budget emphasized the importance of technology transfer by directing that agency budget proposals prioritize and highlight lab-to-market initiatives such as efforts to identify more efficient regulatory and administrative approaches to technology transfer, enhancements to small business innovation programs, entrepreneurial workforce development initiatives, and other programs that improve the transition of federally-funded technologies from discovery to practical use.[10]

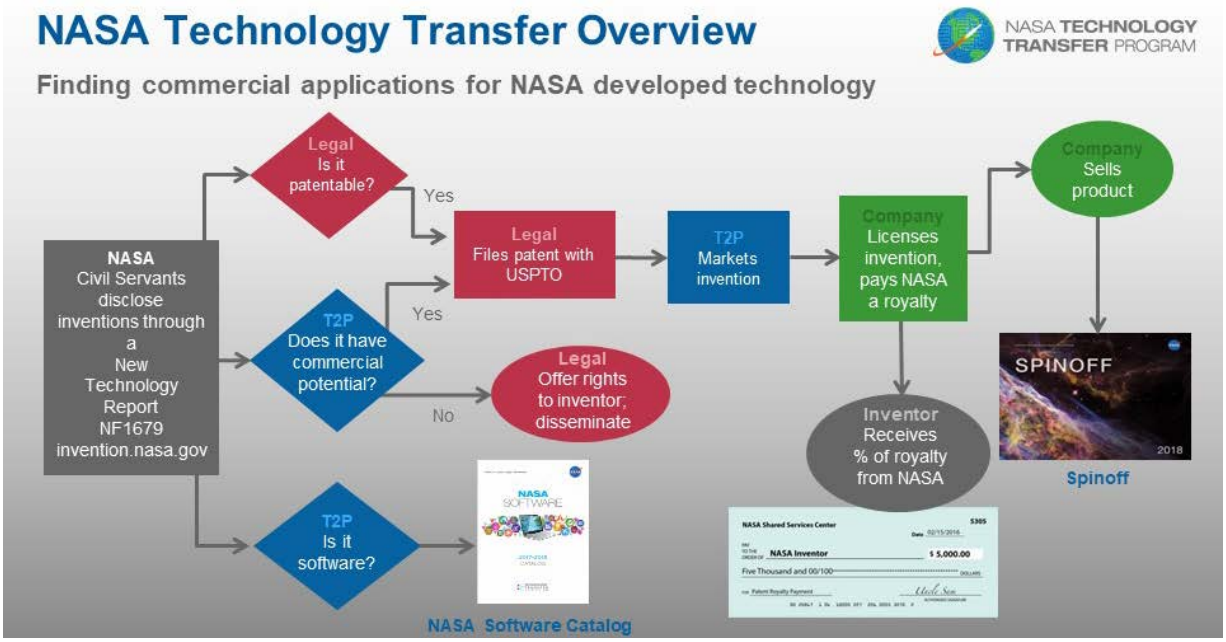
[10] Office of Management and Budget, *FY 2020 Administration Research and Development Budget Priorities* (M-18-22, July 31, 2018).

Technology Transfer Process

NASA employees and contractors who develop new technologies (innovators) are required to report, document, and identify the potential commercial applications of their work by submitting NTRs. NASA has developed an online New Technology Reporting System (e-NTR) capability within the NASA Technology Transfer System (NTTS) that allows innovators to prepare reports and submit them electronically to a technology transfer office.[11] Although the electronic filing is preferred, new innovations can also be reported via paper-based NASA Form 1679.

Once an innovator submits an NTR, a CTTO or delegate reviews the submission to assess its commercial potential.[12] Commercial potential is tied to the value of the technology—its potential benefits, advantages in the marketplace, and profitability. To make this assessment, Technology Transfer Office staff work closely with program and project managers to identify ownership rights, develop technology transfer plans, and take the lead in fostering technology transfer and commercialization opportunities. Each year, the Technology Transfer Office staff and Patent Counsel at each NASA Center review hundreds of proposed innovations to determine potential marketability and intellectual property protections. While individual Centers may have additional steps in the process unique to their organizations, the general process remains the same across the Agency (see Figure 5).

Figure 5: Technology Transfer Program



Source: NASA.
Note: T2P – Technology Transfer Program
USPTO – U.S. Patent and Trademark Office

[11] The NTTS is an Agency-wide database used to track activities related to the technology transfer process.

[12] Each technology transfer office is staffed with technology managers who perform the NTR reviews and assessments.

In March 2012, we reported on NASA's process for transferring technology to the government and the private sector.[13] The report highlighted improvements NASA could make to increase its effectiveness in identifying and planning for the transfer and commercialization of technologies developed as part of Agency projects. Specifically, we identified a lack of awareness by project and other personnel of NASA's policy governing the process and concluded that NASA had missed opportunities to transfer technologies from its research and development efforts and to maximize partnerships that could provide additional resources for technology transfer efforts, and that industry and the public had not fully benefited from NASA-developed technologies. We recommended that the Chief Technologist develop and implement procedures to ensure accountability in the process, emphasize the importance of commercialization plans, provide periodic training on commercialization policies and requirements, and reassess fiscal and personnel resources for technology transfer. The Agency implemented corrective actions and the final recommendation was closed in January 2017.[14]

[13] IG-12-013.

[14] During the recommendation closure process, the Technology Transfer Program and the OIG agreed that emphasizing invention disclosure met the intent of the recommendations and the requirement for commercialization plans was removed from NASA policy.

AGENCY'S EFFORTS AND PROCESSES HAVE IMPROVED TECHNOLOGY TRANSFER OUTCOMES

NASA's Technology Transfer Program Office and personnel responsible for technology transfer at the Centers we reviewed during this audit—Glenn Research Center (Glenn), Goddard Space Flight Center (Goddard), Langley, and Marshall Space Flight Center (Marshall)—have made concerted efforts in recent years to improve the overall awareness of NASA's Technology Transfer Program through increased communication and outreach. In 2012, the Agency introduced the e-NTR as the preferred method of submitting NTRs and in 2014 the Agency implemented a new policy governing the overall technology transfer process. We found that the four Centers have greatly improved their communication and outreach efforts with NASA technical organizations. These efforts have resulted in a considerable increase in the numbers of NTRs submitted, patent applications filed, and licenses negotiated—effectively increasing NASA's overall commercialization efforts.

Improved Awareness of Technology Transfer Process

Modified Monitor Provides Glasses-Free 3D for Pilots, Gamers

Langley Research Center has been working with Dimension Technologies Inc. to develop 3D displays that do not require glasses, as a tool to assist pilots. The technology has already won over video-game enthusiasts for its lifelike imagery and eye-tracking software that allows users freedom of movement.

Source: NASA.

We found an increased and more comprehensive awareness of the Agency's technology transfer efforts and the NTR submittal process at the four Centers we reviewed. Innovators we interviewed said that they recognize the value of technology transfer and their role in identifying technologies that, although designed for a specific mission need, may also have commercial applications that could be pursued by the Agency. Innovators were more aware of the steps for submitting an idea, the organizations involved with the NTR review, and the general process leading to intellectual property protection. Innovators credited Technology Transfer Office staff with meeting more frequently with technical organizations and providing feedback on the status of NTRs as they were being reviewed. Through our interviews with technology managers, it was apparent they are passionate about their work and have increased efforts to better educate NASA employees on the transfer process and enhance communication with innovators.

Additionally, NASA has implemented training measures such as roadshows and informal briefings to promote technology transfer activities.[15] The Agency designed campaigns and posters to educate

[15] A roadshow is a regularly scheduled meeting in which Technology Transfer and Patent Counsel representatives visit Center engineering and science organizations to present technology transfer topics, such as NTR submissions, royalties, metrics, and answer process questions.

personnel on the considerations in deciding whether an invention should be reported, points of contact, and potential royalties the Center and innovator could receive as a result of their discoveries.

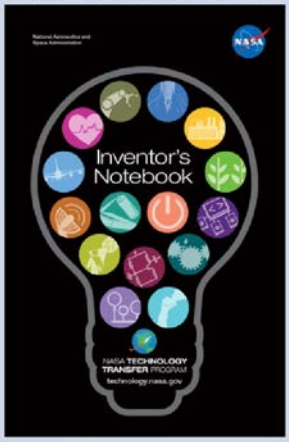
Beginning in 2016, the Program began conducting monthly technology transfer training sessions at all Centers. From FY 2016 through 2018, 9,475 people attended training sessions across the Agency. Interviewees cited these training efforts and the increased presence of informational posters across Centers as being very effective in raising awareness. As an added measure, beginning in FY 2017 the Program began distributing Challenge Coins and Inventor's Notebooks to innovators for submitting NTRs.[16]

Technology Transfer Challange Coin

Source: NASA.

We also met with technical personnel in 12 organizations where NTRs were not submitted during 2014 to 2018 to determine to what extent a lack of awareness about the technology transfer process may have contributed to their failure to report innovations. We found that employees in these organizations were generally aware of NASA's technology transfer efforts but cited other reasons why NTRs had not been submitted. Those reasons included the lack of innovations with commercial potential, innovations submitted by technologists or researchers in other matrixed organizations that support the project, or that the role of the particular organization did not lend itself to new innovations.

Inventor's Notebook



Source: NASA.

For example, the Control Systems Design and Analysis Branch at Marshall is responsible for writing requirements documents. It does not conduct research where innovations could be discovered. Similarly, the Thermal Systems Transfer and Processes Branch at Glenn, which performs thermal component-level analysis work is not developing new technology. Additionally, other organizations did not submit NTRs, such as the Neutron star Interior Composition Explorer (NICER) Project at Goddard, which relies on commercial-off-the-shelf technology to meet its mission goals; and the Mechanical Systems Branch at Langley, which provides engineering support services to flight projects and utilizes mature technologies.[17]

Policies Updated and Clarified

In December 2014, the Office of Chief Technologist issued policy for implementing the processes, requirements, and responsibilities for Agency technology transfer activities.[18] Specifically, this policy better defined the roles of the Chief Technologist, CTTOs, Office of General Counsel, and Center Patent

[16] In FY 2017, the Technology Transfer offices began distributing coins and inventor's notebooks—used by inventors, scientists, and engineers to record their ideas, experimental tests, and results—to civil servant innovators as incentives for submitting NTRs.

[17] NICER is an International Space Station payload devoted to the study of neutron stars through soft X-ray timing.

[18] NPR 7500.2 replaced NPR 7500.1, *NASA Technology Commercialization Process*, which had been in effect since December 2001.

Counsels; designated the NTTS as the Agency-wide database used to document and track all technology transfer activities, procedures for patents, licenses, and distribution of royalties; and required Headquarters to maintain metrics to evaluate technology transfer performance.

Streamlined Electronic Functions Added

The Technology Transfer Program Executive within the Headquarters Space Technology Mission Directorate described several electronic streamlining improvements since our 2012 report.[19] First, NASA developed the previously discussed e-NTR capability within NTTS. The system has standardized and streamlined the Agency's invention disclosure process and was most recently updated in April 2018 with features that include auto-populated fields based on innovator responses, thereby reducing to a third the number of questions asked when completing the online form. Innovators commented that e-NTR has significantly reduced the time—from days to hours—it takes to complete the process.

Radar Device Detects Heartbeats of Victims Trapped under Wreckage

NASA often analyzes weak signals hidden in noise, like alterations in a satellite's path that indicate gravity fluctuations in a planet. With government funding, the Jet Propulsion Laboratory adapted this technology to create FINDER, which uses radar to detect the breathing and heartbeats of victims trapped under rubble. Maryland-based R4 Inc. licensed the technology and continues to develop it. The device has already seen its first sales and saved its first earthquake victims.

Source: NASA.

In FY 2015, the Program released the Innovator Dashboard, which was in part a response to our 2012 report that identified innovators' belief that they were not receiving sufficient feedback after filing their NTR disclosures. This on-line tool allows innovators to track their NTR's progress through technology transfer review. Prior to the Dashboard's release, more than half of the inquiries received by the NTTS help desk were NTR status-related queries. After release, the Program has been able to reduce the size of their help desk, enabling them to hire a new NTTS developer.

Additionally, the Automated Technology Licensing Application System, launched in June 2017, allows entrepreneurs to apply for NASA patent licenses online. This initiative modernized and streamlined technology commercialization efforts, making it simpler and faster for companies to find and use NASA technologies. It also eliminated the manual processing of license applications and includes automated reminders to applicants to complete application information.

Finally, NASA began issuing a Software Release Catalog in 2017. The catalog is an inventory of the free software tools NASA has created and makes available to industry, academia, and other government agencies. This portfolio of software products covers a wide variety of technical applications and is continually updated on NASA's Technology Transfer Portal.[20]

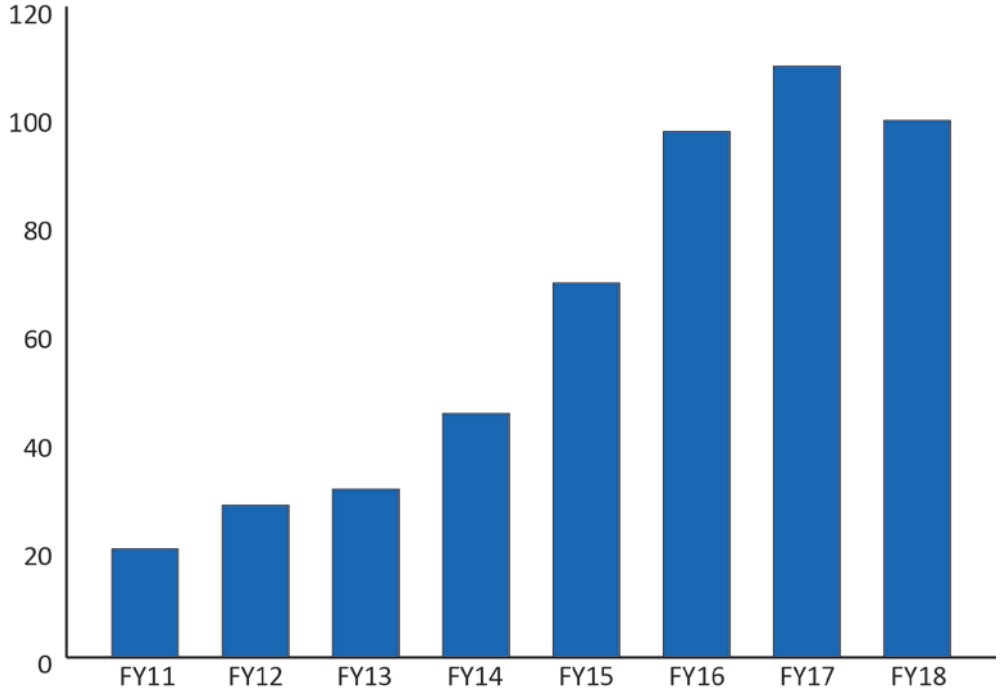
[19] Prior to 2016, the Technology Transfer Program Executive was organized under the Headquarters Office of the Chief Technologist.

[20] The Portal is an internet-based entryway to NASA's intellectual property assets available for technology transfer.

Metrics and Annual Performance Goals Established

With the issuance of NASA Procedural Requirement (NPR) 7500.2 in 2014, the NASA Chief Technologist was tasked with developing and maintaining a set of well-defined metrics to evaluate the performance of technology transfer across the Agency. As such, the Program Executive began collecting and reporting monthly metrics generated from the data in NTTS to track overall program and Center-specific performance. These metrics include the number of NTRs received, number of patent applications filed, number of patents issued, and number of licenses negotiated. For example, NASA has seen a 341 percent increase in annual licensing totals since FY 2011, (see Figure 6). In addition to Agency-wide metrics, the Program tracks trends and progress at each Center.

Figure 6: Patent Licenses Executed, FY 2011-2018



Source: NASA OIG presentation of Agency data.

Furthermore, beginning in FY 2013 the Technology Transfer Program Executive implemented annual performance goals to measure technology transfer performance using six categories: (1) new technology reporting, (2) marketing, (3) patent licensing, (4) software release, (5) program infrastructure, and (6) academic partnerships. Since that time, the Program has reported positive results across all performance goals. Specifically, in addition to increases in technology reporting, patent licensing, and software release, NASA has transitioned from an uncoordinated 10-Center process to a unified approach, eliminated unnecessary steps and redundant practices, and increased the number of academic partnerships with higher education institutions across the country.

Center-specific Process Enhancements

Since our 2012 report, the Centers have developed successful approaches for promoting submissions and processing of NTRs. While not required as part of NASA's technology transfer process, these enhancements work well for the individual Centers. For example, Glenn's use of provisional patent applications protects intellectual property for a nominal fee and allows innovators time to further mature technology, thereby increasing the likelihood that a commercial company would be interested in licensing the technology.[21] Goddard requires that an NTR be submitted as the basis for any internal research and development opportunity.[22] Langley's focus on continuous process improvement, use of a panel to review their technologies for commercial potential and patenting, and development of a technology rating form promotes employee engagement in the process and allows for new ideas to be discussed and implemented, ensuring that technology reviews are done consistently and are appropriately documented. Finally, Marshall's approach to educating NASA employees through presentations at new supervisor and employee orientations, roadshows, posters, and creation of the Inventor Hall of Fame ensures employees are aware of technology transfer and recognize the importance of their role in identifying potential innovations.

Vibration Dampening Technology

In testing, the Ares I launch vehicle displayed a serious vibration problem—shaking that resonated dangerously, causing potentially hazardous conditions in the crew capsule right above the booster. Engineers at Marshall Space Flight Center found a solution, creating a new, low-cost, lightweight damper that could become the industry standard for buildings, bridges, and many other structures that vibrate or shake. New York City-based Thornton Tomasetti markets the technology to make buildings safer against the wind and from earthquakes.

Source: NASA.

[21] A provisional patent application provides intellectual property protection for 1 year.

[22] An internal research and development opportunity is for development of strategic, leading-edge capabilities and technologies of interest to Centers or projects that needed to fulfill exploration and science goals.

LACK OF ADEQUATE CONTROLS AND COLLABORATION IS CAUSING POOR PERFORMANCE OUTCOMES FOR GODDARD'S TECHNOLOGY TRANSFER PROCESS

Goddard, when compared to other NASA Centers, is experiencing poor technology transfer performance outcomes, to include a lower percentage of licenses as well as delays in processing NTRs and patent applications. Goddard's technology transfer process is hindered by a lack of adequate controls in the process and poor collaboration between the Technology Transfer Office and the Office of Patent Counsel, leading to many instances where the Patent Counsel did not use the CTTO review process for determining commercial viability of a new technology. As a result, NASA lacks reasonable assurance that federally-funded, commercially-viable new technologies at Goddard are being effectively reviewed and disseminated to the widest extent practical to benefit the public and private sectors.

Roles and Responsibilities for Center Technology Transfer Office and Patent Counsel

As noted previously, NASA policy establishes roles and responsibilities for personnel who play key roles in technology transfer at NASA Centers; primarily, the CTTO determines commercial viability, and the Center Patent Counsels determine patentability. The CTTO is responsible for the disposition of all NTRs received, to include commercialization and technical viability assessments for technologies with the potential for transfer to industry. Patent Counsel's responsibility is to protect NASA intellectual property assets. Center Patent Counsels make patentability assessments as needed or as recommended by the Center Technology Transfer Office. Per policy, Patent Counsel must file and prosecute "patents on NASA-owned and jointly-owned intellectual property, based primarily on taking into account the recommendations of the CTTO or their delegate in determining the commercial potential of the technology."

Scanning Groceries and Parcels

In preparation for a repair mission for the Hubble Space Telescope, which was launched with a misshapen mirror, Goddard Space Flight Center issued a call for optics companies to accurately measure replacement parts. AOA Xinetics, now a division of Northrop Grumman, created a tool to detect mirror defects, which it has incorporated into a commercial 3D imaging system. Among its applications is a package-detection device, now used by all major shipping companies, and a self-checkout grocery scanner, used in stores around the country.
Source: NASA.

Poor Performance Outcomes for Technology Transfer

One of the performance metrics utilized by the Program Office is the number of patents the Center pursues. Considering the differences in size, mission, staffing, and functions, each Center receives a varying number of NTR submissions from their innovators. We therefore computed the percentage of patents filed compared to the number of NTRs submitted by a NASA civil servant as one way to measure whether each Center is effectively using intellectual property protection.[23] On average, over the last 5 fiscal years we found that Goddard and Marshall—both of which are primarily responsible for developing space flight projects—had a lower number and percentage of patent applications filed than Glenn or Langley—both of which are focused primarily on research and development of new technologies—as shown in Table 1.

Table 1: Percentage of Patent Applications Filed to NTRs Submitted, FY 2014-2018

	Glenn	Goddard	Langley	Marshall
Total NTRs Submitted	778	1,148	1,112	631
Total Patent Applications Filed	147	162	192	49
Percentage of Applications to NTRs	18.9	14.1	17.3	7.8

Source: NASA OIG analysis of Agency data.

Note: We analyzed a 5-year history of NTRs and patent applications filed to compute an average, recognizing that patent applications may be filed during or after the year that an NTR was submitted.

Another measure of performance is the number of patent licenses the Center negotiates. This is an indication of whether the Center is patenting innovations with commercial viability that industry is interested in licensing for commercial use. Goddard received 1,148 NTRs over the last 5 fiscal years and negotiated licenses for 29 innovations or a rate of 2.5 percent. We recognize that research Centers, such as Glenn and Langley, may produce a greater number of innovations that are of interest to the commercial market. However, Marshall, which is primarily responsible for developing space flight projects, received 631 NTRs and negotiated licenses for 55 innovations—an 8.7 percent rate—in the same time period, as shown in Table 2.

Table 2: Percentage of Licenses Executed to NTRs Received, FY 2014-2018

	Glenn	Goddard	Langley	Marshall
Total NTRs Submitted	778	1,148	1,112	631
Total Licenses Executed	60	29	73	53
Percentage of Licenses to NTRs	7.7	2.5	6.6	8.7

Source: NASA OIG analysis of Agency data.

Note: We analyzed a 5-year history of NTRs and licenses to compute an average, recognizing that licenses may be negotiated years after the submission of an NTR and patenting of the innovation.

To measure the efficiency of the Centers' execution of the NTR review process, we evaluated the timeliness of each Centers' processing of NTR submissions. We found that, compared to the other three Centers examined in our review, Goddard was taking longer to process NTRs. Once an NTR is submitted

[23] Although contractors are required to submit NTRs for their innovations through NASA, the Agency does not file patents on their behalf.

by an innovator, the Center's Technology Transfer Office reviews it and makes a determination of commercial viability. To determine the timeliness of NTR processing time, we calculated the amount of time from the initial submission of the NTR by the NASA innovator to the decision point of whether to pursue a patent for the technology. Based on our judgmental sample of 50 new technologies, we found that Goddard took on average over 3 months to process NTRs.[24] Comparatively, Glenn and Langley were taking about a week to process NTRs.

We also evaluated the timeliness of the Centers' Offices of Patent Counsel. Specifically, we reviewed the time it took Patent Counsel to file an application with the U.S. Patent and Trademark Office once the decision was made to pursue intellectual property protection for an innovation. We found that on average it took 1 to 4 months to file a patent application once a final decision to file is made at Glenn, Langley, and Marshall. Goddard's Office of Patent Counsel was taking on average over 11 months to file, with many applications taking well over a year.

Lack of Adequate Controls and Poor Relationship between the Strategic Partnerships Office and the Office of Patent Counsel

While NASA requires Centers to use the recommendations of the CTTO in determining the commercial potential of the technology as the primary driver for filing patent applications, Goddard Patent Counsel filed many patent applications based on its own judgment without consulting its Technology Transfer Office. Specifically, of the 82 patents filed from 2016 to 2018, we found 36 instances (44 percent) where Counsel pursued patents for innovations that were not first recommended by the CTTO. In 13 of those 36 cases, CTTO had decided to not recommend pursuing patents for the innovations. Commercial industry had not expressed interest or sought to obtain a license for any of these 36 patented innovations. Goddard Patent Counsel's failure to use the CTTO review process is likely contributing to the lower percentage of licenses of Goddard innovations. Further, the Patent Counsel Office used $219,040 of funds to patent innovations with no foreseeable commercial interest—funds that could have been used to patent commercially-viable innovations. (See Appendix C for our summary of questioned costs.)

Rechargeable Hearing Aid Batteries Draw from NASA Research

In its early days, NASA spent much effort developing rechargeable silver-zinc batteries, as the pairing offers a higher power-to-weight ratio than any other battery couple. Significant advances in the batteries' durability were made at Glenn Research Center; the company ZPower undertook years of additional development before releasing its rechargeable hearing aid batteries, the first that can run all day on a single charge.
Source: NASA.

In August 2017, Goddard's Deputy Center Director identified performance issues in the two key offices responsible for executing technology transfer and directed them to participate in a Lean Six Sigma review.[25] Completed in November 2017, the review

[24] See Appendix A for details of our sampling methodology.

[25] A Lean Six Sigma is a review to eliminate waste (Lean) while pursuing perfection in processes (Six Sigma).

identified multiple process issues including poor communication, coordination, and a lack of feedback, and assigned action items to the offices to implement improvements. Some of the actions focused on the need for greater collaboration between the two offices and included actions such as establishing regularly-scheduled meetings to coordinate efforts, enhancing joint talks to innovators (i.e., roadshows), and utilizing an open door policy between the two offices.

As of November 2018, 19 of the 31 action items had not been fully implemented. Importantly, of the three action items recommended jointly to senior management of the two offices, only one has been fully implemented. Specifically, the action items to "set mutually agreed upon time limits for completion of each step in the process" and "set an expectation for responding to communication from the other office" were incomplete.

We interviewed each member of Goddard's Technology Transfer Office and each attorney in the Office of Patent Counsel. The poor relationship between the two offices was a major discussion point raised by each individual. Furthermore, the source of the ineffective relationship between the two offices, and the reason a particular action—such as the delay in filing of patents—was identified as being the fault of the other office. In discussions with NASA's Technology Transfer Program Executive, he stated that he was aware of the challenges at Goddard and was developing a new electronic form to use Agency-wide that would require Technology Transfer and Patent Counsel offices at all Centers to review and authenticate their determination of patent decisions. While he believes this will improve the patent application process NASA-wide, this authentication should specifically address the concern at Goddard where NTRs are processed without two-party consent. As of December 2018, this new process had not yet been implemented.

CONCLUSION

Across the Agency, NASA's Technology Transfer Program has made significant improvements since our 2012 report. Specifically, the Program has improved overall awareness among technical, research, and project development organizations and made it easier to submit and review NTRs. We found an increased and more comprehensive awareness of the Agency's technology transfer efforts and the NTR submittal process at all Centers. Innovators credited Technology Transfer Office staff with meeting more frequently with technical organizations and providing feedback on the status of NTRs as they were being reviewed. Additionally, the Agency has implemented training measures such as the use of roadshows and informal briefings to promote technology transfer activities. Further, we found that NASA had updated and clarified its policy providing guidance for implementing the processes, requirements, and responsibilities for Agency technology transfer activities; streamlined its system for electronic submission of NTRs; and began maintaining a set of well-defined metrics to evaluate the performance of Technology Transfer across the Agency. Finally, we found that individual Centers developed successful approaches for promoting submissions and processing of NTRs.

That said, Goddard is experiencing poor performance outcomes for Technology Transfer when compared to other NASA Centers, to include a lower percentage of patents and licenses as well as delays in processing of NTRs and patent applications. Goddard's technology transfer process is hindered by a lack of adequate process controls and poor collaboration between the Strategic Partnerships Office and the Office of Patent Counsel, leading to frequent instances of the Office of Patent Counsel failing to use the CTTO review process for determining commercial viability. Ultimately, until these process and relationship issues are addressed, NASA does not have reasonable assurance that federally-funded, commercially-viable new technologies at Goddard are being effectively reviewed and disseminated to the widest extent practical to benefit the Agency and the federal government.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

In order to improve the effectiveness of the Technology Transfer Program, we recommend that the NASA Technology Transfer Program Executive:

1. Examine Center-specific operations and enhancements to determine those that could be beneficial if implemented Agency-wide.
2. Complete implementation of the two-party authentication system as soon as possible to minimize instances of offices bypassing patenting process requirements.

In order to improve the efficiency and effectiveness in pursuing patents for inventions developed by NASA employees and licensing those technologies to commercial customers, we recommend that the Goddard Center Director:

3. Make needed changes in Goddard's technology transfer processes or personnel to improve the Center's overall performance.
4. Establish firm completion dates for the 12 remaining Lean Six Sigma action items.

Major contributors to this report include Ray Tolomeo, Science and Aeronautics Research Directorate Director; Diane Choma, Project Manager; Theresa Becker; Scott Collins; Greg Lokey; Sarah McGrath; Matt Ward; and Earl Baker.

NASA management concurred with our recommendations and described in their comments corrective actions the Agency plans to take to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon verification and completion of the proposed corrective actions.

Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from April 2018 through March 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

To accomplish this audit, we conducted 103 interviews with personnel located at NASA Headquarters, Glenn, Goddard, Langley, and Marshall. Those personnel interviewed included at NASA Headquarters the Technology Transfer Program Executive and the Agency Counsel for Intellectual Property; and at the respective Centers, Deputy Center Director, Chief Counsel, Chief Technologist, Center Technology Transfer Officer, New Technology Representative, Technology Managers, Patent Attorneys and paralegal staff, innovators (both civil servant and partner), and various Program and project staff, as appropriate.

We queried the NTTS database for the timeframe FY 2014 through May 11, 2018 to establish a universe of 3,380 NTRs. This timeframe ensured that our field work reflected the implementation of the 2012 audit recommendations and corrective actions. We then further stratified the universe of 3,380 NTRs to those submitted in FY 2017 (822 NTRs). This increased the likelihood that the innovator was still with NASA, ensured an adequate innovator response rate for our interviews, and made sure the NTRs would have sufficiently progressed through the technology transfer review process for our analysis. We then randomly selected a sample of 38 of the 822 NTRs for detailed review and interviewed one of the innovators responsible for the new technology regarding their experience with the process.

Additionally, we also judgmentally selected a sample of three organizations at each Center that did not report any new technology during FY 2014 to May 11, 2018. We subsequently interviewed project managers or scientists from the selected projects to determine their perspectives on the technology transfer process and responsibilities.

Use of Computer-Processed Data

We used computer-processed data to complete our audit. Specifically, we obtained a non-statistical, stratified, random sample from the universe of all NTRs submitted in the Agency's NTTS during the period FY 2014 through May 2018 for the four Centers in our audit scope. We verified with the NTTS Program Data Analyst that our search instructions were appropriate and valid to generate the data that we used to support the audit universe.

For our innovator interviews, the NTRs were the basis for discussions and we verified with each innovator that the NTRs were in fact generated by the innovator and accurate. We therefore believe that the computer-processed data that we used to complete our audit was appropriate to support our conclusions.

We interviewed the Technology Transfer Program Executive, the Technology Transfer Program Data Analyst, and the respective Center CTTOs to determine that monthly data quality reviews are conducted by the Program Office to verify data reported to external federal agencies. We determined through discussion with the NTTS Program Manager and System Owner that NTTS has authority to operate and

the database design is appropriate for the application. Further, we determined that the control environment with respect to data quality reviews within the Technology Transfer Program is adequate. We therefore believe that the data we used from NTTS to complete our audit was appropriate to support our conclusions.

We interviewed a systems analyst from Goddard's Satellite Servicing Projects Division concerning the Project's catalog of available technologies that was presented at their Industry Day in January 2018. We determined that the catalog originated from a tracking spreadsheet maintained by the systems analyst; and that not all of the technologies listed in the catalog originated from submitted NTRs, but rather from industry partners. However, we believe that the data we used from the catalog to complete our audit was appropriate to support our conclusions.

Review of Internal Controls

We performed an assessment of internal controls associated with NASA's technology transfer process. Throughout the audit, we reviewed controls associated with the audit objectives and determined that NASA's internal controls need improvement in effective management of the overall NTR and patent process at Goddard. The control weaknesses we identified are discussed in the report. Our recommendations, if implemented, should correct the identified control weaknesses. We specifically reviewed the following documentation:

- NASA Strategic Plan, 2014
- NASA Policy Directive (NPD) 2090.6, *Authority to Enter into License Agreements and Implementation of Licensing Authority* (April 9, 2014)
- NPD 2091.1B, *Inventions Made by Government Employees* (January 23, 2013)
- NPD 2092.1B, *Distribution of Royalties and Other Payments Received by NASA from the Licensing or Assignment of Inventions* (August 22,2014)
- NPD 2092.1C, *Royalties or Other Payments Received by NASA from the Licensing or Assignment of Inventions* (September 13, 2014)
- NPR 2210.1C, *Release of NASA Software* (August 11, 2010)
- NPR 7500.2, *NASA Technology Transfer Requirements* (December 19, 2014)
- NASA Office of the General Counsel, *Agency Patent Strategy and Funding* (March 4, 2015)
- Federal Laboratory Consortium, *Technology Transfer Desk Reference: A Comprehensive Guide to Technology Transfer*, 6th Edition (October 2013)
- Federal Laboratory Consortium, *Technology Transfer Legislation and Policy*, 5th Edition (2013)

Prior Coverage

During the last 6 years, the NASA Office of Inspector General (OIG), the Government Accountability Office (GAO), the Department of Agriculture OIG, the Department of Education OIG, and the Department of Energy OIG have issued 16 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at https://oig.nasa.gov/audits/auditReports.html, http://www.gao.gov, and https://www.oversight.gov/reports.

NASA Office of Inspector General

Audit of NASA's Process for Transferring Technology to the Government and Private Sector (IG-12-013, March 2012)

Government Accountability Office

Federal Research: Additional Actions Needed to Improve Licensing of Patented Laboratory Inventions (GAO-18-327, June 2018)

Small Business Research Programs: Agencies Need to Take Steps to Assess Programs toward Commercializing Technologies (GAO-18-207, January 2018)

Small Business Research Programs: Status of Prior Recommendations (GAO-17-594T, May 2017)

Small Business Research Programs: Most Agencies Met Spending Requirements, but DOD and EPA Need to Improve Data Reporting (GAO-17-453, May 2017)

Small Business Research Programs: Agencies Have Improved Compliance with Spending and Reporting Requirements, but Challenges Remain (GAO-16-492, May 2016)

Small Business Research Programs: Challenges Remain in Meeting Spending and Reporting Requirements (GAO-15-358, April 2015)

Critical Technologies: Agency Initiatives Address Some Weaknesses, but Additional Interagency Collaboration Is Needed (GAO-15-288, February 2015)

Technology Transfer: Federal Laboratory Consortium Should Increase Communication with Potential Customers to Improve Initiatives (GAO-15-127, October 2014)

Small Business Research Programs: Agencies Did Not Consistently Comply with Spending and Reporting Requirements (GAO-14-567T, April 24, 2014)

Small Business Research Programs: More Guidance and Oversight Needed to Comply with Spending and Reporting Requirements (GAO-14-431, June 2014)

Small Business Research Programs: Actions Needed to Improve Compliance with Spending and Reporting Requirements (GAO-13-421, September 2013)

Department of Agriculture

Adequacy of Controls to Prevent the Release of Sensitive Technology (Report 02601-0001-21, March 2016)

Department of Education

Audit of Small Business Innovation Research Program Regulations and Operating Procedures
(ED-OIG/A19P0007, March 25, 2016)

Department of Energy

Followup on Cooperative Research and Development Agreements at National Laboratories
(DOE-OIG-18-22, March 2018)

Followup on the Small Business Innovation Research and Small Business Technology Transfer Programs
(OAI-M-17-06, April 2017)

APPENDIX B: NEW TECHNOLOGY REPORT (EXAMPLE)

National Aeronautics and Space Administration

Disclosure of Invention and New Technology (Including Software)

Form Approved O.M.B. NO. 2700-0009 | DATE

CONTRACTOR CASE NO.

NASA CASE NO. (OFFICIAL USE ONLY)

This is an important legal document. Carefully complete and forward to the Patent Representative (NASA in-house innovation) or New Technology Representative (contractor/grantee innovation) at NASA. Use of this report form by contractor/grantee is optional; however, an alternative format must at a minimum contain the information required herein. NASA in-house disclosures should be read, understood and signed by a technically competent witness in the witness signature block at the end of this form. In completing each section, use whatever detail deemed appropriate for a "full and complete disclosure." Contractors/Grantees please refer to the New Technology or Patent Rights – Retention by the Contractor clauses. When necessary, attach additional documentation to provide a full, detailed description.

1. DESCRIPTIVE TITLE

2. INNOVATOR(S) *(For each innovator provide: Name, Title, Work Address, Work Phone Number, and Work E-mail Address. If multiple innovators, number each to match Box 5.)*

3. INNOVATOR'S EMPLOYER WHEN INNOVATION WAS MADE *(For each innovator provide: Name, Division and Address of Employer, Organizational Code/Mail Code, and Contract/Grant Number if applicable. If multiple innovators, number each to match Box 5.)*

4. PLACE OF PERFORMANCE *(Address(es) where innovation made)*

5. EMPLOYER STATUS *(choose one for each innovator)*

Innovator #1 — Innovator #2 —

Innovator #3 — Innovator #4 —

GE = Government
CU = College or University
NP = Non-Profit Organization
SB = Small Business Firm
LE = Large Entity

6. ORIGIN *(Check all that apply and provide all applicable numbers. If multiple Contracts/Grants, etc., list Contract/Grant Numbers in Box 3 with applicable employer information.)*

- ☐ NASA In-house Org. Mail Code ____ WBS ____
- ☐ Grant/Cooperative Agreement No. ____ WBS ____
- ☐ Prime Contract No. ____ WBS ____
  Task No. ____ Report No. ____
- ☐ Subcontractor; Subcontract Tier ____ WBS ____
- ☐ Joint Effort *(contractor, subcontractor and/or grantee contribution(s), and NASA in-house contribution)*
- ☐ Multiple Effort *(multiple contractor, subcontractor and/or grantee contributions, no NASA in-house contribution)*
- ☐ Other (e.g., Space Act Agreement, MOA) No. ____ WBS ____

7. NASA CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE *(COTR)*

8. CONTRACTOR/GRANTEE NEW TECHNOLOGY REPRESENTATIVE *(POC)*

9. BRIEF ABSTRACT *(A general description of the innovation which describes its capabilities, but does not reveal details that would enable duplication or imitation of the innovation.)*

NASA FORM 1679 Nov 2012 PREVIOUS EDITION IS OBSOLETE. Page 1 of 4

SECTION I – DESCRIPTION OF THE PROBLEM OR OBJECTIVE THAT MOTIVATED THE INNOVATION'S DEVELOPMENT *(Enter as appropriate: A. – General description of problem/objective; B. – Key or unique problem characteristics; C. – Prior art, i.e., prior techniques, methods, materials, or devices performing function of the innovation, or previous means for performing function of software; and D. – Disadvantages or limitation of prior art.)*
SECTION II – TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF INNOVATION DEVELOPED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE *(Enter as appropriate; existing reports, if available, may form a part of the disclosure, and reference thereto can be made to complete this description: A. – Purpose and description of innovation/software; B. – Identification of component parts or steps, and explanation of mode of operation of innovation/software preferably referring to drawings, sketches, photographs, graphs, flow charts, and/or parts or ingredient lists illustrating the components; C. – Functional operation; D. – Alternate embodiments of the innovation/software; E. – Supportive theory; F. – Engineering specifications; G. – Peripheral equipment; and H. – Maintenance, reliability, safety factors.)*
SECTION III – UNIQUE OR NOVEL FEATURES OF THE INNOVATION AND THE RESULTS OR BENEFITS OF ITS APPLICATION *(Enter as appropriate: A. – Novel or unique features; B. – Advantages of innovation/software; C. – Development or new conceptual problems; D. – Test data and source of error; E. – Analysis of capabilities; and F. – For software, any re-use or re-engineering of existing code, use of shareware, or use of code owned by a non-federal entity.)*
SECTION IV – SPECULATION REGARDING POTENTIAL COMMERCIAL APPLICATIONS AND POINTS OF CONTACT (*Including names of companies producing or using similar products.)*

NASA FORM 1679 Nov 2012 PREVIOUS EDITION IS OBSOLETE.

Page 2 of 4

10. ADDITIONAL DOCUMENTATION *(Include copies or list below any pertinent documentation which aids in the understanding or application of the innovation (e.g., articles, contractor reports, engineering specs, assembly/manufacturing drawings, parts or ingredients list, operating manuals, test data, assembly/manufacturing procedures, etc.).)*

TITLE	PAGE	DATE

11. DEGREE OF TECHNOLOGY SIGNIFICANCE (*Which best expresses the degree of technological significance of this innovation?)*
☐Modification to Existing Technology ☐ Substantial Advancement in the Art ☐ Major Breakthrough

12. STATE OF DEVELOPMENT
☐ Concept Only ☐Design ☐Prototype ☐Modification ☐Production Model ☐Used in Current Work

13. PATENT STATUS (Prior patent on/or related to this innovation.)
☐Application Filed Application No. _____ Application Date _____
☐Patent Issued Patent No. _____ Issue Date _____

14. INDICATE THE DATE OR THE APPROXIMATE TIME PERIOD WHICH THIS INNOVATION WAS DEVELOPED (*i.e., conceived, constructed, tested, etc.)*

15. PREVIOUS OR CONTEMPLATED PUBLICATION OR PUBLIC DISCLOSURE INCLUDING DATES *(Provide as applicable: A. – Type of publication or disclosure, e.g., report, conference or seminar, oral presentation; B. – Disclosure by NASA or Contractor/Grantee; and C. – Title, volume no., page no., and date of publication.)*

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Page 3 of 4

16. QUESTIONS FOR SOFTWARE ONLY
(a) Using non-NASA employees to beta-test the program? ☐YES ☐NO If Yes, done under a beta-test agreement? ☐YES ☐NO (b) Modification of this program continued by civil servant and/or contractual agreement? ☐YES ☐NO (c) Copyright registered? ☐YES ☐NO ☐UNKNOWN If Yes, then by whom? _____ (d) Has the latest version been distributed outside of NASA or contractor? ☐YES ☐NO ☐ UNKNOWN If Yes, date of first disclosure: _____ (e) Were prior versions distributed outside of NASA or Contractor? ☐YES ☐NO If Yes, supply NASA or contractor contract: _____ (f) Contains or based on code not owned by U.S. Government or its contractors? ☐YES ☐NO ☐ UNKNOWN If Yes, name of code and code's owner: _____ Has a license for use been obtained? ☐YES ☐NO ☐ UNKNOWN

17. DEVELOPMENT HISTORY			
STAGE OF DEVELOPMENT	DATE (MM/YYYY)	LOCATION	IDENTIFY SUPPORTING WITNESSES (NASA in-house only)
a. First disclosure to others			
b. First sketch, drawing, logic chart or code			
c. First written description			
d. Completion of first model of full size device *(invention)* or beta version *(software)*			
e. First successful operational test *(invention)* or alpha version *(software)*			
f. Contribution of innovators *(if jointly developed, provide the contribution of each innovator)*			
g. Indicate any past, present, or contemplated government use of the innovation			

18. SIGNATURES OF INNOVATOR(S), WITNESS(ES), AND NASA APPROVAL			
TYPED NAME AND SIGNATURE *(Innovator #1)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #2)*	DATE
TYPED NAME AND SIGNATURE *(Innovator #3)*	DATE	TYPED NAME AND SIGNATURE *(Innovator #4)*	DATE
TYPED NAME AND SIGNATURE *(Witness #1)*	DATE	TYPED NAME AND SIGNATURE *(Witness #2)*	DATE
NASA APPROVED / TYPED NAME		SIGNATURE	DATE

NASA FORM 1679 Nov 2012 PREVIOUS EDITION IS OBSOLETE.

Page 4 of 4

APPENDIX C: SUMMARY OF QUESTIONED COSTS

Table 3 summarizes the questioned costs identified during our audit. These costs are the result of Goddard's Office of Patent Counsel bypassing the established process and patenting innovations that the Technology Transfer Office did not recommend for patenting.

Table 3: Summary of Questioned Costs

Issue	Recommendation	Questioned Costs[a]
Patenting technologies without commercial potential	1, 2	$219,040
Total		$219,040

Source: OIG analysis.

[a] Questioned Costs are expenditures that are questioned by the OIG because of alleged violation of law, regulation, or contractual requirement governing the expenditure of funds; costs that are not supported by adequate documentation at the time of our audit; or are unallowable, unnecessary, or unreasonable.

APPENDIX D: MANAGEMENT'S COMMENTS

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

APR 10 2019

Reply to Attn of: Space Technology Mission Directorate

TO: Assistant Inspector General for Audits

FROM: Acting Associate Administrator Space Technology Mission Directorate

Director, Goddard Space Flight Center

SUBJECT: Agency Response to OIG Draft Report, "NASA's Technology Transfer Process" (A-18-011-00)

NASA appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Technology Transfer Process" (A-18-011-00) dated March 7, 2019.

In the report, the OIG found that NASA's Technology Transfer Program Office, along with the other Centers reviewed Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Langley Research Center (LaRC), and Marshall Space Flight Center (MSFC) have made concerted efforts in recent years to improve the overall awareness and effectiveness of NASA's Technology Transfer Program, including simplification of policies, standardization and automation of processes, and increased communication and outreach. Those efforts have resulted in a considerable increase in the numbers of New Technology Report (NTR) s submitted, patent applications filed, licenses negotiated, and software released—effectively increasing NASA's overall commercialization efforts. However, despite these overall improvements, GSFC is experiencing poor technology transfer performance outcomes when compared to the other NASA Centers.

The OIG makes four recommendations, two each to the NASA Technology Transfer Program Executive and the GSFC Director, intended to improve the effectiveness of the Technology Transfer Program and to improve the efficiency and effectiveness in pursuing patents for inventions developed by NASA employees and licensing those technologies to commercial customers.

Specifically, in order to improve the effectiveness of the Technology Transfer Program, the OIG recommends that the NASA Technology Transfer Program Executive:

> **Recommendation 1:** Examine Center-specific operations and enhancements to determine those that could be beneficial if implemented Agency-wide.

Management's Response: Concur. STMD will identify best practices at individual Centers, sharing, and determine which practices can be replicated or scaled to Agency initiatives—as an ongoing component of good program management. As a part of this activity, we will be examining and discontinuing activities that do not advance our overall commercialization efforts. This is something that we have been consistently doing over the past several years, and something that we will continue to do. In fact, much of the successes cited in this report are because of this constant search for best practices.

For example, over the past five years, we have conducted a gap analysis of NASA's program and Federal regulations and established a standardized set of core business practices. We have updated policies and developed and implemented common procedures to enact to these newly agreed-upon practices. We also began identifying individual best practices within those core business areas and scaling them up as appropriate. Examples include the software catalog, the Agency patent portfolio, standardized marketing materials, and the Tech Transfer University (T2U) activity. We have also formed working groups for the licensing managers, new technology representatives, and software group for them to share best practices, standardize procedures, and coordinate activities.

Now, we are making efforts to improve best practices by consolidating Agency functions to centralized locations, eliminating these functions from the other Centers so personnel can focus more on outreach and interactions with our communities—something we have long identified as a best practice. Our additional two key areas of focus this year are exploring centralization of commercialization assessments as well as a zero-base review of all Center activities to determine where efficiencies can be found and whether individual work at Centers can be eliminated, replicated, or scaled to an Agency-level approach.

Estimated Completion Date: This activity is ongoing. We will report on our FY19 progress on or before November 15, 2019.

Recommendation 2: Complete implementation of the two-party authentication system as soon as possible to minimize instances of offices bypassing patenting process requirements.

Management's Response: Concur. Requirements for this task have been formulated and submitted to our development team. We will accelerate this project in our production queue and begin design, testing, and ultimately, release of this new tool.

Estimated Completion Date: September 30, 2019

In order to improve the efficiency and effectiveness in pursuing patents for inventions developed by NASA employees and licensing those technologies to commercial customers, the OIG recommends that the Goddard Center Director:

Recommendation 3: Make needed changes in Goddard's technology transfer processes or personnel to improve the Center's overall performance.

Management's Response: The Goddard Center Director concurs with the recommendation to make needed changes and is implementing changes in Goddard's technology transfer processes or personnel to improve the Center's overall performance.

The Chiefs of Goddard's Strategic Partnership Office (SPO) and Office of Patent Counsel (OPC) will establish regular, ongoing weekly one-on-one meetings to discuss and resolve any operational and/or personnel issues between the two organizations. These meetings will be conducted face-to-face in order to facilitate the best possible communication. At the initial meeting, a prioritized list of remaining issues impeding the optimal performance of Goddard's Technology Transfer Program will be developed. This list, along with a projected schedule for implementing corrective actions, will be presented to the Deputy Center Director for Technology and Research Investments within two weeks of the initial meeting for review and concurrence. Progress updates on implementation will be presented on a monthly basis to the Deputy Center Director for Technology and Research Investments.

Initial contacts with the Center Technology Transfer Officer (CTTO) at LaRC and GRC to discuss best practices in processing NTRs have already been made. While initial discussions indicate that both LaRC and GRC's average time to make patenting determinations on their NTRs is more in line with Goddard's than the one week cited in the report, Goddard management does believe there is room for improvement in its process and will work with the other NASA Centers to identify and adopt best practices. In addition, a set of internal metrics designed to monitor the efficiency of critical portions of the technology transfer process will be developed and implemented with the oversight of the Deputy Center Director for Technology and Research Investments.

In order to improve the communication and relationships between SPO and OPC at the working level, Goddard Center management will commission a 90-day independent study to identify, and evaluate the efficacy of, any personnel actions that could be taken to improve the performance of the two organizations. Possible areas for evaluation include the physical co-location of the two offices and/or the implementation of alternative managerial reporting structures, among others.

Estimated Completion Date: Initiation of corrective actions will take place immediately. Final corrective actions, including actionable recommendations from the 90-day study, are estimated to be completed by no later than December 30, 2019.

Recommendation 4: Establish firm completion dates for the 12 remaining Lean Six Sigma action items.

Management's Response: The Goddard Center Director concurs with the recommendation to establish firm completion dates for the 12 remaining Lean Six Sigma action items.

The Chiefs of Goddard's OPC and SPO will convene a meeting of the personnel from both offices with primary responsibilities tied to those tools and/or processes impacted by the remaining Lean Six Sigma action items in order to set firm completion dates. The SPO Chief will generate and maintain a project schedule based on the milestone and completion dates determined at the joint offices meeting and will report on the implementation status weekly to the Deputy Center Director for Technology and Research Investments. For those action items involving enhancements to the NTTS database, which is outside the direct control of either Goddard office, SPO will document the proposed enhancements in a white paper that will be provided to the Technology Transfer Program Executive for consideration.

Estimated Completion Date: A schedule with firm completion dates for the remaining Lean Six Sigma action items will be finalized by April 19, 2019. The white paper outlining the Lean Six Sigma proposed enhancements to the NTTS database will be finalized and presented to the Technology Transfer Program Executive by May 30, 2019.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should be restricted from public release.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Kimberly Butler on (202) 358-2341.

James Reuter
Associate Administrator (Acting)
Space Technology Mission Directorate

C.J.S.

Christopher J. Scolese
Director, Goddard Space Flight Center

cc:
Chief Technologist/Dr. Terrier
GRC/Dr. Kavandi
LaRC/Dr. Bowles
MSFC/Ms. Singer

APPENDIX E: REPORT DISTRIBUTION

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