Years	FuSE Stream	Subject / Events / Key Contributors	Key Insight Examples
2020	Methodologies	AI and Systems Engineering / *INSIGHT* March 2020 / Dinesh Verma, Tom McDermott, Dan DeLaurentis, Peter Beling, Mark Blackburn, Mary Bone. Laura Freeman, Azad Madni, Tyler Cody, Stephen Adams, Jon Wade, Jorge Buenfil, Paul Collopy, Valerie Sitterle, Jennifer Petrillo, Barclay Brown, Thomas Hagedorn, Benjamin Kruse, Ian Grosse	AI4SE and SE4AI Research Roadmap Goals: 1. Model use for decision making 2. Authoritative source of truth 3. Technical innovation 4. Collaborative environment 5. Digital engineering workforce and cultural evolution • AI as augmented intelligence • Apply VLSI engineering principles • Test & evaluation for AI assurance • Toulmin method to structure validation test plans
2020-2021	Methodologies	*Systems Engineering and Artificial Intelligence* / 2020 AAAI Symposium / Tom McDermott & Tom Shortell	Build science of inter-dependence for autonomous human-machine teams and systems: • Engineering context • Cybersecurity • Machine explanation of decisions • Causal models and counterfactuals • V&V
2021	Methodologies	*Engineering Artificially Intelligent Systems: A Systems Engineering Approach to Realizing Synergistic Capabilities* / 2021 AAAI Spring Symposium / Ali Raz	Interdependencies between algorithms and human users in development of human-centric complex systems: • AI4SE • SE4AI • Human Centered Design (HCD) • Human Factors (HF)
2020-2021	Foundations	*A Complexity Primer for Systems Engineers Revision 1 White Paper* / INCOSE Complex Systems Working Group / Michael Watson, Dean Beale, Dorothy	Characteristics of Complexity: Diversity, Connectivity, Interactivity, Adaptability, Multiscale, Multi-perspective, Behavior, Dynamics, Evolution, System Emergence (general), Unexpected Emergence

		McKinney, Scott Jackson, Sarah Sheard	(complex), Disproportionate Effects, Indeterminate Boundaries, Contextual Influences • Identify the right level of complexity • Ashby's Law of Requisite Variety • Set of guiding principles • Candidate approaches to address complexity in problem context or environment • Modeling methods from Cook Matrix
2020-2022	Foundations	*Systems Engineering Principles* / Systems Engineering Principles Action Team (Systems Community Initiative) / Michael Watson, Bryan Mesmer, Garry Roedler, David Rousseau, Javier Calvo-Amodio, Chuck Keating, William D. Miller, Scott Lucero, Rob Gold, Cheryl Jones, David Long, R. W. Russell, Aileen Sedmak	15 Principles plus 20 sub-principles • Descriptions • Evidence • Implications Principle 5: The real system is the perfect representation of the system. • Distinguishes the real physical system from the model of the system based on a set of model parameters • A perfect model, being the system itself, means all other models have limitations. • Principle 15: Systems engineering is based on a middle range set of theories: general systems theory, physics/logic, social, mathematics 3 Hypotheses: 1. If a solution exists for a specific context, then there exists at least one ideal systems engineering solution for that specific context 2. System complexity is greater than or equal to the ideal system complexity necessary to fulfill all system outputs 3. Key stakeholders' preferences can be represented mathematically

2021-2022	Foundations	Systems Engineering's Evolving Guidelines / SE Principles & Heuristics Bridge Team, INCOSE Systems Science Working Group reoort (IS2022) / David Rousseau, Michael Pennotti, Peter Brook	Architectural framework for evolving SE discipline enabling elegant solutions to complex problems integrating • Practical insights (how) • Scientific theories (how) • Holistic perspectives (what) • Societal values (why) • Personal values (why)
2021-2022	Methodologies	Security in the Future of Systems Engineering / *INSIGHT* June 2022 / Rick Dove and INCOSE Systems Security Engineering Working Group	Six Objectives • Anomalous Behavior Monitoring • Self-Protecting Components • Security Embedded in System • Shared Vision and Respect • Security Agility • Systems Built for Trust Eleven Strategies • Security Proficiency in the SE Team • Collaborative Mutual Protection • Education & Competency Development • Security as Functional Requirement • Loss Driven Engineering • Stakeholder Alignment • Capability Based Engineering • Architectural Agility • Operational Agility • Modeled Trustworthiness • Security Orchestration
2022	Methodologies	Archimedes Initiative / *INSIGHT* December 2022 / SERC (US), TNO-ESI (NL), DLR (DE), TECoSA (SE)	MBSE tools primarily offer techniques for function decomposition and allocation but less to system qualities and system properties (SysML V2 (OMG 2022) is intended to address this issue) Infer state machine models capturing system behavior • Visualize software change impacts on system behavior

			• Easily understandable for engineers • Prevent software regression problems during critical software redesigns • Validated with lithographic machine case study Diagnostic models value in cyber-physical system design and operation • Systemic embedding computational model-based diagnostics throughout lifecycle in parallel with system design • Validated with lithographic machine and industrial printer case studies
2023	Methodologies	SE Heuristics / INCOSE PDP / INCOSE Fellows (Dorothy McKinney lead)	"Rules of thumb" to reduce cognitive load Criteria for useful SE heuristics (subset): • Derived from experience • Validated in multiple domains • Cost-effective applicability • Impactful • Explanatory information • Backed by illuminating stories Additional information (subset): • Rationale • When to use • Cautions • Expertise needed Use Cases for SE heuristics Ongoing tailoring to specific domains
2023	Methodologies	Agility in the Future of Systems Engineering / *INSIGHT* June 2023 / Rick Dove and Keith Willett with Agile Systems and	Uncertain knowledge and dynamic environments Eight strategic aspects: • Being agile operation concept • Product line architectures

		Systems Engineering Working Group	• Shared knowledge management • Continual integration and test • Common mission teaming • Iterative incremental development • Attentive decision making • Attentive situational awareness Maturing & evolving application concepts Supra-system model relevance to agile systems engineering is about data and flow : • The system lifecycle • The program lifecycle • The engineering cycle Feasibility of large scale agile in future of systems engineering: • Agility with long lead time components and dependencies • Agility across organizations boundaries • Orchestrating agile operations Computer and software centricity of complex systems • Perceived opposition between systems engineering and stage gate processes and agile often creates dual organizations that struggle to work effectively
2018-2023	Methodologies	Human Systems Integration / INCOSE HSI Working Group / Guy Boy *Human Systems Integration: From Virtual to Tangible (2020)*	Human-Systems Integration (HSI) technology, organization, people within an environment • Human-Factor Ergonomics • Information Technology • Operational Domain • Systems Engineering
2023	Foundations	System Complexity / IW2023 / Oli de Weck and Joshua Sutherland	Initial experimental validation of system complexity measure

2023	Foundations, Methodologies, Application Extensions	*Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities Fifth Edition*/ INCOSE and Wiley / David Walden, Tom Shortell, Garry Roedler, Bernardo Delicado, Odile Mornas, Yip Yew-Seng, David Endler (editors)	Impact of FuSE in SE Handbook 5th edition: • *A Complexity Primer for Systems Engineers Revision 1 White Paper* (Watson et al) • *Systems Engineering Principles* (Watson et al) • *Systems Engineering Heuristics* (McKinney et al) • Systems Science and Systems Thinking including work of the Bridge Team (Rousseau, Pennotti, Brook) • Human Systems Integration (HSI) technology, organization, people within an environment (Boy et al) • Agile Systems Engineering Life Cycle Model for Mixed Discipline Engineering • Case Study 5: Artificial Intelligence in Systems Engineering – Autonomous Vehicles