ICAS Digital Pioneering Initiative and System of System Challenges

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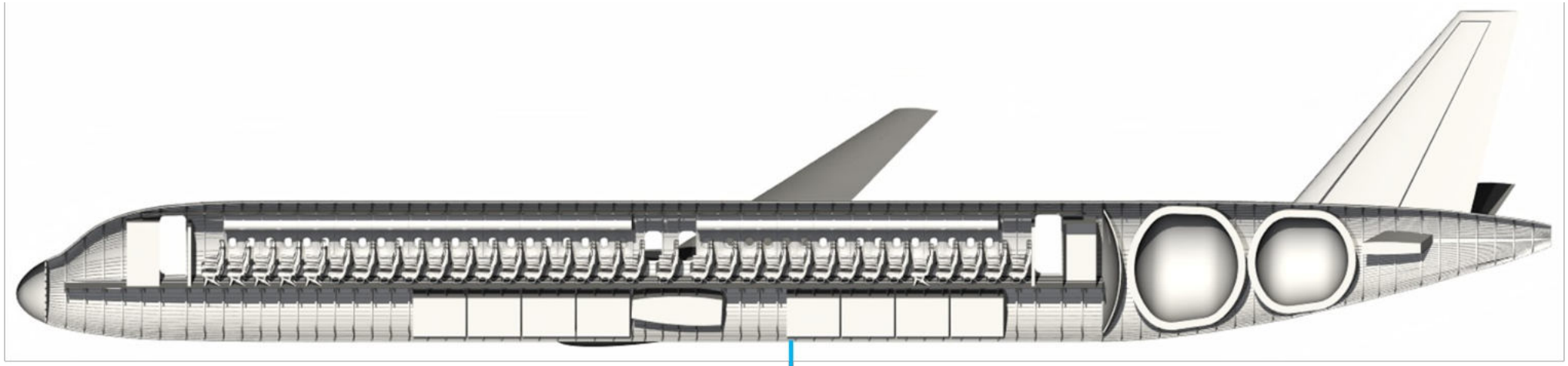
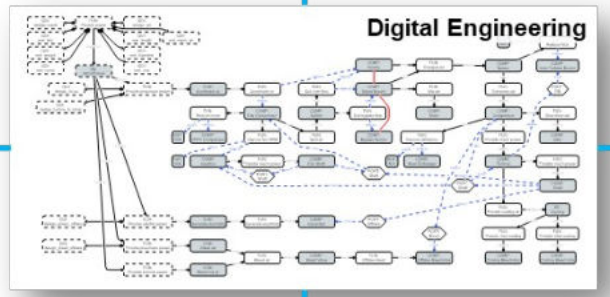
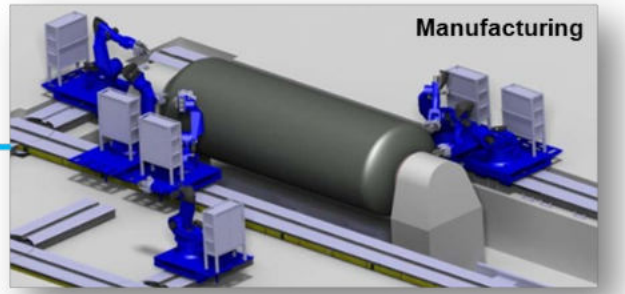
Motivation

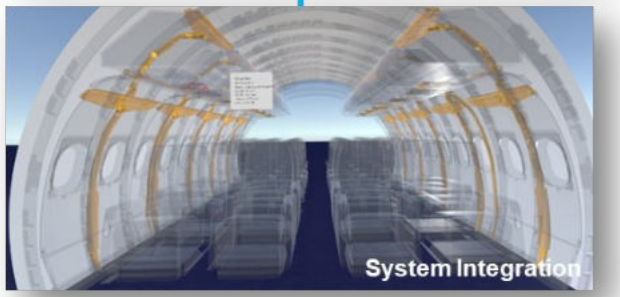


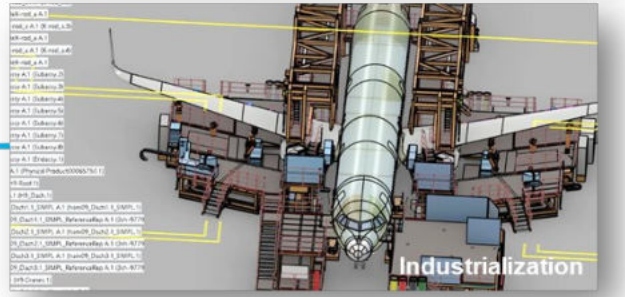
Climate Impact


Digital Engineering


Manufacturing

Certification


System Integration


Industrialization

Techniques for linking models are available

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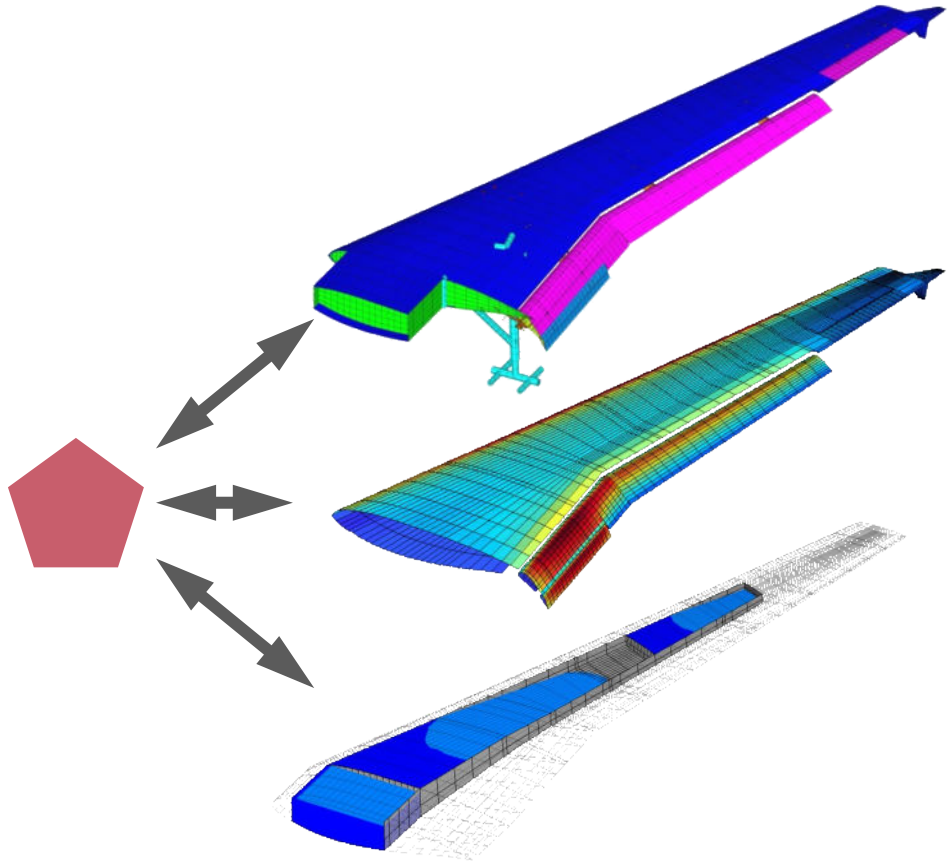
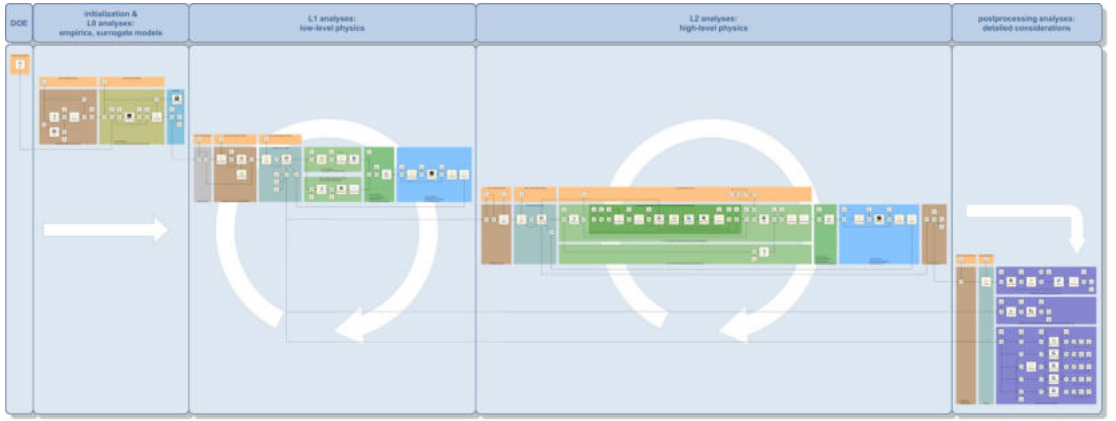
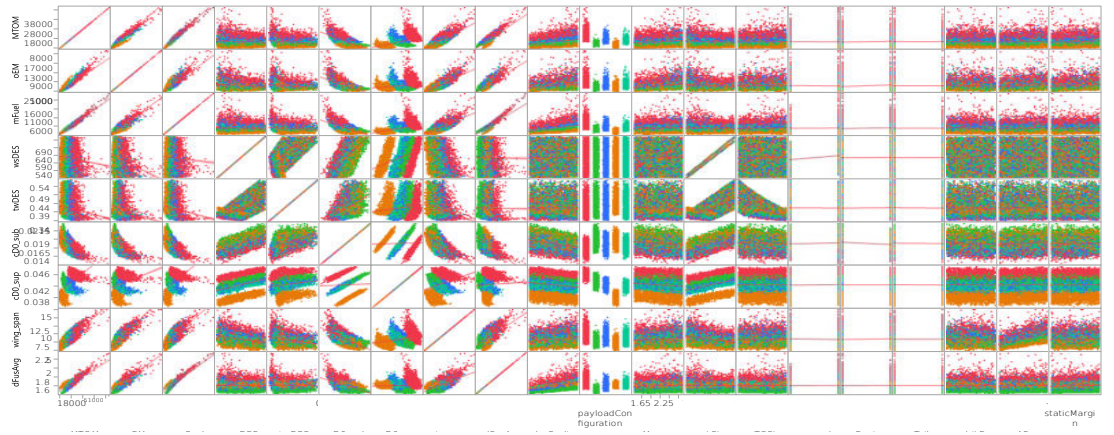
Interfacing Model



MDAO Frameworks





"Having tools" is not *"having skills"*!

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ICAS Digital Pioneering Initiative

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- Share knowledge beyond texts using digital models & data
- Connect individuals with complementary competences and digital tools
- ICAS Sub-Committee Digital Pioneering
- Invite authors of accepted ICAS papers with suitable content
- Workshop to explore methods of digital collaboration

1st Digital Pioneering Workshop 2-3 Sept. 2022

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Covering the world of

Topics

1. **(Model Based) Systems Engineering and System-of-Systems**
   Moderator: Dan DeLaurentis (Purdue University)
2. **Collaborative Multidisciplinary Design Optimization**
   Moderator: Peter Schmollgruber (ONERA)
3. **Collaborative & Digital Design Methods: VR, AR, HMI**
   Moderator: Sara Bagassi (University of Bologna)
4. **Greening of Aviation**
   Moderator: Ingo Staak (Linköping University)
5. **New Modes of Transport: Supersonic transport & UAM**
   Moderator: Luca Boggero (DLR)

Proposed Activities

- **Digital Pioneering Workshops**
- **Yellow Pages**: List models/data, related scientists, publications, links, etc..
- Harmonize **benchmark problems** and collect solutions
- Propose **specific sessions in the ICAS cfp** on reference problems
- Organize specific **workshops on collaborative research techniques**
- **Working groups**
- ICAS **student competition** (as additional workforce for DPI topics)
- **Standardization**: i.e. interfaces
- **White papers**

System-of-systems Engineering Group

- A large consensus that SoSE is not a sub set of MBSE and SE
- There are some differences that need to be acknowledge
- Systems-of-systems are present in our day to day life
- There is a need to develop a strong community around SoSE to help solve our future challenges

Formal Definition

System-of-systems [SoS]:

- A set of systems that interact to provide a unique capability that none of the CS's can accomplish on its own.
  - Each CS is a useful system by itself, having its own management, goals, and resources, but coordinates within the SoS to provide the unique capability of the SoS.
  - Inter-system infrastructure, facilities and processes are generally necessary to provide cohesiveness of the CS's with each other within the system of systems.

Constituent system:

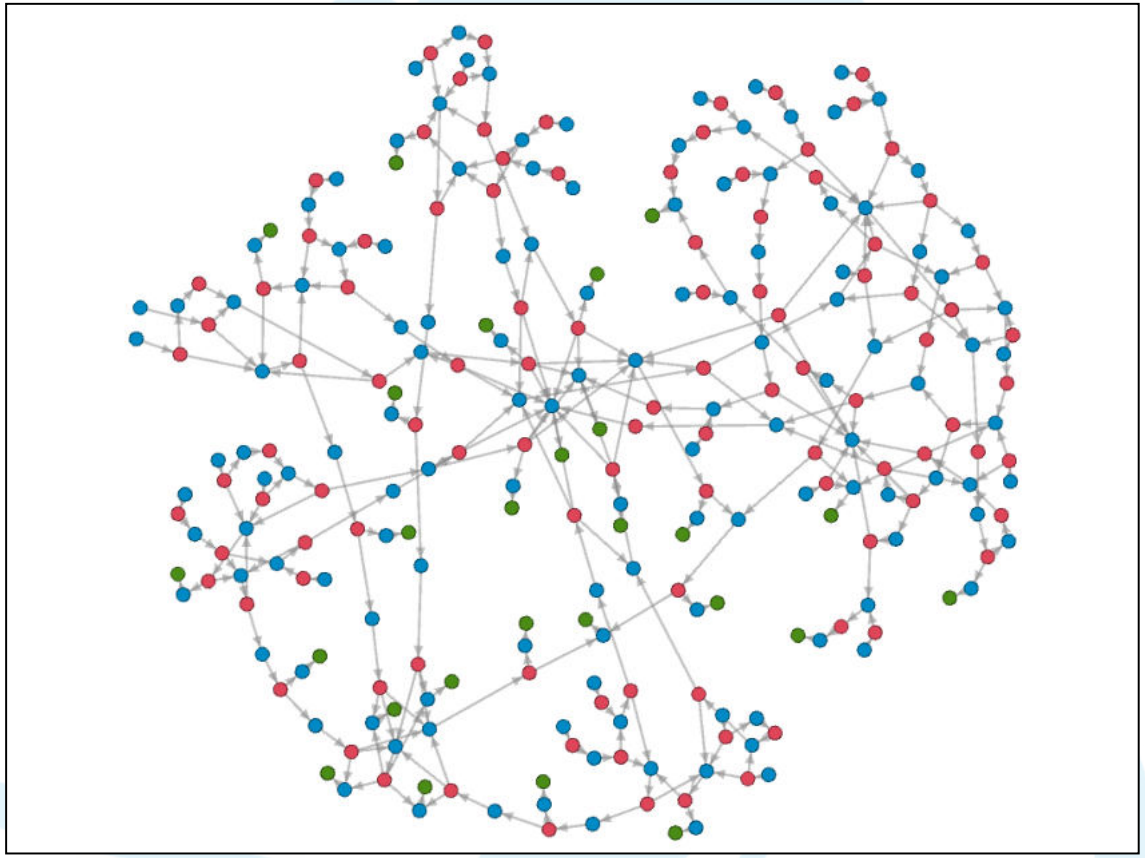
- Independent system that forms part of a system-of-systems (SoS).
- A CS can also be part of several SoS.

Integrated system (or non-SoS):

- A system where the parts provide no meaningful capability outside the system context.

Maier’s characterization of SoS (1996)

1. Operational independence
2. Managerial independence
3. Evolutionary development
4. Emergent behavior
5. Geographical distribution

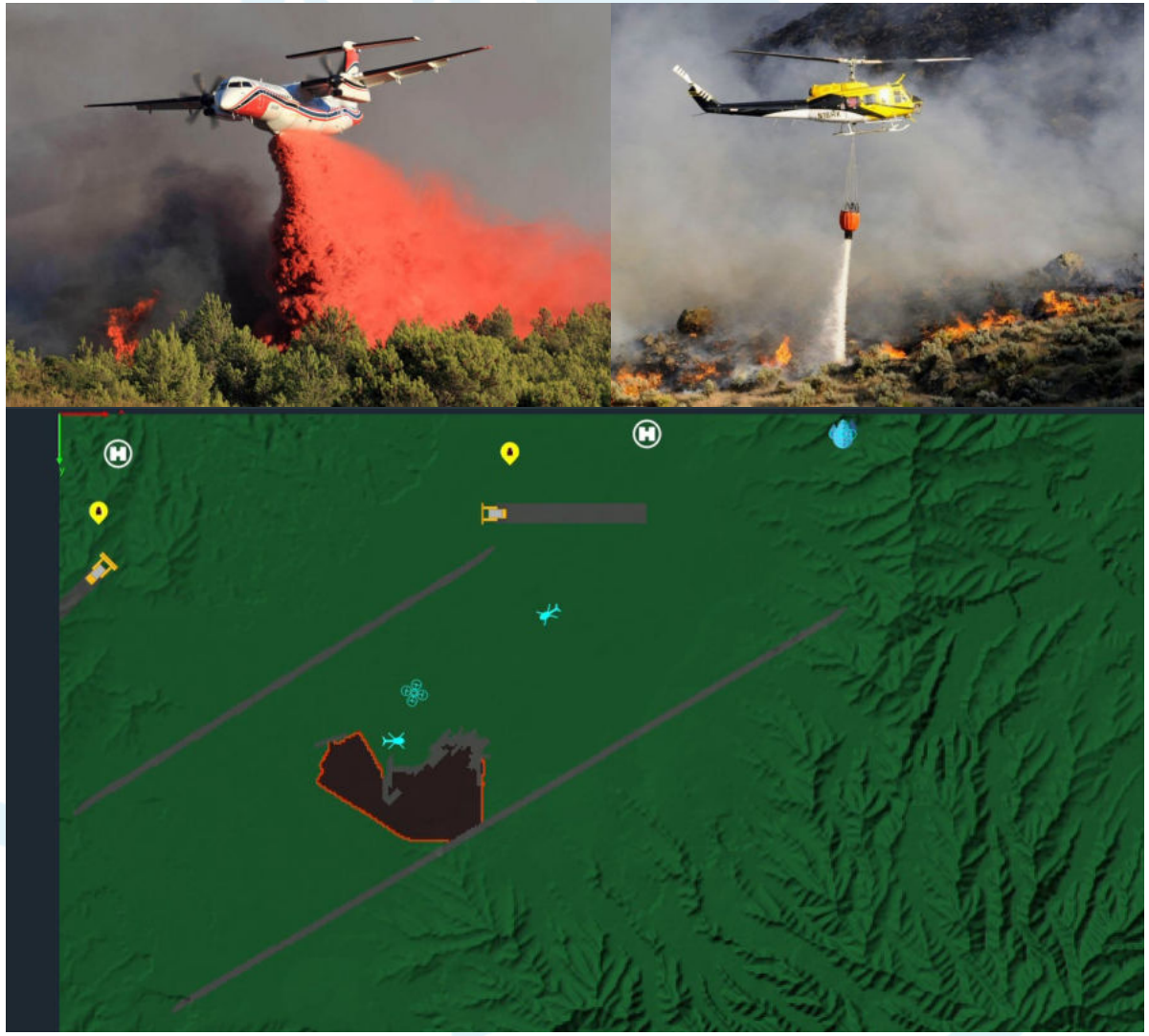


Yellow pages

- Enable efficient community around SoSE
- Related Scientists
- List benchmark problem
- Usable standards
- Publications on ICAS home page
- This supports and is supported by our proposition to formalize SoS in ICAS program

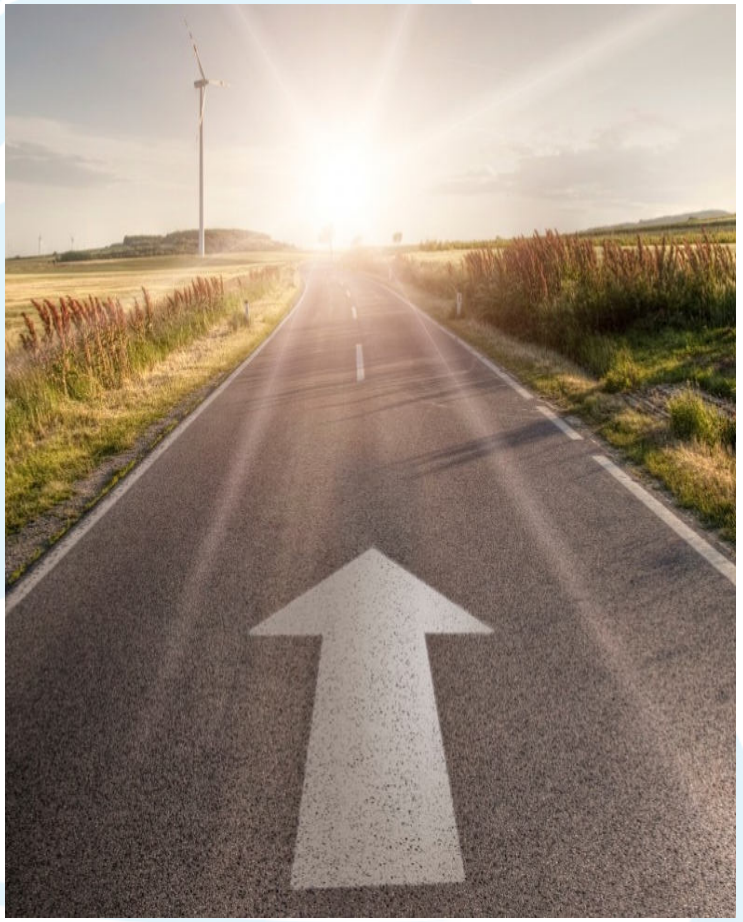
Benchmark problems

- Sharing problems, use cases and test cases to inspire and validate methods and model creation
- Future workshops have people exchange only models that are expressive enough for others to use them effectively.
- Common problem (fire fighting, UAM, ….)
  - Design of experiments
  - e.g., reproducibility of results, model fidelity checking, interpreting context from models
- Address issues such as model fidelity within the context of SoS



Proposal

- ICAS to separate the SE bullet in call for papers into 2-3 topics
  - SE and MBSE (the existing tracks),
  - SoS modeling and simulation, modern decision support via digitalization
  - Consider designing special session to organize and present the groups experimentation results
- Transform ICAS 2022 DPI session presentations into 3-4 page white paper, and use it as our communication platform as it evolves year by year



Workshop and collaboration

- DPI workshop encouraged and supported at each ICAS,
  - Off-year engagement to keep DPI going- options include AIAA AVIATION or SCITECH, Europe CEAS for workshop
- USE DPI Workshops to increase the participation diverse participants (academia, government research labs, industry, operators, and regulatory), hoping that starting small will lead to broader participation in ICAS