National Aeronautics and Space Administration

FY 2022 ANNUAL EVALUATION PLAN

NASA Artemis Program and Stennis Space Center
NASA's Space Launch System (SLS) rocket prior to its Artemis I flight. The Green Run testing was the first top-to-bottom integrated testing of the stage's systems prior to its maiden flight. Testing conducted on the B-2 Test Stand at Stennis, located near Bay St. Louis, Mississippi, and the nation's largest rocket propulsion test site. Image credit: NASA/SSC 22 January 2020

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NASA's FY 2022 Annual Evaluation Plan

The Foundations for Evidence-Based Policymaking Act of 2018 (Evidence Act) reinforces and supports Federal evidence-building activities, Open, Public, Electronic, and Necessary Government Data Act, and Confidential Information Protection and Statistical Efficiency Act. The Evidence Act requires CFO-Act Agencies to publish an Annual Evaluation Plan (AEP) that conveys significant evaluations across the Agency each fiscal year, developed in coordination with the Annual Performance Plan, and is published in NASA's Volume of Integrated Performance. The AEP establishes and informs NASA's key stakeholders about planned evaluations. Evaluations will uncover findings that will inform NASA program budgets, the Strategic Plan and Learning Agenda, annual Strategic Review, ongoing program management and development, and connect the performance planning process.

Evaluation Culture

Evaluation Standards

NASA relies on a culture of evidence-based, data-driven research designs and methodologies to evaluate its programs, policies, and organizations across the agency. Evaluations, as defined by the Evidence Act, are the use of systematic data collection and analysis to assess effectiveness and efficiency or examine interventions of one or more programs, policies, or organizations. The Annual Evaluation Plan details only those NASA evaluations that meet the Agency's definition of "significant" evaluations. Led by NASA's Evaluation Officer, in conjunction with the Statistical Officer and Chief Data Officer, five standards guide NASA's evaluation culture: rigor, relevance and utility, independence and objectivity, transparency, and ethics. These standards, in addition to the criteria established for "significant" evaluations are the foundation that NASA uses to support its array of evaluation activities.

Intended Use and Users

The AEP identifies planned "significant" evaluations from across the Agency. It serves as a primary means to inform Agency senior officials where the most significant evaluations are conducted, cultivate data sharing and resources between NASA organizations, and provide information to help support the Agency's evidence-driven culture. In future years, the AEP will build upon an inventory of significant evaluations to help project where evaluation resources should be allocated based on recommendations from Agency senior officials, the Executive Branch, and Congress. Similarly, the AEP will spur collaboration to better leverage data-sharing and evaluation strategies where possible.

Dissemination and Sharing

NASA has long been committed to disseminating and sharing results from its evidence-building activities with the greater scientific community and, when permissible, making this information broadly available to the public. As detailed in NASA Procedural Requirement (NPR) 2200.2D – Requirements for Documentation, Approval and Dissemination of Scientific and Technical Information, the Agency strives for the widest practicable and appropriate dissemination of information concerning its activities and scientific and technical information. NASA will leverage this framework in sharing findings from its "significant" evaluations.

The Agency's dissemination framework includes an array of symposium presentations, peer reviewed journal publications, and NASA internal and external council discussions. Agency evaluations that provide promising and effective findings are systematically and broadly disseminated to potential beneficiaries and to federal agency partners. Criteria and requirements for the dissemination of

symposia lectures and papers, in addition to journal materials beyond the Agency, are detailed in Chapter 5 of NPR 2200.2D to ensure proper review of substantive content, technical accuracy, overall quality, and value to the larger scientific community. The Evaluation Officer, as well as Mission Directorate Associate Administrators and Center Directors, have responsibility for the technical, scientific, and programmatic accuracy of information released externally from the Agency by their respective programs.

While NASA maintains a free exchange of scientific and technological information among scientists and engineers, between NASA staff and the scientific community, and between NASA employees and the public, the AEP is a formal dissemination of "significant" evaluations. Table 1, below, depicts broad evaluation dissemination methods by stakeholder groups and the formats used to share significant evaluations.

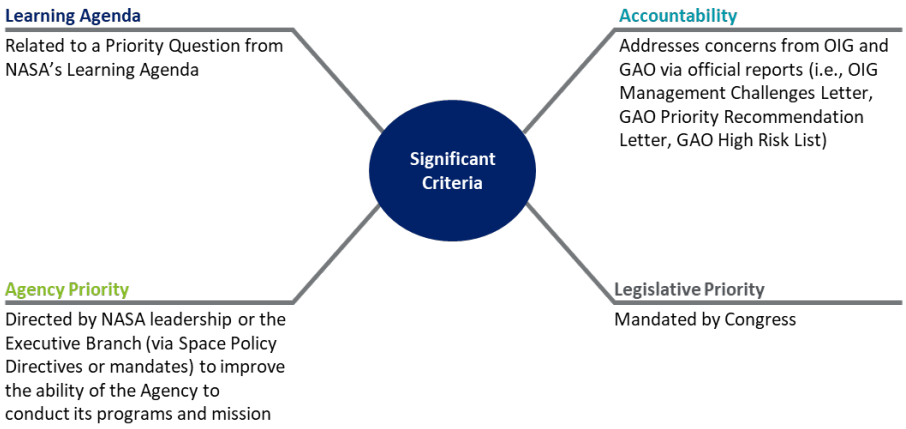
Table 1. Dissemination and Sharing Summary

Stakeholder Group	Dissemination Channel
NASA Senior Officials	Council meetings, Conferences, Reports
Centers and Mission Directorates Leadership	Conferences, Webinars, Performance Reviews
Internal Councils and Symposia	Reports, Briefings, Conferences
External Councils, NASA Advisory Council (NAC)	Conferences, Webinars
Congress	Committee hearings, Briefings
Office of Management and Budget (OMB)	Budget Submission and Reviews, Council Meetings
Public, National Academies	Press releases, Webinars, NAC meetings, Conferences

NASA's Criteria for Defining "Significant" Evaluations

NASA's extensive evidence culture leverages the findings from evaluations across the Agency. Some of these evaluate success of a specific intervention or program and provide targeted findings, while others involve a broader scope and inform policymaking. NASA determined a list of criteria to distinguish which evaluations rise to policymaking significance in accordance with the Evidence Act. These criteria identify NASA's most "significant" evaluations and include those that fit one or more of the criteria illustrated in Figure 1.

Figure 1. Criteria for NASA's Significant Evaluations



FY 2022 Significant Evaluations

Technology Investment

NASA invests in innovative, early-stage technology concepts that could lead to future breakthrough capabilities and enable new paradigms or mission types. NASA is evaluating its strategy for investments in early-stage innovation that enables potential breakthroughs of tomorrow while also ensuring that near-term needs are met through the development and demonstration of more mature technologies.

Diversity is a key aspect of an early-stage investment and partnership strategy. Enabling technology breakthroughs of the future requires NASA to look to diverse sources for ideas and innovation. Companies—small and large, academia, research institutions, students, individual inventors and hobbyists, NASA researchers and others can all provide rich inputs to a thriving innovation ecosystem.

NASA's Space Technology Mission Directorate (STMD) early-stage programs have encouraged participation from underserved and underrepresented communities—including women and women-owned businesses; socially- and economically-disadvantaged individuals, businesses, and research institutions; and entrepreneurs living in or whose businesses are located and operate in states with a lower number of awards—in technology development activities through outreach activities.

For example, the Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR), NASA Innovative Advanced Concepts (NIAC), and the Space Technology Research Grants (STRG) programs have increased their outreach and communications to underserved and underrepresented communities, including Historically Black College and Universities (HBCU) and Minority Serving Institutions (MSI). The SBIR/STTR programs have supported 15 Technology Infusion Road tours that have attracted over 1,200 participants and have resulted in increased participation in STTR proposals. From 2010 through 2020, approximately 10% of SBIR/STTR Phase I awards have been to minority-owned firms. Additionally, NIAC has seen an increase in female grant awardees from 5.6% in 2013 to 12% in recent years. STRG's largest awards – the four Space Technology Research Institutes (STRIs) – all feature MSI participation. One STRI is now led by an MSI university, which recently, post-award, achieved MSI status.

Despite these improvements, NASA believes that more MSIs and HBCUs could be engaged and contributing to space technology research and innovation. Outreach alone does not sufficiently address the underlying factors that create challenges for underserved and underrepresented communities to participate and successfully win awards in early-stage space technology innovation. STMD has begun piloting new approaches, including a directorate-wide pilot—NASA's Minority University Research and Education Project (MUREP) Space Technology Artemis Research (M-STAR)—to seek to address other underlying factors for participation, such as lack of access to NASA experts and lack of understanding of how MSI capabilities align with the NASA Mission. In order to assist HBCUs and MSIs through an increased understanding of these linkages, M-STAR was established to strengthen and develop the research capacity of HBCUs and MSIs in areas of strategic importance to STMD's technology focus areas. In August 2020, M-STAR awarded $604,000 to 15 universities. At the end of the period of performance, the HBCUs and MSIs will submit implementation plans to STMD detailing their institution's plan to compete for STMD opportunities as well as identify any obstacles to success. This initiative will deliver valuable insight to STMD from our HBCU and MSI stakeholders. M-STAR also aims to connect the institutions with STMD experts and familiarize them with STMD's work.

Building on past and current experience, starting in FY 2022, NASA will evaluate other factors that could help to increase HBCU and MSI contributions toward early-stage space technology innovation. This evaluation seeks to understand the factors that are most important in building successful partnerships among HBCUs, MSIs, small businesses, and NASA to develop space technology. NASA will leverage these findings in program interventions to increase the number of HBCUs and MSIs that are awarded STTRs to bring diverse ideas to NASA missions and expand NASA's economic impact in underrepresented communities.

Theory of change

If NASA examines the core capabilities that exist at HBCUs and MSIs and synergies between those capabilities and NASA core competencies, the Agency will develop a more effective platform of information-sharing and relationship-building with HBCUs/MSIs, including access to funding and a more diverse pipeline of innovative solutions.

Evaluation question(s)

What are the factors and to what extent does each factor help increase the contribution of HBCUs and MSIs towards early stage innovation?

NASA will evaluate this question through a study conducted by the NASA STTR program. This evaluation will analyze data in following areas:

- HBCUs/MSIs:
    - The capabilities of the nation's HBCUs and MSIs.
    - How does NASA align those capabilities with the core competencies of the Agency in order to understand potential synergies?
    - What mechanisms facilitate engagement between HBCUs/MSIs, small businesses and NASA to encourage commercialization of technologies in partnership with underrepresented groups?
    - What incentives does NASA utilize to increase participation in these mechanisms?
    - What approach(es) result in successful partnerships between HBCUs/MSIs and small businesses that win NASA's STTR awards, contribute to NASA's missions, and commercialize early-stage innovations from diverse sources?

Since the NASA SBIR/STTR has a wealth of success from non-HBCU/MSI research institutes, it would be valuable to determine if any of the contributing factors that have led to their success could also be factors that could contribute to the success of HBCUs and MSIs.

Data and information

This evaluation will collect data through an intermediary that works directly with the HBCUs and MSIs as well as from customer experience surveys. In addition, existing data from the program's proposal process will be analyzed. The SBIR/STTR program plans to use an agreement with an intermediary in FY 2021 and conduct the evaluation in FY 2022.

Table 2. Data for Technology Investment Evaluation

Source	Purpose
Intermediary data	Understand present trends from HBCUs and MSIs
Existing data	Collected from past awardees through annual STTR proposal processes that will supplement active data gathering to analyze and determine trends
Section 280 customer experience clearance	Learn more about what made past awardees successful and what part of their customer experience with the STTR program may have discouraged participation or success, if any

Methods to be used and evaluation design

NASA will undertake an experimental design process evaluation to understand strategies to increase HBCU and MSI contributions. This will be a mixed-method evaluation. Qualitative and quantitative approaches will be used in the implementation study. This evaluation design will be refined through a partnership with GSA's Office of Evaluation Science (OES) in FY 2021.

Table 3. Technology Investment Evaluation Design

Inputs	Capture quantitative and qualitative data for research institution capabilities through an intermediary • Quantitative data example: number of HBCUs/MSIs that submit capabilities and/or number that have technology areas where there is a great deal of synergy, some synergy, or little to no synergy with NASA core competency areas • Qualitative data example: Awareness of the existence of the capabilities submission database and understanding its benefits
	Capture and analyze STTR past participation data
	Consider insights from NASA's MUREP
Processes	Analyze what synergies can be made to inform which mechanism might best support engagement and ways to experiment with incentives that encourage engagement
	Survey successful STTR awardees through our Section 280 customer experience clearance to see which parts of their experience with the program most contributed to successful partnering between research institutions and small businesses
Expected outputs	Identification of the factors within NASA's span of control (outreach, networking, funding, technical and business assistance, etc.) that are most relevant when considering partnerships between HBCUs/MSIs and small businesses and any negative impacts
	Inform and update the policy to increase the number of HBCUs and MSIs that are awarded STTRs to bring diverse ideas to NASA's missions and expand NASA's economic impact in underrepresented communities

Challenges

Since the HBCU/MSI community is small, getting enough participants will rely on active marketing through a well-connected community intermediary. The ability to get qualitative data about successful STTR awardee partnership characteristics will be limited by the size of the pool and their willingness to provide information. NASA seeks to leverage an intermediary with long standing relationships to the HBCU/MSI community to effectively communicate positive impacts and provide study data.

Dissemination strategies

The results will be shared broadly within NASA to all programs concerned with increasing the participation of underserved and underrepresented communities, with the caveat that this evaluation will focus on the intersection of successful small business and research institution partnerships—a core part of lab-to-market efforts. These results could inform experiments and programmatic strategies to be considered by other programs that engage the small business, entrepreneur, or research community within other early stage programs, the Office of STEM Engagement (OSTEM), and the Office of Small Business Programs. Evaluation results would benefit other agencies' SBIR/STTR programs and the Small Business Administration on ways to increase participation.

Timeframe

The evaluation design will be finalized in FY 2021, and active partnering and evaluation will occur in FY 2022.

Industrial Base

NASA and the Department of Commerce's Bureau of Industry and Security (BIS), National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service, will conduct an evaluation of the factors that drive efficiency in the NASA and United States civil space supply chain network.

This multi-year collaboration will build upon a substantial record of space sector analysis conducted between BIS, NASA and the broader U.S. Government to identify traits that benefit or impede the current health and competitiveness of the civil segment of the U.S. Space Industrial Base. Early findings will also inform the planning and execution of the civil space provisions of the 2020 National Space Policy. NASA and NOAA seek visibility into the current and prospective performance of the civil space community to achieve enhanced situational awareness in times of uncertainty. By understanding more of the industrial base ecosystem that serves the civil space sector, NASA will be able to better forecast pressures, anticipate risks, and mitigate against forces that affect the aerospace supply chain to drive adaptability and enhance decision making. For NASA, the evidence generated by this survey will be used to inform Agency and program acquisition strategy.

Theory of change

If survey results generate valuable information regarding the current state of civil space sector (in particular, concerning sectoral trends and gaps/weaknesses or other deficiencies in the supply chain), this may inform and lead to the modification of Agency acquisition strategy, ultimately improving the efficiency, governance, and management of the Agency and its missions.

Evaluation question(s)

What are the underlying factors and to what extent do these factors affect the aerospace industrial base to support federal civil space acquisition and development?

NASA will evaluate this question through a survey and analysis that looks at the supply chain and underlying factors related to the aerospace industrial base. This evaluation seeks to address impacts to the aerospace supply chain through the following factors:

- Impacts from the COVID-19 pandemic;
- Corporate financial distress;
- Mergers and acquisitions;
- Costs related to foreign sourcing, offshoring of critical supply chain components, and alternatively, reshoring;
- Disruptive new technologies, including advances in artificial intelligence, quantum computing, and additive manufacturing;
- Changing workforce dynamics including emphasis on STEM practices;
- Cybersecurity investments and cybercrime impacts; and
- Constraints related to U.S. federal acquisition reforms.

Data and information

Data gathered as part of this evaluation will be sourced from survey responses comprising of prime contractors and their affiliated vendors, universities, laboratories, grant recipients, investment banks, non-profits, select federal facilities, and both direct and indirect suppliers to NASA, NOAA, and the larger U.S. civil space community.

BIS will work closely with NASA, NOAA and other space sector affiliates, including associations, to minimize the burden on industry while ensuring the robust participation of suppliers currently supporting civil space-related applications, such as human spaceflight vehicles, robotic spacecraft, spacecraft buses, small satellite components, and microelectronics.

Methods to be used and evaluation design

NASA will undertake a non-experimental formative evaluation design to analyze survey results, including a time series analysis of responses over the course of three observation years:

- FY 2021: Survey development, testing, distribution, and organization of mailing list and portal hosted by the Census Bureau;
- FY 2022: Survey analysis of roughly 500 completed survey responses in Wave 1 compiled, analyzed, briefed, and shared; and
- FY 2023: Survey analysis and comparison of roughly 500 to 1,000 completed survey responses in Wave 2 compiled, analyzed, briefed, and shared.

Further evaluation design details are under discussion, with several options, techniques, and tools under consideration. Final determination is expected to be made by the end of the calendar year 2021.

Challenges

Anticipated challenges include willingness of survey respondents to provide detailed, current, and historical information regarding performance, financials and supply chain issues.

Dissemination strategies

A final dissemination plan has not yet been approved. Initial considerations suggest a wide dissemination within NASA to all impacted programs, the broader U.S. civil space community, including primary space agencies and associated partners. In addition, a summary of findings is likely to be disseminated to relevant stakeholders including the Administration, Congress, industry, academia and the public.

Timeframe

The timeframe for this evaluation is FY 2021 through FY 2023.

Internship Outcomes

NASA internships and fellowships leverage NASA's unique missions and programs to enhance and increase the capability, diversity and size of the nation's future science, technology, engineering and mathematics (STEM) workforce. Research demonstrates that internships and work-based learning experiences are positively associated with student outcomes such as STEM concept knowledge and STEM persistence.[1] Thus, participation in such experiences is an important evidence-based practice to addressing current STEM workforce needs. Although there is extant literature documenting the outcomes of such experiences on students, there is much less research documenting the contributions of such experiences to the STEM field. This study will generate evidence that can be used to assess whether NASA internships are associated with positive student experiences and outcomes and ultimately inform programmatic improvement. Additionally, this study will assess the extent to which NASA internships are associated with benefits to NASA.

The purpose of the Internship Outcome Assessment evaluation is to measure students' immediate outcomes of participating in a NASA internship and assess how and to what extent interns are contributing to NASA's missions. Additionally, this evaluation will identify sources of group differences and address how NASA can continue to broaden participation of students from historically underrepresented groups in STEM fields. The findings of this evaluation are intended to be used for programmatic improvement and to assess the feasibility of instituting a yearly evaluation cycle. By comparing and analyzing survey responses and contributions by NASA interns, the Agency will be better able to determine differences based on underrepresented group status and isolate avenues for growth amongst this population.

Theory of change

If higher education students participate in NASA STEM experiences (e.g., internships, competitions, challenges, and activities), NASA will benefit from their contribution to missions and a diverse group of students will be better equipped to persist in STEM academic and career pursuits.

Evaluation question(s)

What common experiential factors exhibited across NASA interns can be diagnosed to broaden the participation of students from historically underrepresented groups in STEM fields in future years?

NASA will evaluate this question through a survey and skills assessment conducted before and after the internship program to measure immediate outcomes across participants. This evaluation will address the following questions:

- To what extent is participation in NASA internships associated with:
  - Intern satisfaction with the program?
  - Interns' self-reported gains in science and research-related outcomes?
  - Interns' likelihood to pursue future STEM-related activities, education, and careers?
- Are there any differences in interns' reports based upon underrepresented group status?
- What insight do mentors provide on the intern program?
- How do mentors characterize interns' contributions to NASA's missions?

[1] National Academies of Sciences, Engineering, and Medicine, 2017

- Do interns demonstrate growth toward mastery of 21st Century Skills across the duration of the internship as assessed by their mentor?

Data and information

This evaluation will utilize two modes of data collection: 1) participant surveys, or questionnaires (for interns and mentors) and 2) a 21st Century Skills Assessment (administered by the mentor). The intern and mentor surveys have been adapted from the Department of Defense Army Educational Outreach Program with permission from program leadership. NASA modified the survey to fit the contextual circumstances, vision, goals, and objectives of NASA's internship program. The questionnaire addresses the following areas of interest:

- Satisfaction with the internship program resources and features;
- Experiences with effective teaching and mentoring practices;
- Gains in science and research-related outcomes; and
- Likelihood to pursue future STEM-related activities, education, and careers

The 21st Century Skills Assessment is an objective assessment measure that is completed by each interns' mentor regarding their progress toward mastery of important 21st Century skills.[2] Mentors assess each intern in a pre/post manner. The first assessment will be completed in the first days of the program (pre). The second assessment will be completed at the end of the program (post). The assessment is used to determine the growth toward mastery for each participant during their time in the internship. Mentors rate each participants' skills in six domains of 21st Century skills:

- Creativity and Innovation;
- Critical Thinking and Problem Solving;
- Communication, Collaboration, Social, and Cross-Cultural Skills;
- Information, Media, and Technological Literacy;
- Flexibility, Adaptability, Initiative, and Self-Direction; and
- Productivity, Accountability, Leadership, and Responsibility

Methods to be used and evaluation design

NASA will undertake a non-experimental outcome evaluation to measure students' immediate outcomes of participating in a NASA internship and assess how sources of group differences can be interpreted to broaden participation of students from historically underrepresented groups in STEM fields. This evaluation will use both quantitative and qualitative methods to analyze survey data. Quantitative data will be summarized using descriptive statistics such as numbers of respondents, frequencies and proportions of responses, average response when responses categories are assigned to a Likert scale (e.g., 1 = "Never used" to 4 = "Used every day"), and standard deviations. Emergent coding will be used for the qualitative data to identify the most common themes in responses.

Inferential statistics will be used to identify sources of group differences and in support of NASA's goal to broaden participation of historically underrepresented groups in STEM fields. Statistical significance will be determined with t-tests, chi-square tests, or various non-parametric tests as appropriate, with significance defined at $p < 0.05$. Because statistical significance is sensitive to the number of

[2] Sondergeld, & Johnson, 2016

respondents, it is more difficult to detect significant changes with small numbers of respondents. Therefore, practical significance, also known as effect size, will be reported when differences are statistically significant.

21st Century Skills Assessment data will be analyzed using 2-Between, 2-Within Repeated-Measures analysis of variance to examine potential differences from pre- to post-observation by underrepresented group status and setting. Descriptive and inferential statistics will be included.

Challenges

NASA strives to execute a utilization-focused evaluation that provides data that is useful for continual programmatic improvement and evidence-based decision-making. Thus, NASA anticipates challenges related to COVID-19 and the practical trade-offs that must be considered in less than ideal contexts. Accurate and timely survey responses will be closely monitored throughout the evaluation.

To ensure a high-quality evaluation is conducted and mitigate against risk, NASA has used the program evaluation standards for evaluator credibility to assess the evaluator's potential bias. To address evaluator credibility, Paragon TEC, Inc, the independent contractor conducting the evaluation, has selected highly qualified, experienced program evaluators to design and conduct this study. The individuals selected to design and conduct this evaluation are independent from the policies, decision-making, operations, and implementation of the activities which are the subject of this investigation.

Dissemination strategies

The findings of this evaluation will be summarized in an evaluation report. The report will be shared broadly among the NASA STEM Engagement community. Primary users and stakeholders will attend at the conclusion of the evaluation. The findings will also be presented at the Office of STEM Engagement (OSTEM) Performance and Evaluation (P&E) Community of Practice, STEM Engagement Council meeting, and to the NASA Advisory Council STEM Engagement Sub-Committee. The OSTEM P&E Team will work with OSTEM leadership and internship project management to finalize a dissemination strategy and identify appropriate audiences.

Timeframe

This evaluation will take place across calendar year 2021 (FY 2021 and FY 2022). NASA will work with OSTEM leadership, internship project management and internship stakeholders to approve the timeframe and identify appropriate cohorts of interns to participate in this evaluation (e.g., spring, summer and/or fall).

Cost and Schedule

NASA is on the cutting edge of scientific discovery and commands space exploration programs that require large funding commitments spanning years or decades. A significant management challenge for NASA is controlling cost and schedule given the size and technical complexity of these projects. Projects can be either directed or competed, and by evaluating the factors that lead to better performance in either of these two acquisition methods, NASA can inform policy to better manage programmatic performance.

In order to evaluate programmatic performance between directed and competed approaches across NASA's space flight acquisition planning process, the Agency will employ an outcome evaluation to compare the two mission acquisition types. By uncovering favorable attributes associated with better performance of each mission type in different scenarios, evaluators will seek to uncover factors that can be used to improve cost and schedule models and help NASA better deliver on its commitments.

Theory of change

If NASA examines the outcomes and drivers for cost and schedule performance of directed and competed missions then the results of that examination can better inform the Agency on a) determining which missions should be directed or competed; and b) understanding the programmatic risk posture for each mission based on performance drivers.

Evaluation question(s)

To what extent is there a programmatic performance difference between directed and competed space flight projects and what factors or criteria are most attributable to that performance difference?

As described in NASA policy NPR 7120.5E, NASA initiates space flight projects in one of two ways: 1) the project is assigned to a NASA Center, either directly or by the Mission Directorate or 2) the assignment is made through a competitive process such as an Announcement of Opportunity (AO).

- (1) A "directed" mission is generated in a top-down process from the Agency strategic goals and through the strategic acquisition planning process. It is defined and directed by the Agency, assigned to a Center or implementing organization.
- (2) A "competed" mission is open to a larger community for conceptualization and definition through a Request for Proposal (RFP) or competitive selection process, such as an Announcement of Opportunity (AO), before entering the conventional life-cycle process.

This evaluation will examine the performance of directed and competed missions to determine how programmatic performance compares between the two types of projects and what, if any, are the factors or criteria that are most attributable to that performance difference. Findings from this evaluation will help inform the Agency on when it's appropriate to utilize a directed versus competed mission approach and what factors or criteria should be included to increase the likelihood of improved programmatic performance.

Data and information

Data will include cost and schedule projections and actuals from various points in project lifecycles. Most data will be collected via the Once NASA Cost Engineering (ONCE) database, including technical and mission classification data. ONCE is composed of historical NASA Cost Analysis Data Requirements (CADRe) that have programmatic data by milestone. Additionally, a project's Key Decision Point Decision

Memos and OMB Quarterly reporting data will be utilized. Other NASA systems will be utilized for data that may be missing from the sources listed above. Data prior to 2001 predated CADRe and is harder to locate.

Methods to be used and evaluation design

NASA will employ a non-experimental outcome evaluation to compare the two mission types. The evaluation itself will have no direct impact on mission type designation (directed vs. competed) and thus will not assign randomization to mission type. Statistical analyses will be conducted to determine if cost and schedule performance is statistically different between the two types of missions. Additionally, the evaluation will attempt to identify and control for variables that could drive performance so the design can better isolate effects of mission type.

NASA began initial data gathering and research in FY 2020. Initial analysis examined raw cost and schedule performance between the two types of missions and determined performance differences by utilizing a two-sample, unequal variance t-test to determine a p-value between the two mission types.

NASA will next expand the data to a broader mission set, including a rerun of t-tests in the data set, and identify and isolate other variables to determine each impact. Currently, evaluators have identified the following variables as having potential impacts on performance: mission category, mission risk classification, mission complexity, technical descopes, and technical drivers.

Due to the limitation of CADRe data, mission datasets will include missions that have launched from 2001 to present. Current analysis includes only Science Mission Directorate missions, but data from other Mission Directorates will be added to data collection and analysis once available.

Challenges

Several challenges present themselves in this evaluation. The mission types explained above have historically large variations in mission performance. This indicates that there are several factors that drive cost and schedule performance. Identifying and isolating those factors will be a challenge. Additionally, the dataset being analyzed is heterogeneous in nature presenting issues with degrees of freedom.

Missions span several Agency policy iterations. Over the last 15 years, NASA has conducted several programmatic policy updates that could affect results. Additionally, it is safe to assume that NASA's process for competed missions has improved, or at least has varied on performance, within this timeframe. This temporal variable will be difficult to control for or could make for inconclusive results.

Dissemination strategies

Results from this evaluation will be communicated to NASA leadership and through one of the Agency's management forums, the Agency Program Management Council.

Timeframe

Initial data collection and raw cost and schedule performance evaluations occurred in FY 2020. The evaluation of the variables of performance will occur from FY 2021 through FY 2022.