Shaping the Future of NASA Systems Engineering: Leveraging Voice of the Customer Insights for Agility, Innovation, and Partnership

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***Abstract* — As part of our ongoing commitment to advance NASA's Systems Engineering discipline and enhance our commercial partnerships, the NASA Engineering and Safety Center recently conducted a Voice of the Customer interviews to capture insights from end users, stakeholders, program teams, and commercial partners. Voice of the Customer initiatives play a critical role in aligning services with evolving user needs and stakeholder priorities, ensuring that Systems Engineering solutions remain relevant, effective, and user centered. By analyzing and prioritizing the feedback gathered, we intend to refine our SE methodologies, addressing critical requirements, targeting areas for improvement, and adapting our processes to stay ahead of emerging challenges. This feedback driven agile approach ensures that NASA's Systems Engineering practices are responsive not only to public and user expectations but also to the rapidly evolving landscape of commercial innovations and industry needs. The insights gained from this Voice of the Customer interviews are expected to inform NASA's Systems Engineering improvement efforts and provide valuable lessons to a broader audience facing similar challenges within governmental and industry sectors. This paper presents key findings from the interviews, the impact of stakeholder feedback on refining Systems Engineering practices, and the ongoing improvement opportunities. Through this collaborative and iterative process, we aim to foster a more agile and adaptive SE framework that supports both current and future missions.**

Keywords—agile, systems engineering, commercial partners, decision making, innovation, partnerships, customers, collaboration

Acronyms

AFRC	Armstrong Flight Research Center
APL	Applied Physics Lab
GSFC	Goddard Space Flight Center
HQ	Headquarters
JPL	Jet Propulsion Lab
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NESC	NASA Engineering and Safety Center
SE	Systems Engineering
TDT	Technical Discipline Team
VoC	Voice of the Customer

I. Introduction

The NASA Engineering and Safety Center (NESC) performs independent assessments and provides technical expertise to NASA projects and programs via Technical Discipline Teams (TDT), which are led by NASA Technical Fellows who provide capability leadership. This includes a yearly assessment of the state of the discipline and the NASA Systems Engineering (SE) TDT has been using Voice of the Customer (VoC) interviews to inform the discipline's strategic and tactical initiatives. A recent VoC centered on agile teams across the Agency showed the need for advancing the speed of agile adoption and implementing lessons learned from these teams to help guide current processes and applications in systems engineering [1]. Key recommendations from that early study involved the formulation of the NASA Agile Community of Practice and a year report highlights the community's ongoing efforts to advance agile values and principles, improve practices, and foster innovation within teams across NASA centers [2, 3].

The 2024 NASA SE TDT led another VoC set of interviews, this time collecting insights from a diverse audience that included NASA personnel, commercial partners, and other contributors such as academia, tool vendors and other government agencies [1]. NASA participants included employees from Johnson Space Center (JSC), Goddard Space Flight Center (GSFC), Headquarters (HQ), Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Jet Propulsion Laboratory (JPL), Langley Research Center (LaRC) and Armstrong Flight Research Center (AFRC). Commercial partners participating in the interviews included but not limited to Applied Physics Lab, Astrobotic, Axiom Space, Boeing, Blue Origin, Firefly, Intuitive Machines, Lockheed Martin, Northrop Grumman, Rocket Lab, Sierra Space, SpaceX, Starlab, and United Launch Alliance.

Interviews were conducted and results compiled independent of NASA personnel. The VoC focused on key areas of SE and commercial partners relationships, gathering feedback from 116 participants, 75 of whom were commercial partners, with 85% of the latter being from new space companies. This

diverse representation provided a broad sample of perceptions on SE performance and its collaboration dynamics.

II. Methods

A diverse population of SE customers were interviewed over the summer of 2024 by a third party to provide perspectives on NASA's SE discipline health, investigate trends, challenges, and potential improvement opportunities. The customer pool included program managers and SE practitioners both internal and external to the Agency, and smaller sample populations to provide expanded information on expectations, external alignment, and newer digital tooling opportunities. Weighting of the population focused heavily on newer more innovative commercial acquisition models to understand if and what changes might be required in the SE response.

Interviews were conducted via phone and virtual Teams meetings. One on one interviews were chosen in lieu of surveys to provide more qualitative richness and specificity in the end product. This was achieved through follow up questions and more personalized query into the responses. Additional interviewees were added to the pool based on suggestions from the initial list of participants and used to further investigate or validate specific findings or trends.

Interview questions were a balanced mix of both open ended and close ended inquiries, purposefully designed to elicit detailed understandings, specific information, and unbiased responses. Some questions were also tailored based on the customer relationship and their connection to the SE service being provided. Participants were asked to prioritize expectations of SE support based on previous insights and discussed how these expectations had evolved over time. They addressed the productivity, communication, and relationship dynamics between NASA and commercial partners, with a focus on evaluating the effectiveness of insight, oversight, requirements quality, systems engineering response, etc.

The interviews delved into where NASA's SE provided the most help versus hindrance, probing specific examples and prioritizing areas needing improvement. Key challenges to enhancing SE efficiency, such as speed and commercial partner collaboration were explored as well as organizational plans to address them. The adoption and evolution of advanced SE techniques since 2019 were also examined, with participants providing examples and their interpretation of advanced techniques, thus attempting to avoid any bias toward digital tooling specific innovations.

Agility was another key area of interrogation, assessing NASA's readiness to work with agile commercial companies, rating both entities capability, and identifying needs and priorities for broader agile adoption. The interviews concluded by soliciting recommendations for additional interviewees and inviting input on any unaddressed issues, ensuring a thorough and unbiased exploration of stakeholder perspectives.

III. Key Findings

A. *NASA's Technical Expertise*

Technical expertise at NASA is recognized by 62% of commercial partners as a significant benefit, NASA's technical resources and knowledge sharing were highly valued, confirmed by 90% of the participants.

B. *SE Improvement Trend*

42% of participants saw improvements in NASA's SE approach sustaining the trend [2023 (43%), 2020 (44%)] from prior studies, though some areas, such as decision making velocity, remain stagnant or declining.

C. *Alignment Issues*

Only 29% of commercial partners felt well aligned with NASA, while 50% reported mixed experiences. Key challenges included slow decision making (20%), procurement issues (20%), and overly prescriptive requirements (15%).

D. *Need for a Commercial Approach*

There was universal agreement (64%) that NASA's bureaucracy, contractual constraints, and slow decision velocity hinders commercial partnerships. 39% of respondents urged NASA to adopt a more commercially driven model, prioritizing flexibility (41%), communication (32%), and responsiveness (20%).

E. *Communication Gaps*

Both NASA and commercial partners identified communication as an area needing improvement, with 39% highlighting the need for better coordination and transparency.

IV. Improvement Opportunities

The findings showed growing expectations and concerns from NASA commercial partners regarding NASA's evolving relationship with commercial industry. As NASA becomes more commercially driven, commercial partners emphasize the importance of flexibility, collaboration, and strong communication. Improvement opportunities are summarized in three sections:

A. *Adopt a Commercial Model*

Commercial partners stress that NASA needs to adopt a more commercial mindset, treating its programs like a business with greater flexibility. Commercial partners highlight that NASA's contracting practices vary across the Agency. There is also concern over NASA applying the same requirements to commercial programs as it does to traditional government programs. NASA must continue to align SE efforts with insight and oversight suited to the contract procurement strategies. Commercial partners would like NASA to embrace a business like approach and improve its communication processes,

including more coordinated forums for collaboration and establishing clear requirements by streamlining processes and improving clarity in expectations related to risk sharing and mitigation.

B. *Speed Up Decision Making*

Faster processes are needed, particularly at key centers, to meet commercial partners responsiveness expectations. There is a call for NASA to learn from the commercial sector, especially in adopting best practices for efficiency and speed. Commercial partners suggest that NASA should be more open to using more innovative approaches, tools, and processes, such as agile, Digital Engineering and advanced SE practices, to improve productivity and efficiency. Many commercial partners suggest that having integrated teams working side by side leads to more cost effective and efficient outcomes. They also express concerns over NASA's slow decision making process, citing the need for more agile, commercial like decision making and a single point of contact from NASA. There is also a push for increased agility, with commercial partners urging NASA to adopt and pilot agile methodologies to streamline processes and decision making.

C. *Strengthen Communication*

Commercial partners seek clearer and more consistent communication with NASA, especially around roles and risk management. Commercial partners emphasize the importance of setting clear expectations early on in partnerships. They note that good relationships take time to develop, and early alignment on strategy, team agreements, and principles can help avoid issues later in projects. Managing expectations and communication is crucial for effective collaboration.

V. Implementation

The results from the VoC interviews are crucial in shaping NASA SE's future direction. After analyzing the data, the Agency SE TDT held meetings with the newer commercially focused program managers to review key findings and insights specific to their programs and their acquisition intent. These results highlighted customer expectations and areas for improvement. At the same time, the detailed findings were shared with the Agency SE TDT and the Agile Community of Practice, sparking discussions to validate the data and propose next steps.

These insights are now driving targeted improvements and informing tactical and strategic planning across NASA's SE processes and workforce. This includes the recent revision of the NPR 7120.5 NASA Spaceflight Program and Project Requirements, a soon to follow revision of NPR 7123 NASA SE Processes and Requirements, and an expansion to the Getting Started with Agile resource. In parallel, coordination with the interview participants is ongoing to validate plans, alleviate issues, and prioritize improvement opportunities.

In all of this, the most important focus is communicating these results to the frontline program and SE workforce, where the lion share of the work happens. This more quickly and effectively allows adjustments to be made that mitigate both technical and programmatic risks to NASA programs, missions, and partners.

VI. Conclusion

This VoC interviews provided insights into how NASA SE should evolve in this era of digital transformation and deepening commercial partnership. Commercial partners expect NASA to evolve toward a more commercial, flexible, and efficient model, focusing on collaboration, agility, and adopting industry best practices. Clear communication, stronger systems engineering, and faster decision making are central to improving NASA's relationships with commercial partners. Customer insights shed lights to the need for incorporating agile approaches to enhancing NASA SE. These findings drive a SE call for action where agile transformation should be one of the highest priorities to continued mission success.

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