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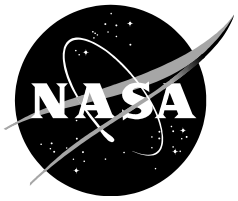

NASA Langley Transformation Plan

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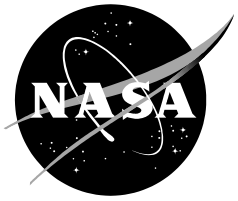

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Abstract

NASA Langley Research Center has a strong history of creating impactful contributions to the NASA mission and the Nation, working across the NASA mission directorate portfolio. NASA Langley develops and delivers innovative solutions and technologies across a diversified portfolio that includes aeronautics, space technology and exploration, and science. As NASA Langley enters its 106th year, the Center is working in a changing environment driven by the global pace of technology advancement and increased global connectivity. It is within this global context that NASA Langley leadership has recognized the need to intentionally invest in modernization efforts and established the Langley Transformation Initiative. This document outlines the Langley Transformation Initiative vision and goals. Current transformation challenges are described, and a strategy is outlined for how the Transformation Initiative plans to advance towards the transformation vision.

1. Background and Context

NASA Langley Research Center has a strong history of creating impactful contributions to the NASA mission and the Nation, working across the NASA mission directorate portfolio. NASA Langley develops and delivers innovative solutions and technologies across a diversified portfolio that includes aeronautics, space technology and exploration, and science. NASA Langley's foundational capabilities span across entry descent and landing, aerosciences, atmospheric characterization, systems analysis and concepts, advanced materials and structural systems, and intelligent flight systems.

As NASA Langley enters its 106th year, it remains an institution focused on research and technology development, yet the Center is working within a national and global environment that has greatly changed during those 100+ years. The global pace of technology advancement and adoption is accelerating, in part due to increased global access to technology and digital tools, increased connectivity ('hyperconnectivity') and technology focused investments across the globe [1]. This rapid pace of modernization and change is being driven by forces outside the Agency's gates (*domestic and international* organizations across academia, established industry, startups, and government entities).

Emerging and disruptive technologies (e.g., artificial intelligence (AI), internet of things, virtual/augmented reality, digital/social connectivity tools, data analytics, automation/autonomy) are expected to have a large influence on work, culture, and organizations over the next decade. Further, it is expected that the technology landscape in the decades ahead will consist of a non-uniform and unpredictable emergence of advancements [1]. In such an environment, research organizations must continuously adopt new tools and approaches to enhance their ability to generate impactful research and technology contributions for stakeholders. Additionally, within the national aerospace domain (particularly within the space domain) there is an evolution underway that has created new partners, collaborators, and stakeholders. The requirement for continuous adaptation goes beyond access/use of digital tools, and also requires the organization to maintain a culture that embraces partnering, continuous preparation for the future, appropriately managing risk aversion to allow and support new approaches, and

maintaining and communicating a clear vision. How organizations react to, and adapt to, these ongoing global changes will determine which organizations are impactful now, and in the decades ahead. Many institutions and corporations have identified the urgency of adapting to these changes, and a need to transform organizations is not new.

It is within this global context that NASA Langley leadership has recognized the need to intentionally invest in modernization efforts *and* efforts to empower the workforce to work more *effectively* by adopting new approaches/behaviors. These modernization efforts are in part implemented under the NASA Langley Transformation Initiative. The Transformation Initiative currently leverages a $2.5M/year budget *and* non-financial resources (e.g., influence and employee engagement) to generate changes that will enable NASA Langley to adapt to the rapidly changing research and technology development environment and to better leverage the ever-growing global knowledge base [2]. The initiative is championed by the NASA Langley Associate Center Director for Technical and executed by the Transformation Portfolio Manager. The initiative is also supported by a Transformation leadership team consisting of the NASA Langley Future of Work lead, OCIO technology and machine learning leaders, NASA Langley Enterprise Architect, and Navigator network leaders (more details on the Navigator network are provided in section 3.0).

2. Transformation Vision, Goals, and Strategy

NASA Langley Transformation Initiative's mission is to enable the Center to thrive as a modern federal research institution by working more effectively to achieve the NASA mission, while also increasing the impact of work products for the benefit of Earth's inhabitants. Looking towards NASA 2040, the Transformation Initiative vision is that the Center's processes and culture will be transformed to *readily adapt to and leverage*: 1) rapid changes in digital, computational, and artificial intelligence tools; 2) the less localized and more digitally fluid workplace environment; 3) an increased need for seamless partnering across internal and external organizations; and 4) evolving stakeholders and requirements. In this document, these four expected requirements will be referred to as Langley Transformation vision targets. Furthermore, it is imperative that the Center develop this agility for adaptation *while also* building in a fundamental cultural 'ownership' for continuous preparation for the future (across the entire matrix of organizations). This transformation will position the NASA Langley of 2040 to continue to deliver high impact research and technology for the Agency and the Nation.

As a baseline of current challenges to achieving the future state, NASA Langley transformation leaders recognize that one of the largest challenges the Center faces is an increased near-term focus across all levels of work and workforce. This shift has resulted in part from the matrixed funding and management model combined with cultural/organizational pressures. Agency budget trends and the tracking, risk, and resource management practices that have resulted from the as-implemented full-cost accounting requirements at NASA also contribute to the increasing cultural pressures for a near-term focus. This near-term focus is combined with a lack of empowerment across various levels of leadership in the matrix organization to claim 'ownership' of enabling the workforce to deliver on today's mission *while* taking steps to prepare for the future. This scenario creates a challenge to adopting new

approaches and tools and can result in a reliance on status quo approaches that may not serve to bring forth the vision for NASA Langley 2040.

It is within this challenge space that the NASA Langley Transformation Initiative has identified two guiding principles aimed at strategically enabling higher impact within the limited resources available. These guiding principles are:

1) The Transformation Initiative will maintain close ties to the Agency Digital Transformation efforts to maintain awareness of investments across the Agency in digital tools and will focus efforts, when appropriate, on aiding NASA Langley's *adoption* and *implementation* of Agency level/Enterprise tools. Maintaining close ties to Agency DT efforts also helps reduce duplication of investments for solving specific challenges, allowing NASA Langley investments to focus on gap areas.
2) The Transformation Initiative will focus on engaging and empowering the workforce to try new approaches that enable them to work more *effectively* and will focus on efforts that can help drive NASA Langley's culture towards behaviors that are required to enable a continued transformation to realize the NASA Langley of 2040.

NASA Langley's Transformation Initiative has identified five current focus areas where investment and support are required to realize the transformation vision, as shown in Figure 1.

Figure 1. Five base focus areas for the NASA Langley Transformation Initiative. Descriptions in text.

1) *Adoption of Modern Tools and Approaches* – This focus area includes digital tools (e.g., technical, business, project management), automation of processes, model-based methods, and modern project management/research/business approaches that are not digital tool focused.
2) *Knowledge Growth and Knowledge Management* – This focus area includes tools and approaches that can bring a broader breadth and greater depth of knowledge into the Center's work than would be feasible through traditional methods. It also focuses on tools and methods to improve knowledge transfer and knowledge management.
3) *Increased Connectivity* – This focus area includes methods that aid the workforce in growing their internal and external professional networks and partnership connections, as well as improvements in communication across all levels of the workforce.

4) *Work Environment* – This area focuses on the processes, policies, cultural norms, and spaces needed for a supportive and productive modern workplace environment.
5) *Transformation Culture* – This focus area includes direct engagement with leadership, project managers, grassroots networks (NASA Langley Navigators), and all levels of workforce to identify drivers and norms required to create a culture that embraces agility, adaptability, transparency, knowledgeability, and interdisciplinary connectivity.

Investment in these focus areas is considered fundamental to achieving NASA Langley transformation goals and enabling the NASA Langley future state described above. Specifically, progress *across all five interconnected* focus areas is required for Langley to progress towards the Transformation vision targets. While these focus areas may evolve with time, based on global trends, technology trends, and challenges reported by the current Langley workforce, they represent the key areas identified as critical for the path forward at this time (2023). Further, the guiding policy of empowering and engaging employees is a critical basis to these five focus areas. Studies have shown that transformation efforts globally and across fields have a high failure rate. However, it has also been shown that a key component to a *successful* transformation is engaging employees. “People are the catalysts of successful transformation” [3].

Growing and sustaining a Transformation culture is at the heart of the current focus areas, and it is expected to remain key to Transformation even as the other four focus areas may evolve over time. Fundamentally, a transformation culture is one in which the workforce at all levels takes ownership of meeting today’s milestones while *continuously* preparing for the future. The NASA Langley Transformation Initiative invests resources across these five focus areas through direct identification of Center needs/gaps (i.e., directed Transformation investments) and through solicitation, review, and selection of employee ideas.

In addition to the challenge of an increased near-term focus, a second challenge area recognized by the Transformation leadership team is the need to clearly communicate the future vision state; i.e., Transformed NASA Langley, to the workforce, stakeholders, and leadership. A tangible and inspiring vision is essential to guide ongoing decision making towards that vision and to enable individuals to better understand their role/responsibilities in making the vision a reality. Steered by studies in behavioral science on driving change and transformation [4], the Langley Transformation Initiative is currently working to engage global experts in the creation of a strategic narrative product representing the *NASA Langley transformation story*. The strategic narrative will provide a concrete visualization of the targeted NASA Langley future state. The narrative product will be shared with workforce, leadership, stakeholders, and partners. The vision narrative will inspire and guide NASA Langley workforce, leaders, and partners to create continued impact for NASA and the Nation.

Changing culture is a large feat for any large organization, especially as leadership changes occur, funding levels shift, and mission focus areas evolve. Yet, this cultural change is at the heart of the Langley Transformation Initiative. A relatable and inspiring vision that maintains relevance over a five-to-ten-year timeframe will aid in the growth and sustainment of a Transformation culture. As part of the Langley’s transformation plan, the strategic narrative

vision will be continually utilized and assessed for ongoing relevance. It is expected that the vision story will need to be updated over time.

3. Partnership and Workforce Engagement

To identify and prioritize directed investment areas, the Transformation Initiative works directly with Center leaders, including: Directorate/Organization leads across technical and mission support organizations (Research, Engineering, Center Operations, etc.), NASA Langley's Team Future (Chief Scientist, Chief Technologist, Senior Advocate for Science and Research, etc.), NASA Langley's Transformation leadership team (Future of Work lead, Langley's Enterprise Architect, OCIO leaders, etc.), and the Office of the Director. Through these close connections, Transformation Initiative leaders maintain a broader comprehension of both internal and external (national, global) practices and advancements that are relevant to transformation goals.

The Transformation Initiative also partners with organizations including the OCHCO Training Office, NASA Langley's Internal Research and Development (IRAD) program, and the Agency Digital Transformation (DT) Initiative, among others. Section 3.0 outlines the connection between NASA Langley's Transformation Initiative and the Agency DT Initiative. Partnership with the Training Office enables leveraging of additional investment funds towards the development of workforce behavioral and communication skills that have been identified by the NASA Langley Transformation Initiative as crucial for achieving the transformation vision outlined in Section 2.0. Examples include brining in national experts to instruct courses in areas such as: advocacy and impact communication, change management, and technical presentation skills.

The Transformation Initiative has also partnered with the NASA Langley Office of Chief Technologist (OCT) to create a combined IRAD and Transformative idea call. This combined call has proven effective at spurring employees to submit not only innovative ideas for early-stage research, but also ideas for new approaches to work effectively and achieve higher impact for NASA Langley's stakeholders. There is a natural synergy between innovative early research goals (pushing forward the state-of-art) and transformation goals (improving execution of research, engineering, business). The Transformation Initiative assesses ideas submitted to the Transformation Idea Portal through this call and unselected, but highly ranked, IRAD submissions with relevance to transformation goals. Further, the Transformation Initiative works with OCT to infuse new approaches into the IRAD process, such as approaches to increase principal investigator knowledgeability. In addition to the joint annual open call for ideas, the Transformation Idea Portal remains open year-round to allow employees to submit ideas when they have them. The Idea portal is open to everyone working at NASA Langley.

Soliciting ideas for employee-led projects directly engages all levels of workforce to consider how their work could be achieved more effectively. Idea solicitation also enables the influx of new ideas with enough specificity to allow assessment on the potential for impact and implementation. In terms of impact, ideas are assessed for the potential to reduce time/cost, increase impact for stakeholders, position NASA Langley to bring in new work, decrease siloing,

improve outcomes and/or improve employee experience. In numerous cases ideas funded through this route have led to the successful transfer of ideas from a NASA Langley Transformation Initiative funded activity to solutions that are now deployed/supported at the Program, Agency, or Federal Government level.

The NASA Langley Transformation Initiative also engages the workforce to achieve transformation goals by partnering with the NASA Langley Navigator network. The Navigator group is a flat, grassroots network with representatives from organizations across the center. The group enables the Transformation Initiative to maintain a direct line of communication across the workforce. The Navigator network is engaged as a resource to communicate outwardly about Transformation Initiative activities and goals from Navigator representatives to their respective organizations (e.g., branches). Additionally, the network is engaged to help flow concerns, challenges, and ideas from the workforce directly to Transformation leadership. The network helps the Transformation Initiative keep a 'realistic pulse' on everyday experiences of the workforce and can help in assessing the reach and impact of transformation activities. Additionally, Navigators serve as a grassroots network who are 'owners' of change. They directly engage to lead transformation focused discussions and activities among their teams and organizations.

Further, the NASA Langley Transformation Initiative uses directed investment to create Center-wide opportunities that help the workforce develop approaches and skills required for transformation. Two recent examples are the Knowledge Growth and Collaborative Innovation Opportunities. Both opportunities were created to target the need for the workforce to grow knowledge beyond their technical/business 'silos'. The Knowledge Growth Opportunity (KGO) funds civil servant employees to attend conferences that are related to their area of work but are 'one to two iterations' beyond their normally targeted events. The KGO has been highly successful both in terms of employee engagement and growing workforce knowledge that can be directly applied to NASA Langley's current mission work (e.g., machine learning, robotics, data analysis, high performance computing, emerging technologies, leadership, and diversity). The Collaborative Innovation Opportunity (CoIO) was created to raise awareness of existing NASA crowdsource and free-lance expert contract mechanisms that can be used to bring in a broader knowledge base to assess emerging technology trends, ideate solutions within a target problem space, or to create software/algorithm solutions. Industry and other government agencies have recognized the value of engaging curated expert crowds and currently leverage crowdsource and free-lance expert contracting at a significantly higher rate than NASA. These types of contracting options are one example where global connectivity has led to new approaches to problem solving. Such approaches can be joined/infused into the more traditional knowledge growth methods that have served research organizations over the last hundred years.

4. Connection to Agency Digital Transformation Targets

The NASA Langley Transformation Initiative focus areas listed in Section 2.0 form a fundamental basis across the Agency Digital Transformation (DT) transformation targets: Transform Discovery, Transform Engineering, Transform Operations, Transform Decision

Making [5]. NASA Langley is aligned with the Agency DT framework and is actively investing in transformation solutions across these four Agency DT target areas. The sections below discuss each Agency DT Transformation Target, give a broad overview of Center current state and recognized gaps, and provide examples of current investments that align with Agency DT Targets. Investments from across NASA Langley organizations and beyond those listed below can be found in the NASA Langley DT Alignment Matrix (submitted as part of this action response).

Transform Discovery:

As one of the NASA research centers, discovery enabling capabilities and tools are critical to NASA Langley's mission. NASA Langley's work spans across all the NASA mission directorates, and spans from early-stage research to development and technology transfer of solutions. Across this scope, the workforce relies on knowledge growth and discovery tools in the development of innovative solutions and to leverage and improve upon internal and external scientific advances. The current state of knowledge discovery includes use of available internet-based search tools and inter-library loan processes to aid literature review and discovery of potential partners/collaborators. However, budget reductions have led to a decrease in access to knowledge portals (e.g., journal portals and database platforms). Hence, continued access to knowledge sources is an area of concern. Another current gap is a need for tools that can ease the time burden and aid analysis of the growing global knowledge base. There is also a need for increased connectedness and cultural incentives to increase interdisciplinary work. The current state is also characterized by data sprawl and challenges with data access, discovery, and re-usability.

In close alignment with the Agency DT, the NASA Langley Transformation Initiative is currently investing in solutions to improve the speed, breadth, and ease of discovery. Below are a few recent examples of NASA Langley Transformation Initiative investments in this target area. These projects were funded due to recognized gaps and needs with respect to discovery:

- NASA Data Catalog – The data catalog is a searchable catalog that can enhance data discovery and re-usability. This investment has been transitioned to an Agency supported tool that is being deployed as an Enterprise solution.
- Searchable SharePoint sites – Organization and branch level SharePoint sites have been created for organizations across NASA Langley. The sites contain details of capabilities and expertise *and are searchable across the Agency* via OneNASA. The sites are intended to enhance capability discovery to increase partnership opportunities across the Center and the Agency.
- Digital Research Assistant – This project focuses on the assessment of requirements and existing tools for a digital research assistant that can aid in searching *and analyzing* scientific literature, or other sources. Such a tool could aid the workforce in more rapidly and thoroughly assessing relevant advancements and emerging trends.
- Data Architecture Assessment – The Transformation Initiative is in the first stages of undertaking a Center-wide data assessment to inform requirements that will aid in the creation of a Center data architecture plan. The intent is to improve data accessibility, re-usability, and discovery while more intentionally informing the direction of future investments in data hardware/architecture.

Transform Engineering:

The NASA Langley Transformation Initiative is investing in digital and modeling tools/methods for engineering. In alignment with the Agency DT framework, there is a recognized need to more rapidly adopt tools that enable more agile processes, complex designs, and interoperable systems. The current state of engineering is characterized by digitized (but not necessarily digital) processes and initial adoption of model based and digital tools. The tools being adopted vary by group, with a variety of solutions being used for similar problems/purposes amongst different groups internal and external to the Agency. A key gap is the need for modeling tools and test systems that can connect to a digital platform that can span concept to testing to provide a real-time/authoritative source of data and enable multi-center and multi-disciplinary partnering, while also providing opportunity for systems level analysis and a 'plug and play' approach for unique models. The development of an Enterprise-level solution may require Agency level leadership and investment across multiple programs to result in an Agency scale digital engineering platform. However, the NASA Langley Transformation Initiative and organizations on Center such as the NASA Langley Engineering Directorate are investing in the adoption of emerging tools /approaches that will help to modernize engineering work and will feed into the type of Enterprise solution described above.

Below is a list of a few recent examples of NASA Langley Transformation Initiative investments in this target area.

- Augmented and Virtual Reality (AR/VR) for Testing – AR/VR tools can enable real-time feedback during testing. Preliminary investment in these areas at NASA Langley has shown that such tools can enable improvements in data gathering by enabling test changes in real-time based on test data output. Use of such tools is also expected to result in time/cost savings, enabling remote testing and an improved experience for customers, as well as decreasing test workforce burnout during long tests.
- Model Based Frameworks – The NASA Langley Transformation Initiative has invested in multiple modeling framework focused projects, including work focused on the development of integrated frameworks that can connect models, uncertainty quantification, and parametric analysis, as well as work focused on assessment and adoption of modern modeling tools for engineering.

Transform Decision Making:

The Agency DT goal to accelerate risk-based and evidenced-based decision making most closely aligns with the NASA Langley focus area of knowledge management, but also directly relates to efforts to improve connectivity and cultural transparency. As stated in the Agency DT framework, decision making in this instance refers to all levels of decision making from program and project management to executive level decisions. It is also recognized that transforming decision making requires: 1) digital tools to enable access and analysis of the relevant data, 2) connectedness that enables engagement of the right decision makers and experts in a timely manner, and 3) processes/tools that naturally result in a transparent and digitally documented decision process. The current state often relies on digitized (not digital) processes, non-real time data sources, 'decision by PowerPoint', and a lack of analytic tools to readily identify the right fidelity in level risk and forecasting.

Below is a list of a few recent examples of NASA Langley Transformation Initiative investments in this target area.

- Smart Projects and Reviews with Transformative Analytics (SPARTA) – NASA Langley's Transformation Initiative continues to partner with other centers and Agency DT in investing in this project management tool, aimed at providing easier analysis and assessment of project management data, including risk.
- Common Data Structure for Project and Program Management – It is recognized that digital decision-making tools/platforms will require ingestion of data. This project is focused on defining a common data structure that is responsive to the requirements of NPR 7120 and 7123, with an intent that such common data structures will be necessary to feed into decision making tools. The Game Changing Development (GCD) Program will recommend use of the resulting common data structure across GCD funded projects.

Transform Operations:

The NASA Langley Transformation Initiative is investing in methods to improve the efficiency and effectiveness of operations processes. The current state is that many operations functions are managed at the Agency level by mission support organizations (e.g., OCHCO, OCIO, etc). The current organizational structure can lead to silos and challenges in how those organizations identify how to prioritize work. The results of this current state are felt by Centers and the workforce. Day-to-day operations of facilities is managed at the Center level, and budget constraints lead to challenges in this area. In alignment with Agency DT, it is recognized that there is a need to further adopt Enterprise business solutions, a service model optimized for customer experience, and modern effective and efficient processes. A current challenge is the need to enable rapid adoption of modern information technology tools combined with a cyber-security posture that is focused on enabling agility and adaptability (rather than a restriction-based posture), while meeting security requirements.

Below is a list of a few recent examples of NASA Langley Transformation Initiative investments in this target area.

- Facility Efficiency Data Analysis – Development of automated tools to analyze facility data to determine power and cooling efficiency. Specifically, this project focuses on the Computational Research Facility at NASA Langley to evaluate data center efficiency to aid data-informed future decisions on data facility costs and consolidation.
- Smart Center – The NASA Langley Transformation Initiative continues to invest in Smart Center capabilities focused on leveraging modern approaches and automated analysis to enable a proactive approach to maintenance with the goal of reducing safety hazards while also reducing down-time of critical facilities.

5. Transformation Timeline and Metrics

The Langley Transformation Initiative was started in 2018 with an initial primary focus on adoption of new technologies and digital tools. Since its inception, the initiative has evolved to focus on addressing the broader challenge of enabling an adaptable workforce and work environment that continuously prepares for the future. Transformation leaders expect that the need for investments and efforts that continuously modernize the work, work environment and workforce will not hit an ending point at some future date. Rather, as the Transformation culture is realized, it will require ongoing efforts to sustain. Further, since the decades ahead will likely

include an unpredictable emergence of advancements, there will be an ongoing need to enable NASA Langley to continuously test and adopt new tools and work approaches.

The NASA Langley Transformation Initiative has worked to identify appropriate metrics to assess the impact of investments, track successful adoption of enterprise solutions, and to track progress towards the targeted culture and future vision state. Metrics related to return-on-investment can be directly tracked for Transformation funded workforce idea projects and directed investments that are focused on new ways of working or adoption of new tools. For example, project leads track and report lessons learned, resulting impact to the organization/mission (e.g., resource savings, improved results, etc), and any sustainment plans for the new capability/tool. During the last 5 years, the Transformation Initiative has invested in numerous pilots, proof-of-concept studies, and implementation projects. These investments have resulted in a variety of advancements that enable NASA Langley to work more effectively. Many of the investments have resulted in updated approaches or tool adoption by NASA Langley workforce. Several have resulted in the transition of Transformation funded projects to Center-wide, Agency-wide, or Government-wide adoption. Examples include Agency level adoption of tools such as a data catalog tool, a workforce mentor matching tool, and government-wide adoption of a procurement compliance search tool (889 compliance). Additionally, the Langley Transformation Initiative works to enable the efficient adoption of enterprise tools and will track the successful adoption of Agency tools as they become available (examples expected in the near-future, enterprise tools being developed under OCIO and Agency DT for data sharing, access to cloud platforms, and project management tools).

Further, in terms of tracking progress towards the targeted future vision and cultural state, the initiative will rely on: 1) tracking of NASA Employee Viewpoint Survey (EVS) data that has direct connection to transformation goals, 2) direct feedback from the workforce both through grassroots networks and through leadership feedback for their organization. An example of Transformation-relevant EVS data is tracking NASA Langley employee feedback on the question “I feel encouraged to come up with better ways of doing things”. The ability of employees to come up with better ways of doing things is directly connected to their ability to prepare for the future (in contrast to feeling unable to move beyond status-quo approaches). Finally, a key metric to the progress and success of the Transformation Initiative will be measured by Langley’s ability to continue to bring in work, innovate, and provide impactful results for the NASA mission. This final metric is directly connected to the Transformation vision targets and the five focus areas.

6. Summary

The NASA Langley Transformation Initiative aims to help NASA Langley prepare for the future and adopt modern techniques and tools that enable the workforce to work more effectively while creating high impact results. The complexity of transforming an organization within a limited budget has led to a strategy that is focused on workforce engagement and targeted investment. The Langley Transformation Initiative is also focused on aligning with Agency Digital Transformation efforts and leveraging partnerships and enterprise solutions. Additionally, efforts are underway to create an environment in which NASA Langley work,

workplace, and workforce can evolve towards a future state where adaptability and agility in a changing global environment enables NASA Langley to continue meeting customer needs while creating high impact for the Nation.

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