# Survey Preamble

This survey is being administered and distributed by the American Institute of Aeronautics and Astronautics Digital Engineering Integration Committee Subcommittee on Computational Design and Analysis for Digital Engineering (AIAA DEIC-CoDADE). This survey is intended to query individuals throughout academia, industry, and governing bodies about the types of computational design and analysis research areas, data, infrastructure scaling, organizational impacts that those individuals experience. As part of this surveying, one objective is to understand the impacts of these factors on the maturity of different non-deterministic methods (e.g., AI) with respect to interoperability and responsible use. Another objective is to query the role that these individuals believe that digital engineering could have with respect to maximizing interoperability with and promoting responsible use of the above-mentioned factors. The results from this survey will be used to provide a direction for generating additional guidelines for promoting responsible use and maximizing interoperability of digital engineering with the use of these different non-deterministic methods.

Responsible use of AI “lies with those persons with authorities for and over the design, requirements definition, development, acquisition, testing, evaluation, and training for any DoD system, even AI ones” (DoD Defense Innovation Board [1]). Responsible use would require ensuring that the engineers have a full-scale, life cycle-oriented view of where their data comes from, how their models are being used, and what sorts of decisions are being made using said models. These would seek to answer two questions: (1) Are the models, data, and decision-making process appropriate for the desired application? (2) Are the models, data, and decision-making process sufficiently mature for quantification of uncertainty and establishing trust?

According to DoD Instruction 8330.01 [1], interoperability is defined as the ability of systems, units, or forces to provide data, information, materiel, and services to, and accept the same from, other systems, units, or forces, and to use the data, information, materiel, and services exchanged to enable them to effectively operate together. In the context of non-deterministic methods (e.g., AI), the goal is to emphasize how interoperability of these methods with other digital infrastructure can supported in a responsible manner. Considering the described requirements for responsible use of AI, the notion of interoperability of infrastructure required for using AI is central to ensuring responsible use.

With DEIC-CoDADE’s positions on what constitutes “responsible use” and interoperability, the following includes definitions and implementation details for digital twins and threads.

**Digital engineering** -

**Digital twin** - A set of virtual information constructs that mimics the structure, context and behavior of an individual / unique physical asset, or a group of physical assets, is dynamically updated with data from its physical twin throughout its life cycle and informs decisions that realize value (AIAA Digital Twin Position Paper).

**Digital thread**: A collection of linked authoritative digital information pertaining to a process, product, or system, whose consistency is actively managed throughout the life cycle. This enables accessibility, traceability, currency, applicability, and credibility of information, thus facilitating the capture, communication, and use and reuse of knowledge to efficiently inform decisions that realize value (AIAA Digital Thread Position Paper).

For further information about the survey or DEIC-CoDADE, please email Abhishek Ram ([aram@draper.com](mailto:aram@draper.com)). All of us in DEIC-CoDADE would like to thank you for the time and effort taken to respond to the survey questions and for your consideration of our positions on digital engineering.

# Questions About Your Organization

1. My organization most aligns with:
   1. Government
   2. Military / Defense
   3. Commercial / Industrial
   4. Academia
   5. Federally Funded, Research & Development Centers (FFRDC)
   6. Other
2. How large is your organization?
   1. N/A: Independent contractor / government / academic
   2. Small business (<100 people)
   3. Medium-sized business (100 – 1500 people)
   4. Large business (>1500 people)
3. How many years of experience does your workforce have?

**[Select All That Apply]**

* 1. 0 to 4 years
  2. 5 to 9 years
  3. 10 to 19 years
  4. 20 to 29 years
  5. 30 years or more

1. How much progress into digital twin and digital thread development has your organization achieved?
   1. Conceptual stage (designed, but no implementation at all)
   2. Minimum viable product (basic implementation, meeting design requirements)
   3. Operational on a team-wide scale (fully implemented in a limited setting)
   4. Operational on a division-wide scale (fully implemented across engineering, manufacturing, etc.)
   5. Operational on an enterprise scale (fully implemented and “fielded” to relevant teams/efforts)

# Questions About Your Experience

1. How long have you been in the science & engineering workforce?
   1. 0 to 4 years
   2. 5 to 9 years
   3. 10 to 19 years
   4. 20 to 29 years
   5. 30 years or more
2. How would you classify your experience and expertise in these subject areas?

**[List of Subject Areas with Options to Choose Levels of Expertise Next To Them]**

e.g., Subject Area \_\_\_\_\_\_ {Dropdown Box With List of Levels of Expertise}

1. Regarding which subject areas would you feel comfortable answering survey questions?

**[Select All That Apply]**

1. Computational Design and Analysis Framework Development
2. Impacts of Computational Design and Analysis on Enterprise Data and Software Architecture
3. Hardware and Software Infrastructure Co-Design
4. Impacts of Socio-Technical Interactions on Computational Design and Analysis Strategy
5. If you would like to see the survey results, please provide your email. Note: this will not be shared to anyone without your permission.

**[Request Short Answer}**

# Computational Design and Analysis Framework Development

1. Select appropriate level of *personal* professional experience and expertise in:  
   **[None / Dabbled / Learning / Occasional / Commonplace]**
   1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
   2. Coupled Multiphysics Mod/Sim
   3. Multiscale Mod/Sim (single or multi-physics/discipline)
   4. Multifidelity Mod/Sim (single or multi-physics/discipline)
   5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
   6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
   7. AI/ML applied to sophisticated automation, data analysis, etc.
   8. Hybrid AI/ML + traditional modeling/simulation integrated methods
   9. Other: [Request Short Answers]
2. Select your best estimate of your *enterprise’s* experience and expertise in:  
   **[None / Dabbled / Learning / Occasional / Commonplace]**
   1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
   2. Coupled Multiphysics Mod/Sim
   3. Multiscale Mod/Sim (single or multi-physics/discipline)
   4. Multifidelity Mod/Sim (single or multi-physics/discipline)
   5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
   6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
   7. AI/ML applied to sophisticated automation, data analysis, etc.
   8. Hybrid AI/ML + traditional modeling/simulation integrated methods
   9. Other: [Request Short Answers]
3. Select your best estimate of your *collaborator’s* *(beyond your enterprise)* experience and expertise in:  
   **[None / Dabbled / Learning / Occasional / Commonplace]**
   1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
   2. Coupled Multiphysics Mod/Sim
   3. Multiscale Mod/Sim (single or multi-physics/discipline)
   4. Multifidelity Mod/Sim (single or multi-physics/discipline)
   5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
   6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
   7. AI/ML applied to sophisticated automation, data analysis, etc.
   8. Hybrid AI/ML + traditional modeling/simulation integrated methods
   9. Other: [Request Short Answers]
4. Interoperability is most realized by the application of DE to which of the following research areas?

**[Select All That Apply]**

* 1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
  2. Coupled Multiphysics Mod/Sim
  3. Multiscale Mod/Sim (single or multi-physics/discipline)
  4. Multifidelity Mod/Sim (single or multi-physics/discipline)
  5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
  6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
  7. AI/ML applied to sophisticated automation, data analysis, etc.
  8. Hybrid AI/ML + traditional modeling/simulation integrated methods
  9. Other: [Request Short Answers]

1. Interoperability is not/least realized by the application of DE to which of the following research areas?

**[Select All That Apply]**

* 1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
  2. Coupled Multiphysics Mod/Sim
  3. Multiscale Mod/Sim (single or multi-physics/discipline)
  4. Multifidelity Mod/Sim (single or multi-physics/discipline)
  5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
  6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
  7. AI/ML applied to sophisticated automation, data analysis, etc.
  8. Hybrid AI/ML + traditional modeling/simulation integrated methods
  9. Other: [Request Short Answers]

1. Would it be responsible to use digital engineering with any of these research areas?

**[Select All That Apply]**

* 1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
  2. Coupled Multiphysics Mod/Sim
  3. Multiscale Mod/Sim (single or multi-physics/discipline)
  4. Multifidelity Mod/Sim (single or multi-physics/discipline)
  5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
  6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
  7. AI/ML applied to sophisticated automation, data analysis, etc.
  8. Hybrid AI/ML + traditional modeling/simulation integrated methods
  9. Other: [Request Short Answers]

1. Which research areas would benefit from additional guidelines for maximizing interoperability?

**[Select All That Apply]**

* 1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
  2. Coupled Multiphysics Mod/Sim
  3. Multiscale Mod/Sim (single or multi-physics/discipline)
  4. Multifidelity Mod/Sim (single or multi-physics/discipline)
  5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
  6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
  7. AI/ML applied to sophisticated automation, data analysis, etc.
  8. Hybrid AI/ML + traditional modeling/simulation integrated methods
  9. Other: [Request Short Answers]

1. Which research areas would benefit from additional guidelines for promoting responsible use?

**[Select All That Apply]**

* 1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
  2. Coupled Multiphysics Mod/Sim
  3. Multiscale Mod/Sim (single or multi-physics/discipline)
  4. Multifidelity Mod/Sim (single or multi-physics/discipline)
  5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
  6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
  7. AI/ML applied to sophisticated automation, data analysis, etc.
  8. Hybrid AI/ML + traditional modeling/simulation integrated methods
  9. Other: [Request Short Answers]

1. How frequently do you plan to use the digital threads you are developing?
   1. One-off digital threads
   2. Few-repeated-use digital threads (used a finite number of times and shelved)
   3. Continuously used and operated digital threads
   4. Other: [Request Short Answers]

# Impacts of Computational Design and Analysis on Enterprise Data and Software Architecture

1. Which kinds of data do you mostly utilize in your work?

**[Select All That Apply]**

* 1. Unstructured text data
  2. Structured data
  3. Boundary conditions
  4. Geometric data
  5. Tolerances
  6. Photographs
  7. Metadata
  8. Other: [Request Short Answers]

1. Is the data you work with:
   1. Measured
   2. Simulated
   3. Fusion (mixed simulated and measured data)
   4. Other: [Request Short Answers]
2. Which types of data would you expect to be the least challenging to manage with respect to digital thread development?

**[Select All That Apply]**

1. Unstructured text data
2. Structured data
3. Boundary conditions
4. Geometric data
5. Tolerances
6. Photographs
7. Metadata
8. Other: [Request Short Answers]
9. Which types of data would you expect to be the most challenging to manage with respect to digital thread development?

**[Select All That Apply]**

1. Unstructured text data
2. Structured data
3. Boundary conditions
4. Geometric data
5. Tolerances
6. Photographs
7. Metadata
8. Other: [Request Short Answers]
9. The utilization of which types of data would benefit from additional guidelines for maximizing interoperability?
   1. Unstructured text data
   2. Structured data
   3. Boundary conditions
   4. Geometric data
   5. Tolerances
   6. Photographs
   7. Metadata
   8. Other: [Request Short Answers]
10. The utilization of which types of data would benefit from additional guidelines for promoting responsible use?
    1. Unstructured text data
    2. Structured data
    3. Boundary conditions
    4. Geometric data
    5. Tolerances
    6. Photographs
    7. Metadata
    8. Other: [Request Short Answers]

# Hardware and Software Infrastructure Co-Design

1. What research areas do you use high performance computing for? **[Select All That Apply]**
   1. Co-simulated (uncoupled) Multiphysics (e.g., aeroacoustics, CHT, FSI, etc.)
   2. Coupled Multiphysics Mod/Sim
   3. Multiscale Mod/Sim (single or multi-physics/discipline)
   4. Multifidelity Mod/Sim (single or multi-physics/discipline)
   5. Multidisciplinary Trade-off Analyses (integrated design/manufacturing, performance/lifing, etc.)
   6. Automation for labor-intensive tasks (meshing, post-processing, etc.)
   7. AI/ML applied to sophisticated automation, data analysis, etc.
   8. Hybrid AI/ML + traditional modeling/simulation integrated methods
   9. Other: [Request Short Answers]
2. What types of data do you utilize in your research areas that use high performance computing? **[Select All That Apply]**
   1. Unstructured text data
   2. Structured data
   3. Boundary conditions
   4. Geometric data
   5. Tolerances
   6. Photographs
   7. Other: [Request Short Answers]
3. What types of scaling do you anticipate your enterprise having to undergo in the future?

**[Select All That Apply]**

1. Strong scaling – Incorporate more hardware to reduce the time-to-solution for a given problem.
2. Weak scaling – Incorporate more hardware to solve larger problems than before.
3. User scaling – Add ability to support growth in concurrent users with minimal efforts.
4. Functional scaling – Add new functionality/interoperability with minimal effort.
5. Horizontal scaling – Add more nodes/racks/data centers.
6. Vertical scaling – Upgrading nodes (e.g., processor, memory, interconnect)
7. Which research areas would benefit the most from which kind of scaling?

**[List of Research Areas with Options to Choose Types of Scaling Next To Them]**

e.g., Research Area \_\_\_\_\_\_ {Dropdown Box With List of Scaling Options}

1. The management of which types of data would benefit the most from which kind of scaling?

**[List of Research Areas with Options to Choose Types of Scaling Next To Them]**

e.g., Types of data \_\_\_\_\_\_ {Dropdown Box With List of Scaling Options}

* 1. Vertical scaling – Upgrading nodes (e.g., processor, memory, interconnect)

1. The utilization of which types of scaling would benefit from additional guidelines for maximizing interoperability?

**[Select All That Apply]**

* 1. Strong scaling – Incorporate more hardware to reduce the time-to-solution for a given problem.
  2. Weak scaling – Incorporate more hardware to solve larger problems than before.
  3. User scaling – Add ability to support growth in concurrent users with minimal efforts.
  4. Functional scaling – Add new functionality/interoperability with minimal effort.
  5. Horizontal scaling – Add more nodes/racks/data centers.
  6. Vertical scaling – Upgrading nodes (e.g., processor, memory, interconnect)

1. The utilization of which types of scaling would benefit from additional guidelines for promoting responsible use?

**[Select All That Apply]**

* 1. Strong scaling – Incorporate more hardware to reduce the time-to-solution for a given problem.
  2. Weak scaling – Incorporate more hardware to solve larger problems than before.
  3. User scaling – Add ability to support growth in concurrent users with minimal efforts.
  4. Functional scaling – Add new functionality/interoperability with minimal effort.
  5. Horizontal scaling – Add more nodes/racks/data centers.
  6. Vertical scaling – Upgrading nodes (e.g., processor, memory, interconnect)

# Impacts of Socio-Technical Interactions on Computational Design and Analysis Strategy

1. What is your impact on digital twins?

**[Select All That Apply]**

* 1. As a vendor of supporting technology
  2. As a developer / product manager of twins or twinned products
  3. As a consumer of twins / user of twinned products

1. Who are currently considered to be stakeholders to your digital engineering efforts?

**[Select All That Apply]**

* 1. Other computational design and analysis teams
  2. Program management
  3. Direct customers
  4. End-product users
  5. Community around end-product users
  6. Tool vendors
  7. Regulatory bodies
  8. Other: [Request Short Answers]

1. Who do you believe should be considered as stakeholders to your digital engineering efforts?

**[Select All That Apply]**

* 1. Other computational design and analysis teams
  2. Program management
  3. Direct customers
  4. End-product customers
  5. Community around end-product users
  6. Tool vendors
  7. Regulatory bodies
  8. Other: [Request Short Answers]

1. Who currently has the most influence over your digital engineering efforts?

**[Select All That Apply]**

* 1. Other computational design and analysis teams
  2. Program management
  3. Direct customers
  4. End-product customers
  5. Community around end-product users
  6. Tool vendors
  7. Regulatory bodies
  8. Other: [Request Short Answers]

1. Have you experienced any recent cost-cutting in your digital engineering efforts? What has been the impact on your enterprise as a whole?

**[Choose One Option]**

* 1. Significant impact
  2. Minor impact
  3. No impact
  4. No recent cost-cutting
  5. Other: [Request Short Answers]

1. Has the size of your organization impacted your ability to implement digital engineering? If so, what has been the impact?

**[Choose One Option]**

* 1. Significant impact
  2. Minor impact
  3. No impact
  4. Other: [Request Short Answers]

1. Has the career age of your workforce impacted your ability to implement digital engineering? If so, what has been the impact?

**[Choose One Option]**

* 1. Significant impact
  2. Minor impact
  3. No impact
  4. Other: [Request Short Answers]

1. Has your digital engineering implementation been impacted by having to integrate various tools? If so, what has been the impact?

**[Choose One Option]**

* 1. Significant impact
  2. Minor impact
  3. No impact
  4. Other: [Request Short Answers]

1. Has the alignment of your organization (e.g., government, defense, commercial, academia) had an impact on your implementation of digital engineering? If so, what has been the impact?

**[Choose One Option]**

* 1. Significant impact
  2. Minor impact
  3. No impact
  4. Other: [Request Short Answers]

# Short Answer Questions

1. What are the fundamental challenges / major barriers to utilizing digital engineering in this context?

**[Short Answer: No More Than 500 Words]**

1. What are the major tools/technologies/methods we would need to meet any previously identified gaps?

**[Short Answer: No More Than 500 Words]**

1. Would you like to identify yourself to the surveyors? Note: this is independent of the previous question asking for emails.

**[Short Answer: No More Than 500 Words]**