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The Future of Systems Engineering

INCOSE FuSE
Future of Systems Engineering

Topics

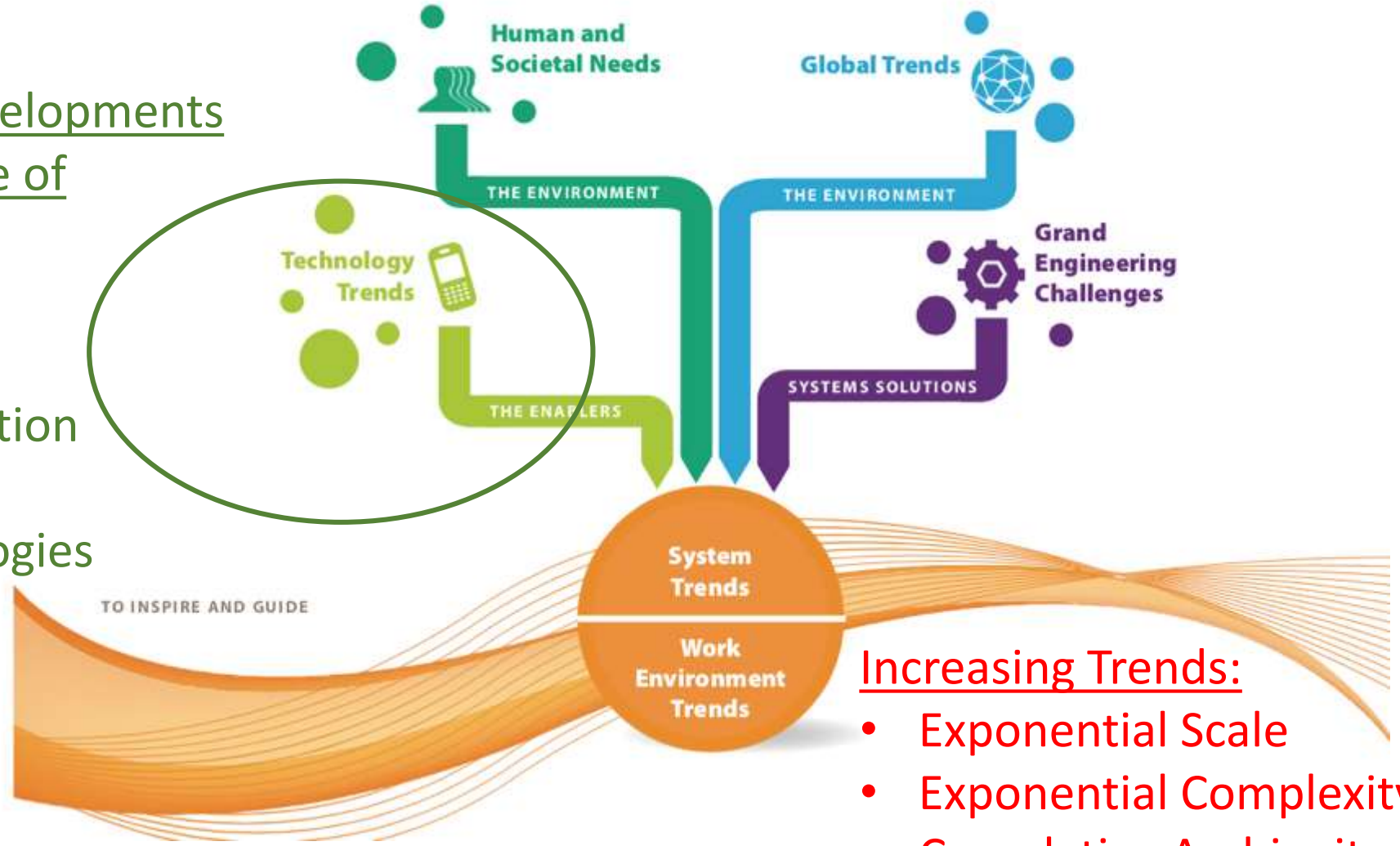
- Build on the *A World in Motion: Systems Engineering Vision 2025* published by INCOSE
- Address the Challenges of Elegant Design as stated by Michael D. Griffin, "How do we fix system engineering?", 61st International Astronautical Congress, Prague, Czech Republic, 27 Sep – 1 Oct 2010
- FuSE Roadmap

A Systems Community Initiative

Global Context for Systems Engineering

Accelerating Technology Developments & Infusion Impact the Nature of Systems

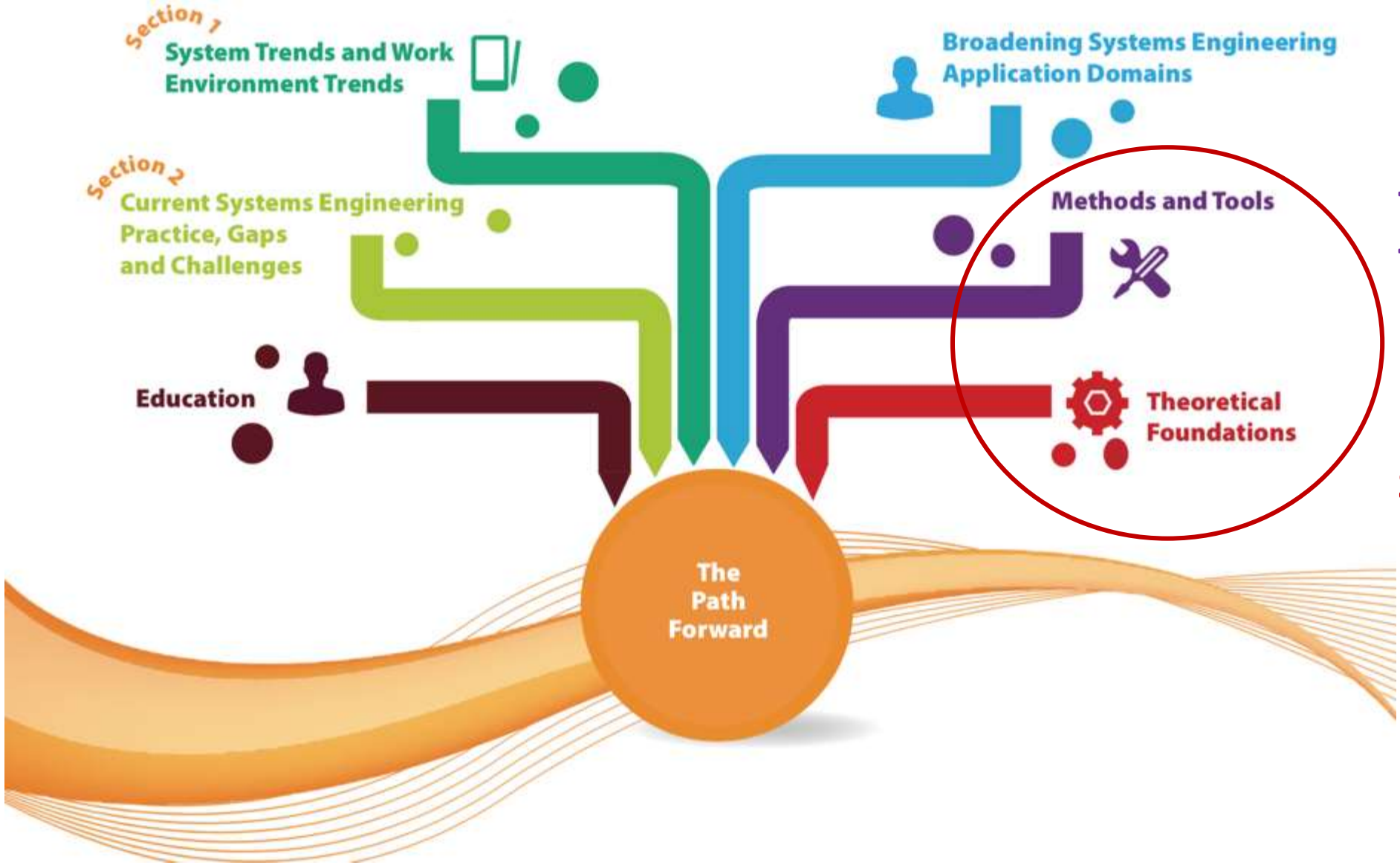
- Computational Power
- Software Systems
- Human-Computer Interaction
- Sensor Technologies
- Communications Technologies
- Material Science
- Bio-Technology
- Miniaturization



Increasing Trends:

- Exponential Scale
- Exponential Complexity
- Cumulative Ambiguity
- "Lack of Control"

The Future State of Systems Engineering



Leverage Technology for Methods & Tools that are Fit for Purpose

Foundations for Systems Engineering (F4SE)

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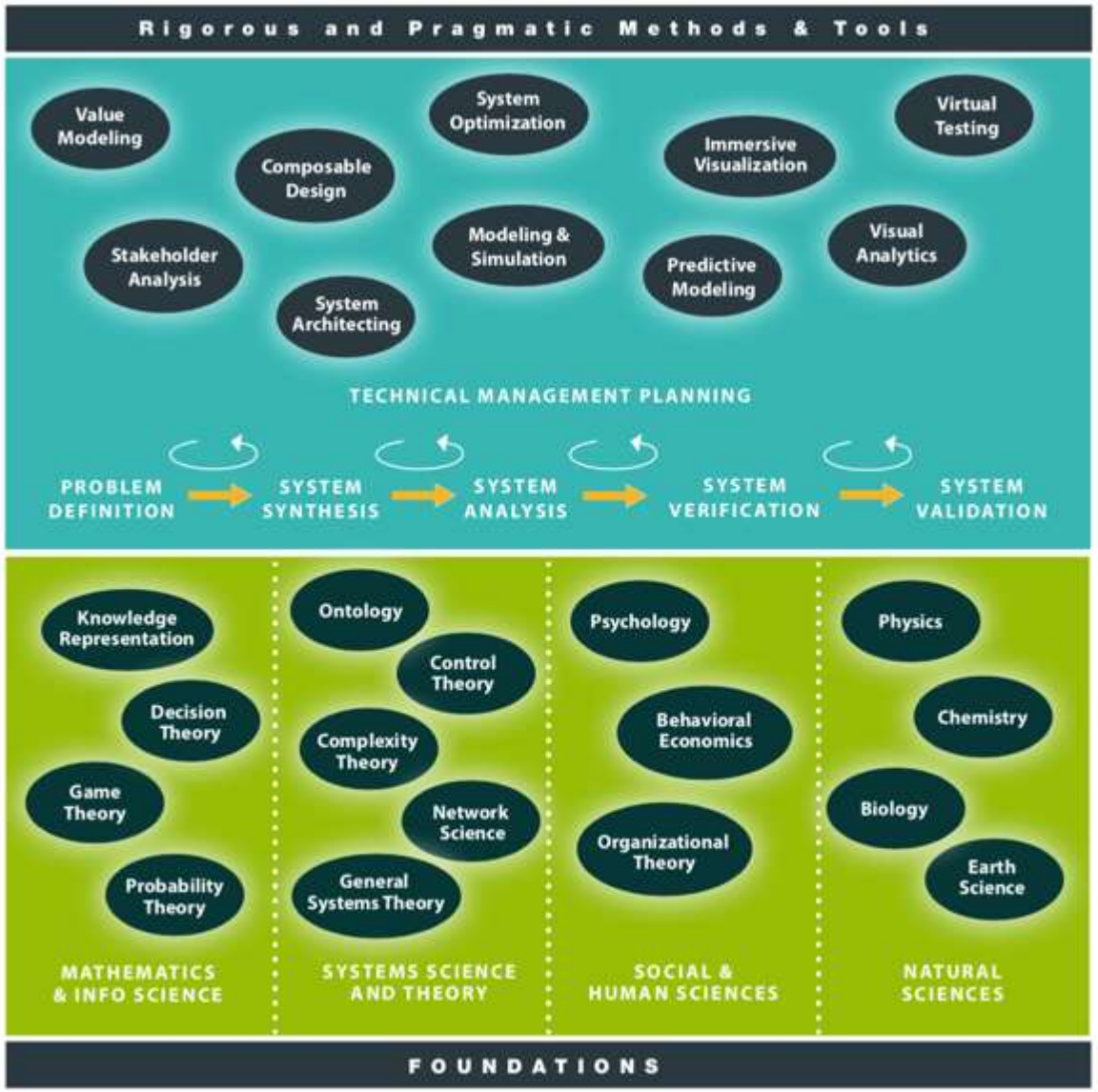

From Empirical Heuristics to Analytics

Rigorous & Pragmatic Methods & Tools

- **Elegant Design**
- **Executable Models**
- **Formal Verification & Validation**

Foundations

- **Mathematics & Info Science**
- **Systems Science & Theory**
- **Social & Human Sciences**
- **Natural Sciences**

Elegant Design: Attributes Germane to Systems Engineering

Michael D. Griffin, "How do we fix system engineering?", 61st International Astronautical Congress, Prague, Czech Republic, 27 Sep – 1 Oct 2010

1. The system actually works
   - "The system produces the anticipated behavior, the expected output, over the expected range of input conditions, control variations etc"
2. The system is robust/resilient
   - "The system should not produce radical departures from its expected behavior in response to small changes to its operating input, external state, or external environment"
3. The system is efficient
   - "The system produces the desired result for what is thought to be a lesser expenditure of resources than competing alternatives"
4. The system accomplishes its intended purpose while minimizing unintended actions, side effects, and consequences
   - "Control of these effects is a more subtle facet of system engineering, less noted but of considerable significance"

FuSE Projects Chartered and Proposed

1. Collaborate with Groups Inside and Outside the Systems Community to Develop:
   a. Foundations for Systems Engineering [Summit in Conjunction with INCOSE EMEA Workshop October 10-11]
   b. Methods, Processes, Tools for Artificial Intelligence (AI) including Autonomous Systems and Machine Learning
   c. Methods, Processes, Tools for the Acquisition, Support and Use of Data [Knowledge Management & Ontologies Working Group?]
   d. Methods, Processes, Tools for Complexity [INCOSE Complex Systems & CIPR Working Groups and SF Bay Area Chapter]
   e. Methods, Processes, Tools for Agility [INCOSE Agile Systems & Systems Engineering Working Group]
   f. Advances in Computing for Engineering
2. Evolving Systems Expertise
   a. FuSE Route-Map and Horizon Scanning Workstream
   b. Create a Body of Knowledge for Evolving, Adaptive Systems
   c. Develop Heuristics & Guidelines Relevant to these Evolving Systems and Variable Environments
   d. Cyber security [INCOSE Systems Security Engineering WG]
3. Workforce
   a. Create an Education/Training Capability to Educate the Evolving Systems Workforce
4. Broadly Apply
   a. Evangelize the Credibility & Value of Systems Engineering and a Systems Approach
   b. Develop in Our Community the Understanding that Complicated/Deterministic Systems are a Special Case and that Different Methods, Processes, and Tools are Required for Complex/Non-Deterministic Systems [INCOSE/SAE/ASME Verification & Validation Uncertainty Quantification Initiative]
   c. Build Community and Expansion of Boundaries of Systems Engineering Use

The Future of Systems Engineering

- Emerging technologies are driving the complexity, interactions, and scale of systems exponentially
- Application of AI, machine learning, and deep learning technologies are not proven to “do no harm”
- Engineering methods & tools must evolve to engineer elegant systems that are “fit for purpose” and “do no harm”

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