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NASA's Hopes and Fears of Digital Engineering

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Abstract. Missions and research objectives at the National Aeronautics and Space Administration (NASA) continue to increase in scope and complexity while under austere schedule and budget constraints. Digital transformation is a key enabler for NASA to do more with less. But as many large and storied organizations are experiencing, the rate of digital transformation is as much a social problem as a technical one. Contributing social factors include the distribution of the inherent willingness of individuals to adopt new technologies and the natural tendencies of like-minded individuals to succumb to groupthink within their communities of practice. A team of NASA systems engineers recently attempted to identify and expose those tendencies and kick-start more productive dialog in the area of digital engineering by leading a group model building session using community-based system dynamics approaches at the 2024 NASA Systems Engineering Workshop, which included over 400 participants. This paper captures the approach, results, and findings of this ambitious experiment.

Keywords. Digital engineering, MBSE, group model building (GMB), community-based system dynamics (CBSD).

Introduction

As stated in INCOSE Vision 2035 (2022):

By 2035, systems engineering will leverage the digital transformation in its tools and methods, and it will be largely model based using integrated descriptive and analytical digital representations of the systems. Systems design, analysis, and simulation models, immersive technologies, and an analytic framework will enable broad trade-space exploration, rapid design evolution, and provide a shared understanding of the system throughout its life cycle.

This aligns well with how the National Aeronautics and Space Administration (NASA) is actively engaged in a comprehensive digital transformation, which the Agency is counting on to enable broader and more complex missions. As is detailed in NASA's Digital Transformation Strategic Framework & Implementation Approach (NASA, 2022), digital transformation must enable our workforce and processes to be

increasingly partnered, fast, affordable, transparent, and inclusive. The Agency is focusing on a robust technical implementation supported by infrastructure to support the workforce in their own personal transitions through the likes of training, development activities, communities of practice, and written guidance. All of that will only be as good as the cultural shifts that need to happen along the way, which in many regards depends on the tendency of each individual to adopt change (Rogers, 2003).

The authors of this paper recognized the diverse spread across NASA of the willingness to adopt new digital engineering (DE) approaches, that DE advocates and detractors will naturally self-isolate, and that progress will be halted until communication among the groups resumes. We also saw an opportunity to ignite these needed conversations by facilitating a community-based systems dynamics (CBSD) exercise at a broadly-attended internal event – the NASA Systems Engineering Workshop 2024. The goal was to gauge the readiness of the NASA systems engineering (SE) community for DE, start the conversation among believers and skeptics about things that need to happen for DE to be fully adopted, and to help either ‘side’ empathize and understand the hopes and fears of the other. This paper walks through the approach used at the workshop: a brief overview of DE with insight into echo chambers and the concept of the innovation adoption curve, followed by the results from questions that elicited the feelings of the participants when asked about their hopes and fears when faced with implementing DE.

Digital Engineering at NASA

Digital Engineering (DAU, 2024) is:

An integrated digital approach that uses authoritative sources of systems' data and models as a continuum across disciplines to support lifecycle activities from concept through disposal.

This definition can be deconstructed according to Figure 1. Elements of Digital Engineering. An integrated digital approach goes beyond the digitization of files by discretizing information such that both computers and humans can directly and dynamically interact with it. The resultant information elements are connected to conceptually related information while consistency is maintained across digital threads. Standards for authoritative sources of truth are maintained such that the information is official, controlled, trusted, and accessible. The goal is a comprehensive and cohesive digital environment that is interdisciplinary and supports the entire lifecycle.

The primary digital transformation goals within NASA’s Engineering domain center around the more effective data-centric flow and management of information in support of standardized engineering and business/institutional processes and workflows (with the required data/information constructs and meta data needed for maximum benefit). Using integrated toolchains and associated digital threads across the system lifecycle will enable programs and projects to decrease the time required to define mission architectures and designs, reduce design errors and later rework, facilitate change impact analysis, and enable data-centric management of all data and information associated with engineering products, services, design, and associated artifacts (Hill, Nicoli, Pierce, Woodham, & Gati, 2024).

Specific to SE, the adoption of model-based systems engineering (MBSE) is advancing on a project/program-basis, including mission- and campaign-level architecture, as NASA Digital Engineering Program Manager Terry Hill discussed for the Moon-to-Mars Campaign at the INCOSE International Symposium (Hill, Carnevale, Morris-Eckart, Sundaram, & Farhaj, 2024).

To better understand the Agency’s MBSE workforce maturity, processes, and tool usage, a multi-phase application of the INCOSE Model-Based Capability Matrix maturity assessment was conducted. The overall finding is that there are projects at NASA operating at very advanced levels of MBSE capability maturity, the institutional capability, and what is more typically in practice, are more in the nascent ‘ad-hoc’

and ‘Targeted Application’ stages of maturity. These efforts and the results are documented in the proceedings of the INCOSE International Symposium 2024 (Pierce, Nicoli, Hill, & Cornford, 2024).

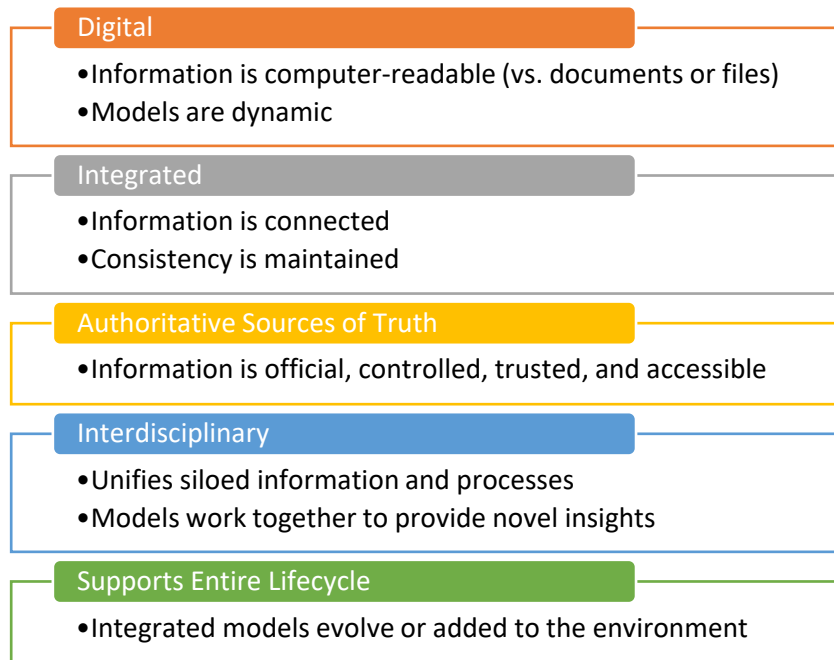


Figure 1. Elements of Digital Engineering

NASA Systems Engineering Workshop

The NASA Systems Engineering Workshop is an annual hybrid gathering of SE practitioners from all ten NASA centers; there were over 400 participants at the 2024 workshop hosted by NASA’s Glenn Research Center in Cleveland, Ohio. This is strictly an internal event that is limited to NASA civil servants and support contractors, as a primary objective is to foster candid conversation among peers to improve the practice of SE within NASA. Ideal participants are passionate about SE, interested in improving the SE community, and willing and likely to share the insights and lessons learned gained from this opportunity with practitioners in their home organization. The workshop program is designed with the mid-career practitioner in mind, but it does include attendees from the full spectrum of experience, including early career engineers all the way to senior practitioners.

As a single-track, multiday commitment focused on SE, the workshop presents a unique opportunity to get unbiased feedback and to capture community feedback from the full spectrum of SE practitioners at NASA. If participants were given the choice to participate in a facilitated session on DE, those who are less interested in the topic would be correspondingly less interested in attending.

Session Motivation & Inspiration

Digital Engineering Echo Chambers. An echo chamber is a social phenomenon where like-minded individuals interact predominantly with each other, either through self-selection or through external influences (such as social media algorithms). The result of this isolation is the conclusion that one’s own opinions are much more common than they really are since most of the people they interact with agree with them. The situation is a severe detriment to establishing the common ground throughout a community

needed to affect change and progress. This echo chamber effect can be seen in large organizations, like NASA, regarding DE.

Projects that adopt advanced DE approaches are formed by early-adopters of the technology and grow new practitioners. MBSE practitioners form communities of practice and meet regularly. They share their excitement about each new capability developed. These practitioners work together to calculate a valid return on investment. Modelers and DE advocates become collectively enthralled over the improved rigor, the time-savings, and how much more can be accomplished with a smaller team. And they cannot fathom why everyone else have not implemented their way of business.

Meanwhile, those less inclined to adopt new technologies find themselves on document-based projects with mostly other non-DE converts. Skeptics are not interested in joining an MBSE community of practice and are much less likely to attend training or seminars on the topic. They do not appreciate any return on the investment and perceive significant upfront costs. Their tendency is to let others take the risks associated with trying new things. Many are convinced that implementation will take much more time, either personally or for the project schedule, than is available. And some of them have significant negative impressions from failed attempts to adopt new approaches in their past.

There are strongly held opinions on both sides of the divide and with this tendency to self-isolate, mutual understanding and true progress is hindered. This is the primary motivation for this exercise – to break down these echo chambers, to ignite conversations, and to encourage empathy between believers and skeptics. The need here is bidirectional – the believers need to hear what the skeptics have to say as much as the reverse.

Hopes & Fears. The inspiration for this session came from the INCOSE 2023 International Symposium panel entitled *The Innovative Edge of Participatory Methods in Systems Engineering* and moderated by Jennifer Russel. The panel discussed the value of methods to gather input from large assemblies and demonstrated them with the use of live polling. Specifically, it was panelist Dana Polojärvi, a professor at the Maine Maritime Academy, who suggested the use of group-model building (GMB) and community-based system dynamics (CBSD) in a SE context. He also made a point that resonated strongly with the efforts to digitally transform engineering at NASA – facts often do not matter if you have not paid attention to their hopes and fears (Polojärvi, 2023).

The use of “hopes and fears” was a reference to a GMB script developed by George Richardson and David Andersen and documented in the wiki-book *Scriptapedia* (2019). The Hopes and Fears GMB script is a divergent-thinking technique meant to be used as part of a larger GMB session. The basic idea is participants are asked to capture their hopes and fears individually on sticky-notes. The moderator would then lead the group in the sorting and analysis of the results, which would then be used as a basis for more in-depth conversations. When applied to the NASA SE Workshop, the idea was to scale this hands-on exercise to something conducive for hundreds of participants while still sparking much needed conversation.

Process

The session began with a brief introduction to what DE is and why some at NASA are excited by the growing implementation of it. As a SE event, a deeper overview of MBSE was also given. This emphasized that MBSE supports the existing products and processes to add consistency, clarity, and connectedness to both. The session motivation was discussed in terms of breaking down echo chambers and the importance of addressing hopes and fears before engaging in fact-based debate. The session was then handed over to the control of the session facilitator who further stressed the importance of open-mindedness and safe, candid dialog.

The exercise itself was introduced to participants as:

- Process
 - Identify your tendency to adopting DE
 - Consider and share your Hopes for DE
 - Consider and share your Fears for DE
 - Empathize with others
- Expected Outcomes – for Skeptics
 - A better understanding of the excitement
 - Reduced resistance to change
 - Identification of specific next steps
- Expected Outcomes – for Believers
 - A better understanding of resistance
 - Identification of specific concerns to address

Practically, that meant participants would determine where they fit on the innovation adoption curve, capture their hopes and fears for DE, and attempt to predict what some of the emotions of the ‘other side’ are. They would do this in about five minutes on a provided worksheet, which was important to allow people to capture their personal ideas before being influenced as results are collected live. Each set of information was collected in a series of live conference polls. After some brief full-room discussion, the participations were asked to discuss what they saw in the live polls and to write down a personal action.

Introducing the Innovation Adoption Curve

The innovation adoption curve is a concept from the Diffusion of Innovations theory first defined by Everett Rogers in his book *Diffusion of Innovations* (Rogers, 2003). The theory predicts how new ideas, practices, and technologies spread through a population. It postulates that individuals each have a natural tendency to adopt or change that can be described by a spectrum from innovators to laggards, and that the distribution of these tendencies will follow a normal distribution called the innovation adoption curve – see Figure 2.

At the extreme, Innovators are the unique visionaries who provide the initial spark of inspiration and commit their lives to making their dreams a reality; consider what Steve Jobs did for the smartphone. The more moderate members of the Innovators group are the driven enthusiasts and are willing to help make things happen, even before technologies are ready for production. They want the technology and are willing to make it happen for themselves if the market is taking too long to provide it.

The Early Adopters are excited to reap the value of a new technology, even if they are not willing or able to make the change happen themselves. These people have a need to be on the edge of progress and are willing to endure some degree of pain to achieve it. It was Early Adopters that would stand in long lines hoping to get one of the first smartphones instead of waiting a week or two before they were broadly available. It is also these Early Adopters that Geoffrey Moore claims, in his book *Crossing the Chasm* (Moore, 1991), are critical in capturing before attempting to convert more conservative elements of a population.

The next two groups represent the Majority. The Early Majority recognize and believe in the value of a new idea or technology, but they are not willing to take risks and go out of their ways to adopt it. The Late Majority are even more conservative, who tend to be neutral to the value of the change. They will adopt the technology eventually once they see that it is established as the norm.

Finally, the Laggards will only adopt a new technology as a last resort. They struggle to see the value of change and may hold strong opinions against it. These are the people who will only buy a smartphone when the phone companies stop making flip-phones.

A common representation of the innovation adoption curve defines the groupings along standard deviation delineations. For this exercise, a version was used with five evenly spaced sections. This choice was made

to facilitate a simple self-identification by splitting each group in half and allowing a 1-10 selection. Technically, this was needed for the live polling conference tool to create a live histogram of the responses. It also meant we had a clear delineation between “Believer” (1-5) and “Skeptic” (6-10).

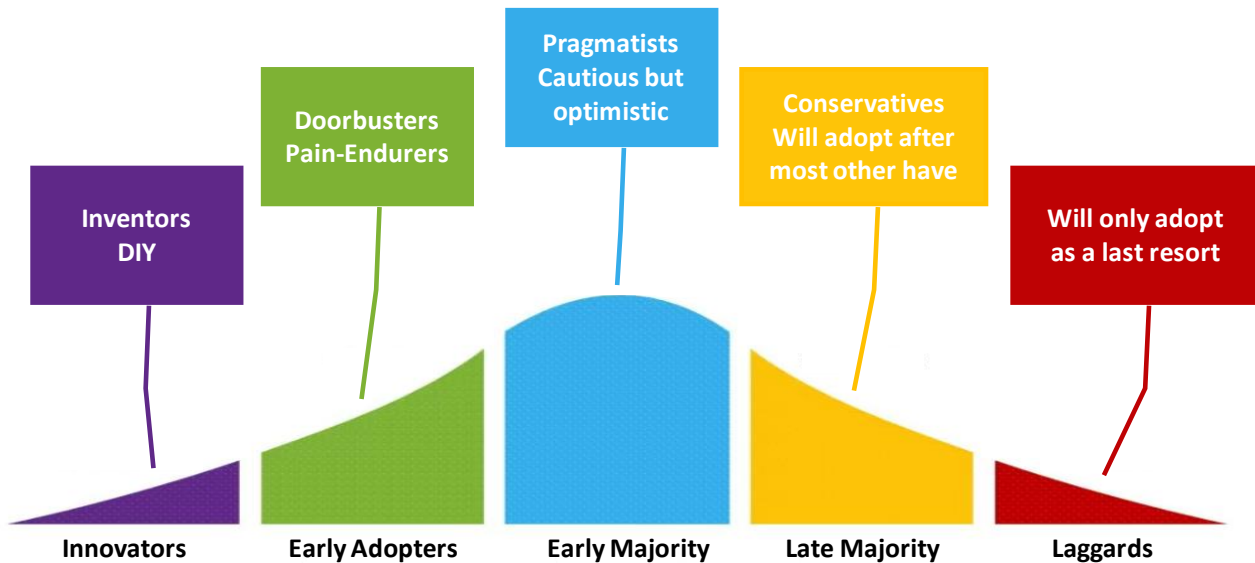


Figure 2. The Innovation Adoption Curve

Eliciting Participant Hopes & Fears for Digital Engineering

Participants captured their hopes and fears for DE individually on their provided worksheets during a five-minute window. They then took turns inputting them electronically in the conference polling tool using their mobile phones or other devices. As entries were posted, a word cloud (a visual representation of a set of words that places emphasis on frequently used concepts; see Figure 4) was dynamically generated by the conference tool and was presented live. Instructions were provided to use one-word entries, as the word cloud would treat each word in a phrase individually. Hyphenation was offered as a workaround for short phrases. Individuals could enter as many words per poll as desired. Because results were presented dynamically, participants could ‘copy’ the words of others, creating extra emphasis on key ideas and generating a desired group-think effect.

There were six Hopes and Fears polls in all:

1. Believers’ Hopes
2. Skeptics’ Hopes
3. Skeptics’ Impressions of Believers’ Hopes
4. Believers’ Fears
5. Skeptics’ Fears
6. Believers’ Impressions of Skeptics Fears

Results

The results from the live exercise are presented here. The top results are either reproduced or presented using the graphics of the conference polling tool. As an experiment in the applications of generative artificial intelligence (GenAI), attempts to summarize using available chat-based AI tools are also presented.

Innovation Adoption Self Assessments

The results of the live poll on where each NASA SE Workshop participant self-identifies on the innovation adoption curve for DE are shown as a histogram in Figure 3. The results are in the range of expectations. The curve is in the family of a normal distribution but is biased left of center. Of the 232 that participated in this poll, 71% are on the believer side of the spectrum, but two-thirds of those are in the 4-5 range. Theoretically, these individuals will adopt DE willingly, but they will not make it happen, they will not be the first to try it, and they will wait until things are proven and ready. This slight believer-bias of the participants may be a true reflection of SE at NASA, but it may represent some selection-bias in participants. It is possible the NASA SE Workshop selection process, which targets mid-career SE with a passion for systems engineering and a desire to improve it across the Agency, may favor DE believers.

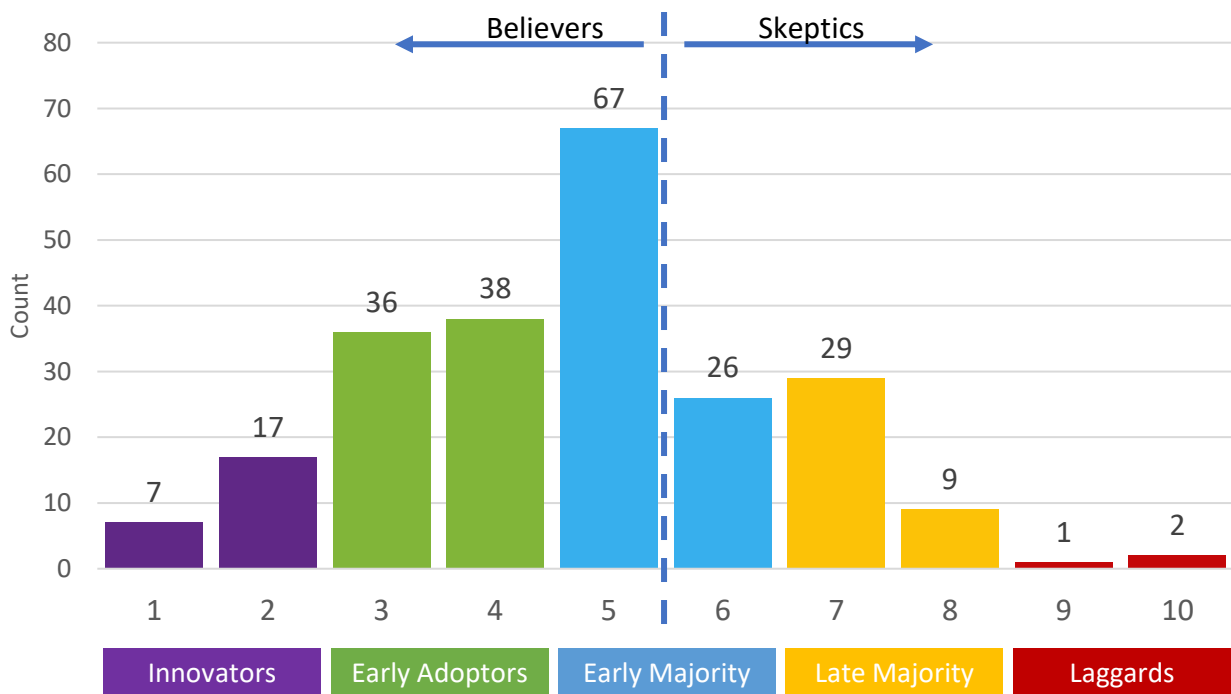


Figure 3. NASA SE DE Adoption Curve

Participant Hopes & Fears

A word cloud was generated live during the session and displayed on screen for each hopes-and-fears poll. Many of those are presented here below.

Believers’ Hopes. The word cloud of believers’ hopes for DE is in Figure 4. The AI-generated categorization of this prompt is in Table 1. Summary of Believers’ Hopes. While many believers are motivated by being on the cutting edge, they are more prominently looking forward to being more efficient and effective.



Figure 4. Believers’ Hopes for Digital Engineering

Table 1. Summary of Believers’ Hopes

Term Category	Count	Example Terms
Efficiency	41	Efficiency, Efficient, Time-saving, Streamlining, Optimize
Integration & Connectivity	20	Integration, Connected, Collaboration, Teamwork, Synergistic, Interoperability
Transformation & Progress	15	Transformative, Progress, Innovation, Growth, Advancement
Accessibility & Ease of Use	14	Accessible, Easy, User-friendly, Simplicity, Clarity
Knowledge & Understanding	9	Knowledge, Insightful, Comprehension, Transparency, Truth
Productivity & Effectiveness	8	Productive, Effective, Deliverables, Done correctly, Actual Progress
Positive Sentiment	8	Positive, Optimistic, Inspired, Hopeful, Excited
Specific Pain Points	5	No-more-SE, Non-duplication, Error-reduction, Time-saver, Quick-solving
Other	10	Unique terms that don't clearly fit into the above categories

Skeptics’ Hopes. The word cloud of skeptics’ hopes for DE is in Figure 5. The AI-generated categorization of this prompt is in Table 2. Summary of Skeptics’ Hopes The skeptics also look forward to increased efficiency, but to a lesser degree. Similarly, they also hope for positive change, but use more qualified terms, such as “good-enough”, “promising”, and “improve” compared to the believers’ use of “transformative” and “progress”. The areas of truth and consistency are also more prominent in the responses of the skeptics; this may indicate they tend to be more concerned with the things that could go poorly with DE.



Figure 5. Skeptics’ Hopes for Digital Engineering

Table 2. Summary of Skeptics’ Hopes

Term Category	Count	Example Terms
Efficiency & Streamlining	15	Efficiency, Streamline, Effort, Convenient, Value-added
Integration & Connectivity	9	Integration, Connected, Single-source-of-truth, Commonality, Holistic
Positive Change & Improvement	8	Transformative, Improvement, Good-enough, Innovative, Positive
Accessibility & Ease of Use	6	Accessibility, Access, Useful, Clarity
Truth & Consistency	6	Consistency, Truth, Fidelity, Single-source-of-truth
Concerns & Skepticism	6	Apprehension, Vulnerable, Flat-Earth, Inconsistency, Unaccountability, Risk
Other	15	Unique terms that don't clearly fit into the above categories

Skeptics’ Impressions of Believers’ Hopes. The word cloud of skeptics’ impressions of believers’ hopes for DE is in Figure 6. The AI-generated categorization of this prompt is in Table 3. Summary of Skeptics’ Impressions of Believers’ Hopes The first observation is that while we were asking the skeptics to be empathetic and genuinely consider what the believers might be trying to get out of DE, what we got was much more of a critique of the believers. There is a strong theme of the believers being naïve and overly optimistic. There is even an implication that believers are inexperienced, so further research into whether a correlation exists there is potential forward work.



Figure 6. Skeptics’ Impressions of Believers' Hopes

Table 3. Summary of Skeptics’ Impressions of Believers’ Hopes

Term Category	Count	Example Terms
Naive & Overly Optimistic	24	Naive, Overhyped, Optimistic, Unrealistic, Rainbows-Unicorns, Hopeful (used skeptically)
Hopeful & Ambitious (Neutral/Positive)	11	Hopeful (used genuinely), Ambitious, Opportunity, Eager, Aspirational
Skeptical & Uncertain	7	Skeptical, Unlikely, Disaster, Impractical, Good luck, Prove-it-works
Other	13	Inexperienced, Rushed, Risk-taker, Similar, Lazy, Cure-all, Simplification

Believers' Fears. The word cloud of believers' fears for DE is in Figure 7. The AI-generated categorization of this prompt is in Table 4. Summary of Believers' Fears The responses show that believers do have concerns about the successful implementation of DE, and the depth and diversity of the responses show they have experienced many of them so far along the way. Examples include tool failure, access issues, unfunded mandates, general lack of support, and the resistance of colleagues. There is also a sentiment among the believers that failure in DE would have negative repercussions for those who advocated for it. While both camps have concerns, those of believers are more focused on the immediate implementation challenges compared to the general doubts of the skeptics.



Figure 7. Believers' Fears for Digital Engineering

Table 4. Summary of Believers' Fears

Term Category	Count	Example Terms
Implementation Challenges	23	Slow, Complexity, Cost, Learning-curve, Information-overload, Difficult, Unsortable
Lack of Support & Resistance	18	Not-enough-support, Inertia, Excel-huggers, Skeptics, Resistance, Lack of acceptance, Naysayers
Failure & Negative Outcomes	14	Failure, Fumbles, Misuse, Breaking everything, Critical-failure, Waste, False hope, 404
Fear of Change & Uncertainty	12	Change, Chaos, Apprehension, What-we-don't-know, Fear of the known, Metathesiophobia
Security & Control	8	Security, Vulnerabilities, Hacking, Blackbox, Loss-of-"Why"
Other	25	Unique terms or those not fitting neatly into the above categories

Breakout Table Responses

Breakout Observations. The top inputs, based on the indicated ‘up-votes’, from the breakout table discussions are presented in Table 7. Much of the conversations at the tables centered on the tools. They are often too complex with significant learning curves, which represent barriers to adoption. These issues are compounded if engineers need to learn a new tool every year, whether it is because of inconsistent tool use across NASA centers, programs, and projects, or whether new tools, or tool versions, are released and updated.

There was evidence of bi-directional empathy happening, as several tables recognized that both skeptics and believers share many of the same fears. The difference is often the level of optimism that the associated challenges will be successfully overcome.

Table 7. Breakout Table Observations

Observation	Up-Votes
Lack of longevity... Adopting a new tool is fine, but not when there's a new one every year. The lifecycle of some of these tools is shorter than the programs we are using them on.	23
Believers and skeptics both fear complexity.	19
Everyone wants efficiency, but there are fears that it won't actually be achieved due to lack of accessibility and the learning curve.	17
Learning curve	14
Similar hopes	13
Duplication of tools – multiple orgs using different tools for the same tasks.	11
We have some of the same fears, but different levels of expectations on the ability to overcome them.	8
Complexity of tool makes it difficult to learn and adopt.	8

Personal Action Plan Summary. The summary of the collected personal action plans (via GenAI) is presented in Table 8. The most common personal action was to pursue DE and MBSE training opportunities, which was followed closely by the desire to further explore the use of available tools through trials, pilots, or even implementing them to some degree on a project. Among the DE advocates, there was marked realization that they needed to do more back in their home organizations to help those more skeptical make the adoption. There is a strong emphasis on collaboration, networking, and knowledge sharing, which may come in the form of lessons learned, know-how, or success stories.

Table 8. Personal Action Plan summary

Category	Description
Learning and Training	Desire for education about DE and MBSE benefits and limitations.
Implementation and Use of Tools	Keen to explore and utilize DE tools.

Communication and Advocacy	Communicate DE and MBSE value, evangelize methodologies, document lessons learned, and advocate for infrastructure funding.
Manage the Change	Address fears, approach differing opinions with open mind.
Action-Oriented Approach	Call to action - “Just do it”, willing to experiment.
Collaboration and Networking	Coordinate with DE leads, network with home organizations.
Exploration and Curiosity	Desire to explore new tools, investigate strategies, ask experts.

Analysis Across Session Inputs

A cross-cutting assessment of the individual poll results reveals, as expected, a complex and diverse environment in which DE is trying to take hold at NASA. One key consideration when reviewing this information is that the hopes and fears inputs were captured before meaningful group conversations took place, so it should be considered a baseline from which to build upon.

Everyone Seeks Efficiency. Both Believers and Skeptics want to be more efficient in developing systems. While views differ on how to achieve it, improved efficiency is a promising common ground from which to start.

Implementation Is Difficult. Believers fear the tools will break, their efforts will be for naught, and reality will fall short of the promises some of them have been making. Skeptics fear that the implementation will not realize an improvement, that it will be too complex and chaotic to be useful, or even that it will catastrophically fail. Everyone worries about cost, learning curves, and the lack of support.

The Communication Gap Needs Bridging. The poll results from both groups confirm a lack of mutual understanding. To the skeptics, believers are naïve risk takers. To the believers, skeptics are outdated and overly risk averse. Many of those believers are leading the digital transformation and are surprised that everyone does not inherently want to use their tools. It will only be through continued open dialog that our community can work together towards a DE implementation that works for everyone. This means moving beyond dismissive labels and working towards understanding the opposing point of view.

Put the People First. A human-centered approach will be crucial to effective DE implementations. A consistent theme among the polls is that the usability and learning curve, driven by new tools, different tools, or complexity, are major barriers to adoption at all levels of readiness. Ensuring engineers can stay connected with their information will also mitigate the concerns related to lack of control, new information silos, and the loss of judgment in decision making.

Recommendations

In the opinion of the authors, the following recommendations will benefit organizational digital transformation efforts, and they will be broadly applicable in industry and academia.

Start the Conversation. This exercise validated its own purpose by highlighting the lack of understanding among DE skeptics and believers. Organizations that face similar circumstances should endeavor to correct that situation, whether the matter at hand is DE or not. Of 3.5 days of workshop, the 1-hour Hopes & Fears of DE exercise received the second-most votes for favorite session (behind a talk by top NASA leadership). Some participants made plans to repeat the exercise locally at their home organization. While many appreciated the dialog it started and the potential benefit it had for DE, others were inspired to use these collaborative methods in other areas of their work. The authors present this application of the Hopes and Fears exercise as an example for potential use elsewhere. NASA can be characterized as a large

government entity with well-established culture and procedures. Development teams that differ significantly from that characterization would especially benefit from repeating this approach internally.

Champion the Champions. The Innovators and Early Adopters of any innovation movement are inherently motivated to effect the change while suffering the initial hardships. However, they are not necessarily inclined to community building, user engagement, outreach, training, fundraising, and proposal writing. Perhaps most especially, they are not likely to be natural collaborators with those of diverse perspectives (i.e., skeptics). Organizational leadership and others who are not technically inclined should support them in these areas. You do not need to be a DE expert to advocate for DE.

Demonstrate Tangible Value. Inputs from both directions suggest the importance of having firm proof of the promises being made. Early Adopters recognize that they need to implement DE within their scope, show and quantify that success, and share the results as broadly as possible. This will show the Early Majority how to do it and that adoption is a safe proposition. It is both helpful and is something the Early Majority are waiting for. It will also help to calm the fears of the more conservative members of the population.

Conclusions

NASA attempted a social experiment by conducting a group-therapy session with hundreds of engineers and getting them to talk about their emotions. It was a clear success in that it met its objectives of getting the believers and skeptics of DE and MBSE to look past the facts on the surface and begin to consider the more fundamental reasons people are genuinely excited about the prospect of DE and why others are not more quickly deciding to adopt it. It will be by bridging this communication gap that the NASA engineering community can work together to meet the challenges of implementing DE with a human-centered focus that will realize the shared goal of increased efficiency.

NASA, and the international engineering community, has made great strides towards realizing our digital future, but we are still in the early stages of implementation and adoption. Progress must be made steadily to diffuse each new capability through the practice of engineering with collaborative efforts, well supported initiatives, and demonstratable value. With the increased efficiencies and effectiveness realized, NASA will be better equipped to rise to the challenges before it by advancing aerospace technology, making scientific discoveries, exploring the Solar System, and improving life back on Earth.

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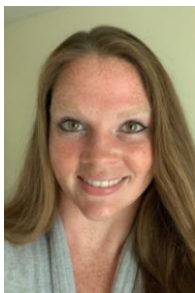
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Biography



Greg Pierce is the Digital Engineering Lead for the Engineering Directorate at Johnson Space Center and is the Deputy Chief of the Applied Systems Engineering Branch. He was the JSC-lead for the 2024 NASA Systems Engineering Workshop and was co-lead for the “Our Hopes and Fears of Digital Engineering” session. He serves on NASA’s MBSE Leadership team and leads NASA’s MBCE activities. He also contributes to the leadership of the systems engineering discipline at JSC in several capacities, such as chairing the JSC Systems Engineering Working Group. Pierce is a career systems engineer with extensive experience in the development of flight systems such as space suits and jetpacks. Pierce, a long-time INCOSE CSEP, has a BS in aerospace engineering from the University of Michigan in Ann Arbor.



Nancy Noyes has a total of 17 years of systems engineering experience across her employment with the Department of Defense and NASA. She is serving her most recent 4 years as a digital engineering practitioner in her systems engineering role for NASA Marshall Space Flight Center. Nancy represented MSFC on the 2024 NASA Systems Engineering Workshop planning team and was co-lead for the “Our Hopes and Fears of Digital Engineering” session. She and her husband moved to Huntsville, Alabama from northern New Jersey in escape of the winter cold, allowing Nancy's network to grow while she continues to learn how digital tools improve the creation and management of work products along with data sharing and security.