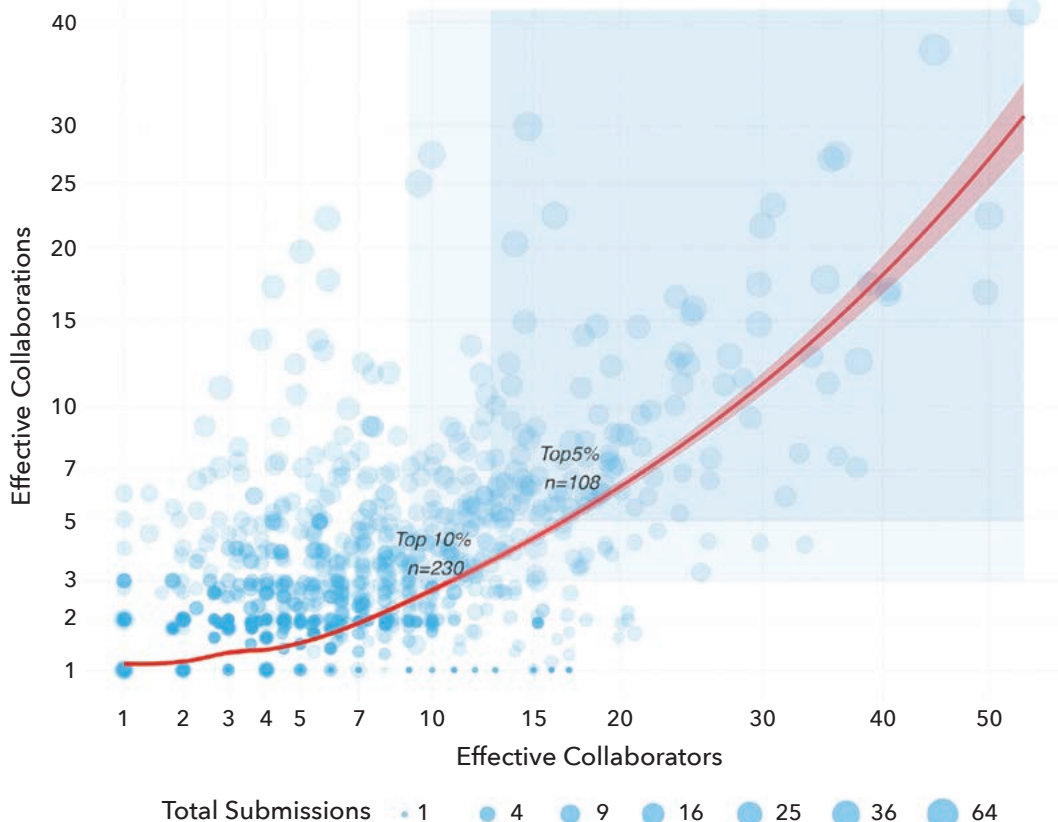


INSIGHT

This Issue's Feature:
**The State of the Systems Engineering
Discipline: A Longitudinal Analysis
of INCOSE International Symposium**



Simpson's indices of collaboration (2012-2025)

Illustration credit: from the article

*The State of the Systems Engineering Discipline: A Longitudinal Analysis
of INCOSE International Symposium Contributions (2012-2025)*

by Christian Sprague, PhD

MAY 2025
VOLUME 28 / ISSUE 2

A PUBLICATION OF THE INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING



WELCOME TO CATIA MBSE USER DAYS FRANCE



MAY 20TH-25, 2025



VELIZY FRANCE



This event is held in French



Inside this issue

FROM THE EDITOR-IN-CHIEF	6
SPECIAL FEATURE	9
The State of the Systems Engineering Discipline: A Longitudinal Analysis of INCOSE International Symposium Contributions (2012–2025)	9
I. Executive Summary	9
II. Authors Analysis	15
III. Topics Analysis	24
IV. Acceptance Analysis	35
V. Discussion and Future Directions	43
VI. Appendix	46

About This Publication

INFORMATION ABOUT INCOSE

INCOSE's membership extends to over 25,000 members and CAB associates and more than 200 corporations, government entities, and academic institutions. Its mission is to share, promote, and advance the best of systems engineering from across the globe for the benefit of humanity and the planet. INCOSE chapters worldwide, includes a corporate advisory board, and is led by elected officers and directors.

For more information, click here:

[The International Council on Systems Engineering](http://www.incose.org)
(www.incose.org)

INSIGHT is the magazine of the International Council on Systems Engineering. It is published six times per year and

OVERVIEW

features informative articles dedicated to advancing the state of practice in systems engineering and to close the gap with the state of the art. **INSIGHT** delivers practical information on current hot topics, implementations, and best practices, written in applications-driven style. There is an emphasis on practical applications, tutorials, guides, and case studies that result in successful outcomes. Explicitly identified opinion pieces, book reviews, and technology roadmapping complement articles to stimulate advancing the state of practice.

INSIGHT is dedicated to advancing the INCOSE objectives of impactful products and accelerating the transformation of systems engineering to a model-based discipline.

Topics to be covered include resilient systems, model-based

systems engineering, commercial-driven transformational systems engineering, natural systems, agile security, systems of systems, and cyber-physical systems across disciplines and domains of interest to the constituent groups in the systems engineering community: industry, government, and academia. Advances in practice often come from lateral connections of information dissemination across disciplines and domains. **INSIGHT** will track advances in the state of the art with follow-up, practically written articles to more rapidly disseminate knowledge to stimulate practice throughout the community.

Editor-In-Chief insight@incose.net	William Miller +1 908-759-7110
Theme Editor Christian Sprague, PhD	
Layout and Design chuck.eng@comcast.net	Chuck Eng
Member Services info@incose.net	INCOSE Administrative Office +1 858 541-1725

Officers

President: Ralf Hartmann, *INCOSE Fellow, proSys*
President-Elect: Michael Watson, *Leidos Dynetics*

Directors

Director for Academic Matters: Alejandro Salado, *University of Arizona*
Director for Americas Sector: Renee Steinwand, *ESEP, Booz Allen Hamilton*
Director for EMEA Sector: Sven-Olaf Schulze, *CSEP, Huenemeyer Consulting GmbH*
Director for Asia-Oceania Sector: Quoc Do, *ESEP, Frazer-Nash Consultancy*
Technical Director: Tami Katz, *Ball Aerospace*
Deputy Technical Director:** Jimmie McEver, *JHU APL*
Services Director: Heidi Davidz, *ESEP, ManTech International Corporation*

Secretary: Stueti Gupta, *BlueKei Solutions*
Treasurer: Alice Squires, *ESEP, University of Arkansas*

Deputy Director, Services:** Chris Browne, *CSEP, Australian National University*
Director for Strategic Integration: David Long, *INCOSE Fellow, ESEP, Blue Holon*
Director, Corporate Advisory Board: Michael Dahhlberg, *ESEP, KBR*
Deputy Director, Corporate Advisory Board:** Robert Bordley, *General Motors Corporation*
Executive Director:** Steve Records, *INCOSE*

** Non voting

PERMISSIONS

* PLEASE NOTE: If the links highlighted here do not take you to those web sites, please copy and paste address in your browser.

Permission to reproduce Wiley journal Content:
Requests to reproduce material from John Wiley & Sons publications are being handled through the RightsLink® automated permissions service.

Simply follow the steps below to obtain permission via the Rightslink® system:

- Locate the article you wish to reproduce on Wiley Online Library (<http://onlinelibrary.wiley.com>)
- Click on the 'Request Permissions' link, under the 'ARTICLE TOOLS' menu on the abstract page (also available from Table of Contents or Search Results)
- Follow the online instructions and select your requirements from the drop down options and click on 'quick price' to get a quote
- Create a RightsLink® account to complete your transaction (and pay, where applicable)
- Read and accept our Terms and Conditions and download your license
- For any technical queries please contact customer@copyright.com
- For further information and to view a Rightslink® demo please visit www.wiley.com and select Rights and Permissions.

AUTHORS – If you wish to reuse your own article (or an amended version of it) in a new publication of which you are the author, editor or co-editor, prior permission is not required (with the usual acknowledgements). However, a formal grant of license can be downloaded free of charge from RightsLink if required.

Photocopying

Teaching institutions with a current paid subscription to the journal may make multiple copies for teaching purposes without charge, provided such copies are not resold or copied. In all other cases, permission should be obtained from a reproduction rights organisation (see below) or directly from RightsLink®.

Copyright Licensing Agency (CLA)

Institutions based in the UK with a valid photocopying and/or digital license with the Copyright Licensing Agency may copy excerpts from Wiley books and journals under the terms of their license. For further information go to CLA.

Copyright Clearance Center (CCC)

Institutions based in the US with a valid photocopying and/or digital license with the Copyright Clearance Center may copy excerpts from Wiley books and journals under the terms of their license, please go to CCC.

Other Territories: Please contact your local reproduction rights organisation. For further information please visit www.wiley.com and select Rights and Permissions.
If you have any questions about the permitted uses of a specific article, please contact us.

Permissions Department – UK

John Wiley & Sons Ltd.
The Atrium,
Southern Gate,
Chichester
West Sussex, PO19 8SQ
UK
Email: Permissions@wiley.com
Fax: 44 (0) 1243 770620
or

Permissions Department – US

John Wiley & Sons Inc.
111 River Street MS 4-02
Hoboken, NJ 07030-5774
USA
Email: Permissions@wiley.com
Fax: (201) 748-6008

ARTICLE SUBMISSION insight@incose.net

Publication Schedule. **INSIGHT** is published six times per year. Issue and article submission deadlines are as follows:

- June 2025 issue – 1 March 2025
- August 2025 issue – 1 May 2025
- October 2025 – 1 July 2025
- December 2025 – 1 September 2025
- February 2026 issue – 1 November 2025
- April 2026 issue – 2 January 2026

For further information on submissions and issue themes, visit the INCOSE website: www.incose.org

© 2025 Copyright Notice.

Unless otherwise noted, the entire contents are copyrighted by INCOSE and may not be reproduced in whole or in part without written permission by INCOSE. Permission is given for use of up to three paragraphs as long as full credit is provided. The opinions expressed in **INSIGHT** are those of the authors and advertisers and do not necessarily reflect the positions of the editorial staff or the International Council on Systems Engineering. ISSN 2156-485X; (print) ISSN 2156-4868 (online)

ADVERTISE

Readership

INSIGHT reaches over 25,000 members and CAB associates and uncounted employees and students of more than 130 CAB organizations worldwide. Readership includes engineers, manufacturers/purchasers, scientists, research and development professionals, presidents and chief executive officers, students, and other professionals in systems engineering.

Issuance	Circulation
2024, Vol 28, 6 Issues	100% Paid

Contact us for Advertising and Corporate Sales Services

We have a complete range of advertising and publishing solutions professionally managed within our global team. From traditional print-based solutions to cutting-edge online technology the Wiley-Blackwell corporate sales service is your connection to minds that matter. For an overview of all our services please browse our site which is located under the Resources section. Contact our corporate sales team today to discuss the range of services available:

- Print advertising for non-US journals
- Email Table of Contents Sponsorship
- Reprints

- Supplement and sponsorship opportunities
- Books
- Custom Projects
- Online advertising

Click on the option below to email your enquiry to your nearest office:

- Asia and Australia corporatesalesaustralia@wiley.com
- Europe, Middle East and Africa (EMEA) corporatesaleseurope@wiley.com
- Japan corporatesalesjapan@wiley.com
- Korea corporatesaleskorea@wiley.com

USA (also Canada, and South/Central America):

- Healthcare Advertising corporatesalesusa@wiley.com
- Science Advertising Ads_sciences@wiley.com
- Reprints Commercialreprints@wiley.com
- Supplements, Sponsorship, Books and Custom Projects busdev@wiley.com

Or please contact: Marcom@incose.net

CONTACT

Questions or comments concerning:

Submissions, Editorial Policy, or Publication Management

Please contact: William Miller, Editor-in-Chief
insight@incose.net

Advertising—please contact:

Marcom@incose.net

Member Services – please contact: info@incose.org

ADVERTISER INDEX

May Volume 28-2

Dassault Systemes	inside front cover
Purdue University – Master's in Systems Engineering	page 7
Caltech	page 8
INNOSLATE	page 49
<i>Systems Engineering Journal</i> – Call for Papers	page 49
IS2025 Ottawa – Keynote Speakers	back inside cover
INCOS Career Center	back cover

CORPORATE ADVISORY BOARD — MEMBER COMPANIES

Advanced Systems Engineering, LLC
Aerospace Corporation, The
Airbus
AM General LLC
Analog Devices, Inc.
Arcfield
Auburn University
Australian National University
AVIAGE SYSTEMS
Aviation Industry Corporation of China, LTD
BAE Systems
Bechtel
Becton Dickinson
Belcan Engineering Group LLC
BMT Canada
Boeing Company, The
Booz Allen Hamilton Inc.
Boston Scientific Corporation
BTS Software Solutions
California State University Dominguez Hills
Carnegie Mellon Univ. Software Engineering Institute
Change Vision, Inc.
Colorado State Univ. Systems Engineering Programs
Cornell University
Cranfield University
C.S. Draper Laboratory, Inc.
Cubic Corporation
Cummins, Inc.
Cybernet MBSE Co, Ltd
Dassault Systèmes
Defense Acquisition University
Deloitte Consulting, LLC
Denso Create Inc
DENTSU SOKEN INC
Drexel University
Eaton
Eindhoven University of Technology
EMBRAER
FAMU-FSU College of Engineering
Federal Aviation Administration (U.S.)
Florida Institute of Technology
Ford Motor Company
GE Aerospace
General Dynamics
General Motors
George Mason University
Georgia Institute of Technology
Hitachi Energy
Honeywell Aerospace Technologies
Huawei Technologies Co. Ltd
IBM

Idaho National Laboratory
IQNOX, LLC
ISAE - Supaero
ISDEFE
IVECO Group
Jama Software
Jet Propulsion Laboratory
John Deere & Company
Johns Hopkins University
KBR, Inc.
KEIO University
L3Harris Technologies
Lawrence Livermore National Laboratory
Leidos
LEONARDO
Lockheed Martin Corporation
Los Alamos National Laboratory
Loyola Marymount University
Magna
ManTech International Corporation
Marquette University
Massachusetts Institute of Technology
MBDA (UK) Ltd
Medtronic
MetaTech Consulting Inc.
Missouri University of Science & Technology
MITRE Corporation, The
Mitsubishi Electric Corporation
Mitsubishi Heavy Industries, Ltd
Modern Technology Solutions Inc
National Aeronautics and Space Administration (NASA)
National Reconnaissance Office (NRO)
National Security Agency Enterprise Systems
Naval Postgraduate School
Nissan Motor Co, Ltd
Northrop Grumman Corporation
Pacific Northwest National Laboratory
Pennsylvania State University
Petrionas International Corporation Limited
Prime Solutions Group, Inc
Project Performance International (PPI)
Purdue University
QRA Corporation
RealmOne
Rolls-Royce
RTX
Saab AB
SAFRAN
SAIC
Sandia National Laboratories
Saudi Railway Company

SENSEONICS
Shanghai Formal-Tech Information Technology Co., Ltd
Shell
Siemens
Sierra Nevada Corporation
Singapore Institute of Technology
Southern Methodist University
SPEC Innovations
Stevens Institute of Technology
Strategic Technical Services LLC
Studio SE, Ltd.
Swedish Defence Materiel Administration (FMV)
Systems Planning and Analysis
Taiwan Space Agency
Tata Consultancy Services
Thales
The George Washington University
The University of Arizona
The University of Utah
Torch Technologies
TOSHIBA Corporation
Trane Technologies
Tsinghua University
UK MoD
UNCOMN
Universidade Federal De Minas Gerais
University of Alabama in Huntsville
University of Arkansas
University of California San Diego
University of Connecticut
University of Maryland
University of Maryland, Baltimore County
University of Maryland Global Campus
University of Michigan, Ann Arbor
University of New South Wales, The, Canberra
University of South Alabama
University of South-Eastern Norway (USN)
University of Texas at El Paso (UTEP)
US Department of Defense
Veoneer US Safety Systems, LLC
Virginia Tech
Volvo Cars Corporation
Volvo Construction Equipment
Wabtec Corporation
Wayne State University
Weber State University
Wichita State University College of Engineering
Woodward Inc
Worcester Polytechnic Institute (WPI)
Woven by Toyota, Inc.
Zuken, Inc

FROM THE EDITOR-IN-CHIEF

William Miller, insight@incose.net

We are pleased to publish the May 2025 *INSIGHT* published cooperatively with John Wiley & Sons as the systems engineering practitioners' magazine. The *INSIGHT* mission is to provide informative articles on advancing the practice of systems engineering as the state-of-the-art advances as evidenced in *Systems Engineering*, the Journal of INCOSE also published by Wiley, as well as papers presented at symposia and conferences by INCOSE and in the broader systems community.

The focus of this May issue of *INSIGHT* is "The State of the Systems Engineering Discipline: A Longitudinal Analysis of INCOSE International Symposium Contributions (2012–2025)" analyzed by INCOSE member Christian Sprague, PhD. The results of his analysis are of value to INCOSE in meeting the objectives of the INCOSE Strategic Plan v1.0 (17 June 2024) and especially of the future of systems engineering (FuSE) to realize the *System Engineering Vision 2035*. FuSE is charged by the Strategic Plan Objective O.1 Advance systems engineering as the world's trusted authority and Key Result KR1.1 Satisfaction of/progress against future of systems engineering roadmap.

Christian's article is a first-of-its-kind meta-analysis of data structured and maintained by INCOSE International Symposia submission database providing unprecedented insights into systems engineering evolution through a comprehensive examination of fourteen years of INCOSE

International Symposium contributions. By analyzing over 4,000 submissions from nearly 5,000 authors, this study delivers unique value through three interconnected analyses: 1) authors analysis, 2) topics analysis, and 3) acceptance analysis. Christian integrates these three interconnected analyses synthesizing key findings, identifying future research opportunities, recommendations for the systems engineering discipline, and a vision for systems engineering's future. The article appendix details the specifics of the analyses: 1) International Symposium submission database, 2) Simpson's indices for collaboration-based network analysis, 3) submission classification analysis, 4) statistical modeling, and 5) limitations and assumptions.

The Authors Analysis reveals a distinctive "hourglass network" where 10% of contributors generate 43% of intellectual output, alongside a critical 94% first-year attrition rate of submitters who do not submit beyond their initial submission. This social architecture illuminates both resilience mechanisms and vulnerability points within the knowledge ecosystem, offering stakeholders targeted intervention opportunities for community development.

The Topics Analysis documents the discipline's methodological transformation, quantifying the shift toward model-based systems engineering (MBSE) growing from 30% to 40% while revealing persistent knowledge gaps in theoretical foundations and empirical validation. The detailed taxonomic classification exposes high-value research frontiers at disciplinary

intersections previously unidentified.

The Acceptance Analysis uncovers systematic patterns in knowledge validation, demonstrating how acceptance rates have tightened year-over-year (90% to 40%) while certain submission characteristics significantly impact outcomes. This evidence-based filter mechanism provides contributors with strategic insights for knowledge dissemination.

Christian's analysis does not address causation. There is known, anecdotal, and unknown context to the results he reports. An example of the former is the drop off in participation of US government employees and perhaps contractors attending conferences beginning in 2012 attributable to an infamous event held by the US General Accounting Office (GAO) outside Las Vegas, US-NV, in 2010 widely publicized in 2012. A consequence was severe restrictions on authorized US government travel and conference expenses that continues to the present. The current cuts in US government funded research and development for academia and industry will affect participation in INCOSE events. Your editor is aware of individuals who have continued to participate in INCOSE extents at their own expense. Anecdotal context should be substantiated and unknown context discovered. An example is the causation of the 94% attrition rate of first-time submitters not subsequently submitting papers/presentations needs discovery.

Perhaps some of the gaps in Christian's analysis such as theoretical foundations

and empirical validation are addressed elsewhere. Your editor encourages similar analyses of authors analysis, topics analysis, and acceptance analysis in other systems community venues, including: a) Conference on Systems Engineering Research (CSER), b) Council of Systems Engineering Universities (CESUN) <https://cesun.org/>, c) INCOSE EMEA and Asia-Oceania sectors, d) INCOSE national chapters and regional events <https://www.incose.org/events>, e) systems community related events

by IEEE, IISE, AIAA, etc, and f) Systems Engineering Research Center (SERC) <https://sercuarc.org/> and it's partners in the Archimedes Initiative (see December 2022 *INSIGHT* Vol 25 Issue 4).

We hope you find *INSIGHT*, the practitioners' magazine for systems engineers, informative and relevant. Feedback from readers is critical to *INSIGHT*'s quality. We encourage letters to the editor at insight@incose.net. Please include "letter to the editor" in the subject line. *INSIGHT* also

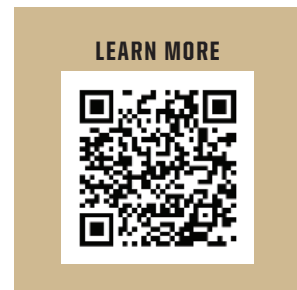
continues to solicit special features, stand-alone articles, book reviews, and op-eds. Please contact us at FuSE@incose.net if you are interested in contributing to our body of knowledge accounting for uncertainty in the engineering of systems. For information about *INSIGHT*, including upcoming issues, see <https://www.incose.org/publications/INSIGHT>. For information about sponsoring *INSIGHT*, please contact the INCOSE marketing and communications director at marcom@incose.net. ■



Your next giant leap is online *Earn your Master's in Systems Engineering*

Purdue University's online Master of Science in Systems Engineering offers a flexible, interdisciplinary curriculum for professionals looking to advance their expertise in complex system design, analysis, and optimization. Developed with Purdue's Systems Collaboratory, this program emphasizes leadership, technical communication, and cross-disciplinary problem-solving, allowing students to tailor their learning experience to career goals while gaining cutting-edge knowledge applicable to aerospace, manufacturing, and defense industries.

- Control Systems
- Engineering Economic Analysis
- Game Theory
- Human Factors
- Machine Learning
- Multidisciplinary Design Optimization
- Practical Systems Thinking
- Project Management
- Reliability Based Design





Need to Scale Active Learning in the Enterprise? We Have the Science for That.

Empower your team with the essential digital engineering and machine learning skills to excel in today's competitive landscape. With a strong foundation in SE/MBSE taught by industry-leading experts, your team will be well-equipped to elevate performance and enable data-driven organizational transformation. Custom client programs and public courses available. Explore your options today.

Customizable Learning Programs For Your Organization & Teams



**Customizable
Programs for Groups and
Enterprise Learning**



**New Courses in
Artificial Intelligence &
Machine Learning**



**Short Courses
and Certificates
for Individuals**

Caltech Center for Technology &
Management Education

Get started:

ctme.caltech.edu

Connect with an advisor:

execed@caltech.edu

Aerospace • Agriculture • Automotive • Biotech • Chemical • Communications
Defense • Electronics • Energy • Government • High-Tech • Life Sciences
Medical Devices & Diagnostics • Precision Manufacturing • Scientific Research



The State of the Systems Engineering Discipline: A Longitudinal Analysis of INCOSE International Symposium Contributions (2012–2025)

Christian Sprague, PhD, Stevens Institute of Technology, INCOSE, csprague@stevens.edu

Copyright ©2025 by Christian Sprague. Permission granted to INCOSE to publish and use.

Acknowledgements: This research utilized data structured and maintained by the International Council on Systems Engineering (INCOSE) International Symposium submission database. The data was modified for analysis purposes using methodologies developed by the researcher and may not be identical to those data collected and maintained by INCOSE's official records. Results, information, and opinions solely represent the analysis, information, and opinions of the author and are not endorsed by, or reflect the views or positions of, grantors, INCOSE, Stevens Institute of Technology, or any employee thereof.

■ ABSTRACT

This first-of-its-kind meta-analysis provides unprecedented insights into systems engineering's evolution through a comprehensive examination of fourteen years of INCOSE International Symposium contributions. By analyzing over 4,000 submissions from nearly 5,000 authors, this study delivers unique value through three interconnected analyses: The Authors Analysis reveals a distinctive "hourglass network" where 10% of contributors generate 43% of intellectual output, alongside a critical 94% first-year attrition rate. This social architecture illuminates both resilience mechanisms and vulnerability points within the knowledge ecosystem, offering stakeholders targeted intervention opportunities for community development. The Topics Analysis documents the discipline's methodological transformation, quantifying the shift toward model-based systems engineering (MBSE) growing from 30% to 40% while revealing persistent knowledge gaps in theoretical foundations and empirical validation. The detailed taxonomic classification exposes high-value research frontiers at disciplinary intersections previously unidentified. The Acceptance Analysis uncovers systematic patterns in knowledge validation, demonstrating how acceptance rates have tightened year-over-year (90% to 40%) while certain submission characteristics significantly impact outcomes. This evidence-based filter mechanism provides contributors with strategic insights for knowledge dissemination. Through synthesizing these analyses, this research provides a cohesive portrait of a discipline at an inflection point—transitioning from practice-driven origins toward greater formalization. For INCOSE leadership, educators, and practitioners, these integrated insights enable data-driven strategies to strengthen community resilience, address knowledge gaps, and enhance systems engineering's capacity to tackle the increasingly complex sociotechnical challenges of the 21st century.

I. EXECUTIVE SUMMARY

A. Purpose and Scope of Analysis

This longitudinal meta-analysis examines the state of the systems engineering discipline through an unprecedented examination of INCOSE International Symposium contributions spanning 2012–2025.

By systematically analyzing over 4,000 submissions from nearly 5,000 authors across fourteen years, this research illuminates the intellectual trajectory, social architecture, and validation mechanisms that collectively shape systems engineering's development during a period of significant

methodological transformation.

The investigation addresses four interrelated dimensions that together offer a glimpse into the knowledge ecosystem within which systems engineering operates. First, the author demographics analysis investigates participation patterns,

geographic distribution, institutional affiliations, and collaborative networks to reveal how the discipline's social structure influences knowledge creation. Second, the content analysis traces the evolution of submission types, methodological approaches, and application domains to identify paradigmatic shifts in systems engineering practice. Third, the submission acceptance analysis assesses the filtering mechanisms that determine which contributions enter the formal knowledge base, revealing both explicit criteria and implicit preferences that shape the discipline's intellectual direction. Finally, the analysis synthesizes these dimensions to characterize the resilience, vulnerability, and trajectory of the international systems engineering community.

This research employs a multi-method analytical framework that integrates bibliometric techniques, social network modeling, and statistical classification to extract meaningful patterns from the symposium submission data. The bibliometric component quantifies content trends across topics, methodologies, and domains, while network modeling visualizes and measures collaboration structures that facilitate knowledge exchange. Advanced statistical approaches, including logistic regression, identify systematic predictors of submission acceptance while controlling for confounding variables.

The findings presented here serve multiple stakeholder communities within the systems engineering ecosystem. For INCOSE leadership, the analysis provides empirical foundations for strategic decision-making regarding community development, knowledge gaps, and symposium structure. For educators, the documented evolution of methodological approaches offers evidence-based insights to align curriculum with emerging practice. For practitioners, the identified trends in methods, tools, and application domains provide direction for professional development. For researchers, the mapped knowledge landscape reveals high-value opportunities – specifically at the intersection of underdeveloped theoretical foundations and empirical validation needs.

As the first comprehensive meta-analysis of this extensive dataset, this research establishes both a historical record of systems engineering's past development and a strategic guide for shaping its future direction. By systematically documenting the discipline's intellectual growth, social dynamics, and validation mechanisms, the study provides an evidence-based foundation for enhancing systems engineering's capacity to address increasingly complex sociotechnical challenges in the 21st century.

B. Key Findings

For readers interested in the methodological details of the database underlying these findings, details are provided in the Appendix under *Methodological Details: International Symposium Submission Database*.

1. Conference Overview

The International Symposium has maintained a robust global presence throughout the past fourteen-year analysis period, demonstrating INCOSE's commitment to fostering international engagement within the systems engineering community. Between 2012 and 2025, the symposium rotated across twelve distinct locations spanning three continents, with venues distributed across North America (8 locations including Seattle, Las Vegas, Washington DC, and Honolulu), Europe (3 locations including Edinburgh, Rome, and Dublin), and Australia (Adelaide). This geographic distribution pattern, while intentionally international, reveals a notable concentration in North American venues, which comprise approximately 67% of the total hosting locations.

The symposium's submission volume exhibits a distinct temporal pattern characterized by remarkable stability followed by significant expansion. From 2012 to 2022, submissions maintained consistent annual volumes ranging between 200-300 contributions. However, the post-pandemic period witnessed an unprecedented surge in participation, with submission counts escalating dramatically to 411 in 2023, peaking at 576 in 2024, before moderating slightly to 404 in 2025. This pronounced growth coincides with the return to in-person conference formats after the virtual-only events necessitated during the COVID-19 pandemic (2020-2021).

Throughout the fourteen-year period, the symposium has maintained four primary contribution tracks – papers, presentations, panels, and tutorials – but their relative prominence has undergone significant transformation. The early period (2012-2017) featured overwhelming dominance of the papers track, which constituted the primary vehicle for knowledge exchange. A pivotal shift occurred in 2018 with the introduction of the presentations track, which rapidly gained traction and achieved near parity with papers by 2024. This structural shift from predominantly paper-based dissemination toward more diverse presentation formats suggests a strategic rebalancing of formal documentation and interactive knowledge sharing. The swift adoption of the presentations format indicates growing demand for dynamic, demonstration-oriented venues to share

emerging practices and tools and testing early-stage concepts, particularly as model-based approaches mature.

Collectively, the geographic patterns, submission volume trends, and track evolution provide critical context for interpreting disciplinary health – which will be further explored in subsequent sections – and gives structure to evaluate discipline's unfolding during this pivotal period of methodological transition.

2. Authorship Patterns

Analyzing the authorship patterns in the INCOSE International Symposium from 2012-2025 reveals a complex social architecture that shapes how systems engineering knowledge forms. The data paints a portrait of both stability and flux within the community's participation dynamics.

Notably, the symposium's author demographics exhibit substantial turnover rates, with yearly retention averaging approximately 43%. Despite this apparent instability, the community has experienced significant growth in active contributors, particularly during 2022-2024, culminating in a peak of 1,071 unique authors in 2024. This expansion is continually refreshed by new participants, who constitute an average of 61% of each year's contributor pool. Such demographic patterns suggest a discipline that maintains vitality through brand-new perspectives while simultaneously struggling with participant retention.

Contribution patterns demonstrate pronounced concentration within the authorship population. The distribution of intellectual output follows a classic power-law relationship characteristic of most knowledge-production communities (Gini coefficient of 0.45). The upper echelon of contributors – specifically the top 1% – accounts for 13.2% of all submissions, while the top 10% generates 43.5% of total content. This concentration becomes even more striking when juxtaposed with the finding that 68.6% of authors (3,301 individuals) contributed only once throughout the fourteen-year period. In contrast, the most prolific individual author generated 74 submissions – equivalent to continuous participation averaging more than five contributions annually.

The longitudinal analysis of collaboration reveals subtle yet meaningful explanation in how systems engineering knowledge is co-created. Solo authorship has experienced a modest decline (from 33.4% in 2012 to 28.0% in 2025), accompanied by corresponding increases in team-authored submissions. This gradual shift suggests a discipline increasingly incorporating integrative perspectives when addressing advanced systems engineering challenges.



Figure 1. International Symposium conference locations

Note: The geographic distribution of the International Symposium (IS) conference locations from 2012–2025. The visualization maps 12 distinct host cities across North America, Europe, and Australia using a geospatially accurate WGS84 projection. The map highlights the conference's international rotation strategy, with strong representation in North America (7 locations: Seattle, Las

Vegas, Washington DC, Orlando, Philadelphia, Detroit, Honolulu) and Europe (4 locations: Edinburgh, Rome, Dublin, Ottawa), plus one location in Australia (Adelaide). A red annotation indicates the 2020–2021 virtual conferences conducted during the COVID-19 pandemic. Data source: <https://www.incose.org/events/incose-previous-international-events>.

One striking finding is how future participation correlates with previous engagement. First-time contributors face what might be termed a “steep experience gradient,” with only 5.3% returning in the subsequent year. However, this frequency rises dramatically with accumulated experience, reaching 67.6% for those with seven or more years of participation history. This pattern creates a self-reinforcing dynamic where established contributors become increasingly embedded in the community while newcomers largely depart – effectively establishing a stable core amid peripheral flux.

The collaboration network analysis further illuminates the social structure underlying systems engineering knowledge production. Simpson's diversity indices reveal that researchers who develop connections with diverse collaborators tend to engage in more substantive distributed collaborations across projects. The relationship between collaboration breadth and depth intensifies at higher values, suggesting a network effect where well-connected contributors unlock exponentially more opportunities for meaningful engagement across the discipline.

These authorship patterns highlight an intellectual ecosystem with pronounced stratification – a discipline where knowl-

edge contribution follows distinctive patterns of concentration and where participation experiences differ markedly between established and new contributors. Understanding these dynamics provides crucial insight into both the resilience mechanisms and vulnerability points within systems engineering's knowledge architecture.

3. Content Evolution

The analysis of International Symposium submissions provides deep insight into the intellectual development of systems engineering over the past fourteen-year period. These patterns manifest not merely as fluctuations in topic popularity, but as indicators of how the discipline conceptualizes, approaches, and engineers systems.

Interestingly, contribution types demonstrate remarkable stability in their proportional distribution across the study period. Methodological contributions consistently dominate the knowledge landscape, comprising 30–40% of submissions annually. This prevalence underscores a discipline occupied primarily with developing structured approaches, frameworks, and processes to address complex system challenges. Tools and technologies follow closely behind, maintaining 25–30% of submissions – a testament to systems engineering's practical orientation toward

operationalizing frameworks through tangible implementations.

Around 2015, a subtle but notable shift occurred: applications-focused submissions experienced a modest decline, coinciding with a complementary increase in methodological contributions. This inflection point suggests a disciplinary pivot away from implementation case studies, instead amplifying efforts toward method and process development.

The most pronounced transformation appears across the landscape of systems engineering approaches. Model-based systems engineering (MBSE) approaches have demonstrated continuous growth throughout the study period, rising from approximately 30% to 40% of submissions. This growth trajectory accelerated notably after 2020, establishing MBSE as an increasingly dominant paradigm within the discipline. This ascendance has occurred in parallel with a proportional decline in traditional, document-centric approaches, suggesting a zero-sum relationship where MBSE gains have come at the expense of content interested in foundational systems engineering approaches.

Application domains exhibit equally revealing pattern shifts. Computing, software, and intelligent systems are emerging as increasingly central for systems engineer-

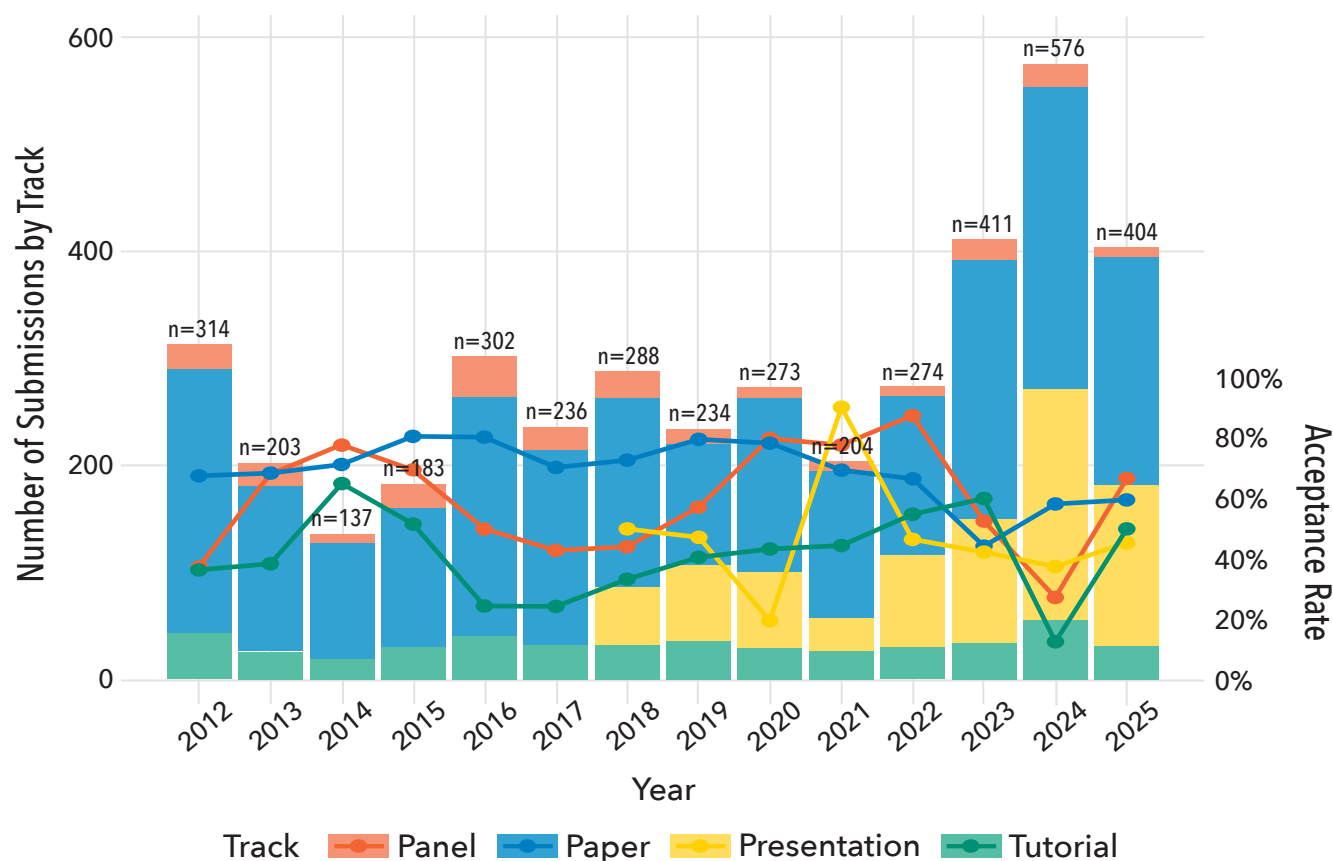


Figure 2. Submission trends by track type and annual acceptance rates (2012-2025)

Note: A dual-axis visualization showing the evolution of INCOSE submissions over time. The stacked bars represent the absolute number of submissions categorized by track type (Papers, Presentations, Panels, Tutorials, and Other), with each type distinguished by color according to the INCOSE color palette. The line overlay, referenced on the secondary y-axis, tracks the annual acceptance rate per track as a percentage. Labels above each bar indicate the total submission count for each year (n=value).

The general trend shows a stable submission volume from 2012-2021, followed by a significant spike in 2023 (n=576), with papers dominating early years while presentations gained substantial share from 2018 onward, all accompanied by a notable decline in acceptance rates after 2021. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

ing practice, showing consistent growth particularly in recent years. This upward trajectory corresponds with the proportional decline of domain-free approaches since 2020, suggesting a disciplinary movement away from generalized methodologies toward specialized implementations tailored for digital engineering and computational environments.

Meanwhile, traditional systems engineering domains maintain their stronghold despite these shifts. Aerospace and defense applications, coupled with commercial and industrial systems, demonstrate moderate yet stable representation throughout the study period. This constancy amid methodological transformation indicates these sectors' enduring importance as proving grounds for systems engineering approaches, even as the discipline diversifies its application contexts.

The gradual alignment between MBSE's methodological growth and the increasing

prevalence of computing, software, and AI applications reveals a deeper narrative of disciplinary convergence. Systems engineering is increasingly operating in digital contexts where model-based approaches provide natural interfaces to software engineering methods. This alignment facilitates integration across disciplines that were previously separated by incompatible representations – potentially enabling more sophisticated processes to increasingly software-intensive systems.

What arises from these patterns is not merely a catalog of changing topics but a portrait of a discipline in transition – developing from its practice-driven origins toward greater technological sophistication while maintaining connection to traditional application domains. This reorientation suggests systems engineering is not simply adopting new tools but fundamentally reconceptualizing how engineered systems are understood, designed, and implemented

in an increasingly digital world.

4. Acceptance Dynamics

The acceptance analysis examines the systemic patterns in the symposium's review process, investigating what submissions achieve acceptance, whether evaluations demonstrate consistent fairness, and which factors most significantly predict outcomes. Figure 2 demonstrates significant variation across submission tracks, with papers showing higher average acceptance rates (67.4%) compared to presentations (42.8%), panels (54.8%), and tutorials (38.9%). This distribution primarily reflects the supply and demand dynamics of the technical program – where program capacity constraints and allocation decisions meet submission quality and quantity.

Systems thinking, complexity, and sociotechnical approaches demonstrate the highest acceptance rate (67.6%) among engineering methodologies, suggesting

preference for integrative perspectives that encompass both technical and social dimensions of systems engineering. Submissions by authors with academic affiliations achieve substantially higher acceptance rates (65.0%) compared to non-academic authors (53.1%), indicating potential differences in how scholarly and practitioner-oriented contributions are evaluated.

A logistic regression statistical model reveals that acceptance decisions follow consistent (unbiased) evaluation patterns rather than arbitrary judgments, with the model achieving exceptional explanatory power (McFadden R^2 : 0.465; AUC: 0.848). Key predictors of acceptance include reviewer evaluations (the strongest predictor), track type, and author team composition. Overall, the model confirms the review process operates with reasonable fairness, without evidence of bias or manipulation.

Most notably, the temporal analysis reveals a significant year-over-year decline in acceptance rates from approximately 90% in 2012 to 40% by 2025, holding all other factors constant. This pronounced time effect suggests increasing selectivity and standards as the symposium has grown, independent of changes in submission volume, quality, or composition. The virtual conference format during COVID-19 (2020-2021) demonstrates a significant positive effect on acceptance probability (OR=3.216, $p<0.05$), suggesting these exceptional circumstances greatly influenced acceptance dynamics.

The experience gradient in acceptance patterns is particularly noteworthy. Submissions featuring experienced authors (those with multiple years of symposium participation) show progressively higher acceptance probabilities. This creates a reinforcing cycle where established contributors maintain greater inclusion in the technical program, potentially creating structural barriers for newcomers whose perspectives might challenge established thinking.

These acceptance patterns reveal a technical program that results from meritocratic evaluation and systematic structural influences. Collectively, these shaping both what enters the systems engineering knowledge base and how the discipline develops.

C. Implications for Systems Engineering Community

The patterns uncovered in this longitudinal analysis suggest potentially important implications for the systems engineering community. While these findings specifically reflect this particular knowledge exchange venue, these findings may indicate broader trends worthy of further investigation.

At the community's core lies what might be termed the "hourglass network" structure. The International Symposium submission data reveals thousands of contributors entering at the top, yet narrows dramatically as just 10% of these participants generate nearly half of all intellectual output. This concentration suggests both potential stability and possible vulnerability. The small core of prolific contributors appears to function as intellectual stewards, potentially maintaining continuity at the cost of filtering innovation. Additionally, this structure may create conditions where certain perspectives receive disproportionate representation in the formal knowledge base.

The "94% problem" – where approximately 94% of first-time contributors to the IS do not return the following year – represents a concerning pattern within this particular knowledge venue. This high attrition rate suggests the possibility of lost intellectual diversity, as new perspectives may depart before they can meaningfully contribute to the discipline's development through this forum. This pattern might indicate challenges in the knowledge transfer mechanisms within the symposium context, though additional research would be needed to determine whether these contributors engage through other venues.

The potential knowledge transfer challenges become particularly noteworthy when considered alongside the documented shift toward model-based approaches. While MBSE provides enhanced computational capabilities, it represents a fundamental change in how systems knowledge is represented and manipulated. The symposium data indicates MBSE submissions have increased from approximately 30% to 40%, suggesting growing prominence of modeling approaches that may require different competency development pathways than traditional document-centric systems engineering.

This transformation occurs within a discipline that demonstrates limited empirical validation research, representing just 3% of symposium contributions across fourteen years. Without systematic validation of which approaches deliver measurable value in specific contexts, the systems engineering community may lack sufficient evidence-based research to guide effective methodological selection. This relative absence of validation studies within the symposium suggests a potential gap that merits attention.

The institutional dynamics revealed in the acceptance analysis add another important dimension. The academic-industry divide – reflected in the 12% acceptance rate gap between scholarly-affiliated and practitioner submissions – suggests the possibility of

parallel knowledge streams that may evolve with limited cross-pollination.

Geographic representation patterns suggest North American perspectives predominate in this venue (approximately 50% of contributors), potentially limiting the diversity of thought represented. This geographic concentration may reflect symposium location patterns or other factors requiring further investigation.

These patterns collectively suggest a discipline likely approaching an inflection point with different possible trajectories. The systems engineering community might benefit from thoughtful consideration of how to balance methodological innovation with knowledge transfer mechanisms that preserve valuable experiential wisdom. As model-based approaches continue advancing, ensuring the development of complementary systems thinking and non-technical competencies may prove essential.

With deliberate action, the systems engineering community could potentially enhance mechanisms that systematically capture experiential knowledge, validate effective practices through empirical research, and create knowledge transfer pathways that combine modeling proficiency with robust foundational approaches. This might involve reimagining knowledge transfer not merely as document-based or model-based, but as a multifaceted learning system that addresses both explicit and tacit dimensions of systems engineering expertise.

By understanding these potential dynamics within the IS context, stakeholders may gain insights that help intentionally shape community development strategies, prevent inertia, and strengthen the discipline's capability to address increasingly complex sociotechnical challenges.

D. Recommendations for Stakeholders

Based on the comprehensive analysis of INCOSE's International Symposium data from 2012-2025, the following evidence-based recommendations emerge for key stakeholders in the systems engineering ecosystem:

1. For INCOSE Leadership

Engineer a compelling value ecosystem for new contributors. The data reveal a fundamental value gap, evidenced by only 5.3% of first-time contributors returning the following year. This requires reimagining the contributor experience as an integrated system with compounding benefits:

1. Implement a strategy that pairs established contributors with newcomers to preserve institutional wisdom while infusing fresh perspectives. This connection would address the

vulnerability created by the current hub-and-spoke community structure where knowledge concentration in a small core creates both opportunity and risk. Consider structured mentorship programs, collaborative submission opportunities, and recognition systems that reward knowledge transfer activities between experienced and emerging contributors.

2. Strategically diversify conference locations to expand global participation. The geographic analysis demonstrates that regional proximity significantly impacts author participation patterns, with clear clustering effects around host locations. Implementing a more balanced global rotation strategy – particularly increasing representation in Asia-Oceania and underrepresented European regions – could catalyze engagement from burgeoning systems engineering communities. However, this should be done in balance to mitigate disrupting the mature North American community.
3. Elevate integration of modeling approaches with implementation evidence. The increasing representation of MBSE submissions creates an opportunity to strengthen connections between modeling methodologies and practical outcomes. Consider implementing pathways that encourage contributors to demonstrate how modeling approaches translate to measurable systems improvements, dedicated tracks highlighting implementation results, and cross-disciplinary dialogues that connect modeling practitioners with domain experts and academic researchers. This integration would enhance knowledge transfer while providing more substantive value for symposium participants across the theory-practice spectrum.

2. For Systems Engineering Educators and Researchers

1. Develop integrated MBSE-systems thinking curricula that bridge the technical-conceptual divide. The data reveals simultaneous growth in model-based approaches and strong demand for systems thinking, complexity, and sociotechnical perspectives suggests powerful innovation potential at their intersection.
2. Target research toward identified knowledge gaps in the systems engineering landscape. The relative underrepresentation of empirical validation, theoretical foundations,

and certain application domains (particularly infrastructure systems) represents high-value research opportunities.

3. Design research programs that explicitly bridge academic-practitioner divides. Collaborative research initiatives with mixed academic-industry teams could help overcome the documented participation and acceptance gaps between these communities.
 4. Cultivate transdisciplinary research communities that extend beyond traditional systems engineering boundaries. The growth in systems engineering approaches suggests fertile ground for cross-disciplinary innovation, particularly with fields like cognitive science, complexity theory, and sustainability.
- ### **3. For Systems Engineering Practitioners**
1. Amidst developing model-based competencies, invest in empirical awareness and theoretical understanding. The clear trend toward MBSE approaches indicates this is becoming the dominant paradigm, however, the higher acceptance rates for research-oriented submissions suggests demand for valuable insights outside technical contributions.
 2. Structure knowledge capture and dissemination to better translate practice into formal contributions. The underrepresentation of application-based, empirically rich papers, coupled with lower acceptance rates for non-academic contributions, points to opportunities for practitioners to more effectively share implementation experiences.
 3. Develop personal collaboration networks that span academic and industry boundaries. The data shows increasing collaboration breadth and depth among authors, suggesting network development represents a vital strategic resource for both knowledge access and contribution impact.
 4. Leverage symposium participation for strategic learning. The documented pattern of increasing content toward MBSE and computing, software, AI domains provide valuable insights for organizational capability development and workforce planning.

These recommendations, grounded in the empirical evidence from fourteen years of INCOSE symposium data, offer a roadmap for strengthening both individual participation and collective advancement of the systems engineering discipline during a period of significant paradigmatic and

community transformation.

E. Conclusion

This comprehensive analysis of the INCOSE International Symposium highlights a systems engineering discipline in transformation – methodologically, structurally, and culturally. As the field continues to grow, two major critical decision points will likely heavily influence its development and impact. First, the discipline currently faces the challenge of either maintaining its traditional identity as a technically oriented discipline focused on practical methodologies or developing more robust foundations that could establish a distinctive epistemological framework beyond process-oriented approaches. Second, the discipline's ability to effectively bridge the divide between academic research and practitioner implementation, while creating viable engagement pathways for new contributors globally, will determine whether it becomes a truly cross-cutting field or becomes increasingly specialized with a concentrated knowledge base.

The remainder of this report is organized into four major sections that systematically examine the International Symposium knowledge ecosystem. Section II (Authors Analysis) explores the social architecture behind INCOSE contributions, analyzing geographic distribution, institutional affiliation patterns, and collaboration networks that shape knowledge creation and dissemination. Section III (Topics Analysis) investigates the intellectual content evolution through track types, contribution categories, methodological approaches, and application domains, revealing how systems engineering's substantive focus has transformed over fourteen years. Section IV (Acceptance Analysis) examines the technical review mechanisms that filter and validate systems engineering knowledge, identifying factors that predict submission acceptance and how these patterns reflect disciplinary priorities. Section V (Discussion and Future Directions) synthesizes these findings into a cohesive narrative of disciplinary transformation, offering strategic recommendations and research opportunities to address identified knowledge gaps and community challenges. The Appendix provide detailed methodological documentation, providing analytical transparency for future research.

The findings from this study ultimately offer stakeholders – from INCOSE leadership to educators, researchers, and practitioners – evidence-based insights to navigate the critical decisions that lay ahead. By understanding the discipline's intellectual, social, and validation architectures, stakeholders can intentionally

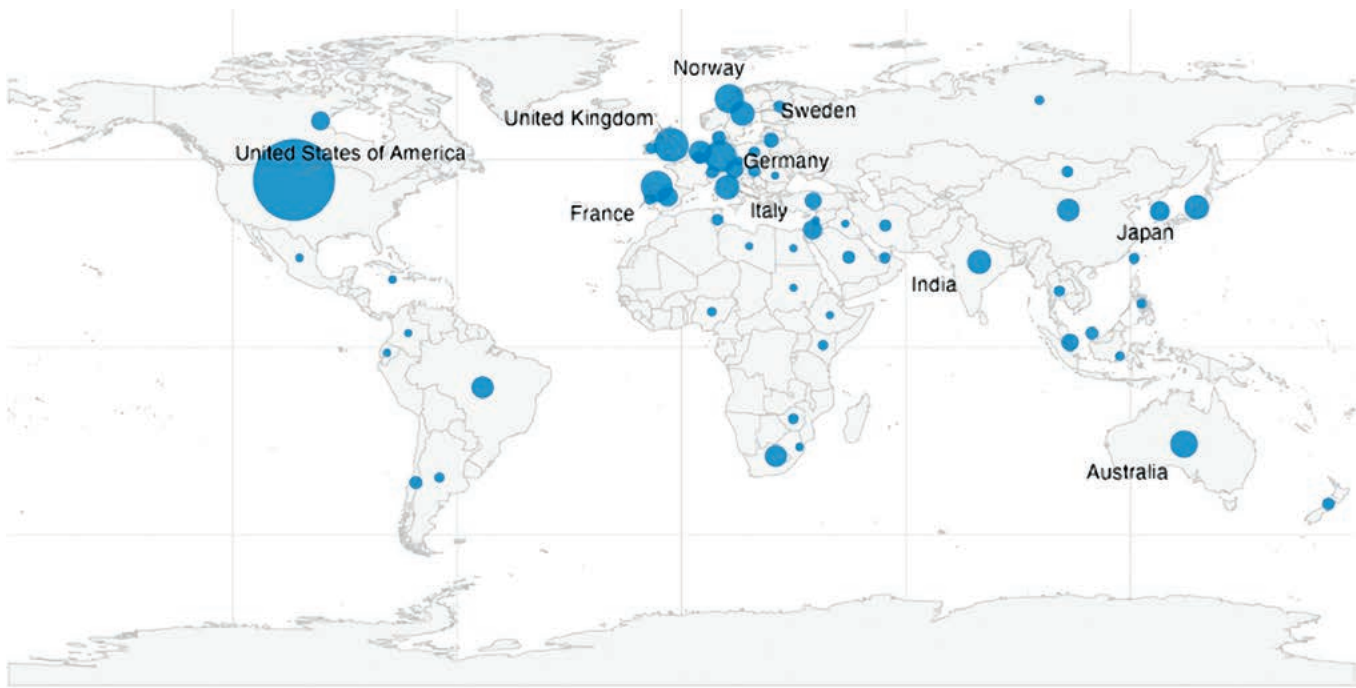


Figure 3. Percentage author contributions by country of origin

Note: The global distribution of authors contributing to INCOSE submissions from 2012-2025. The map employs a proportional symbol approach, with circle size representing each country's percentage contribution to the overall author pool. The United States demonstrates the highest representation (approximately 50%), followed by significant contributions from European countries (United Kingdom (6%), Germany (5%), France (5%)), as well as Australia (3%), Japan (2%), and India (2%). Data processing

required standardization of country names through custom mapping functions to ensure proper geographic attribution. The map was generated with WGS84 projection (EPSG:4326) for accurate global positioning. Country labels are applied to the top 10 contributing nations to minimize obscuration while maintaining readability. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

shape its trajectory toward greater innovation, inclusivity, and real-world impact in addressing increasingly complex social and technical challenges.

II. AUTHORS ANALYSIS

A. Introduction

The systems engineering discipline constitutes its own sociotechnical system whose shape is defined by the contributing community. This section examines the human infrastructure behind INCOSE International Symposium contributions from 2012 to 2025, revealing patterns that illuminate how knowledge is generated, disseminated, and concentrated within the field.

By analyzing metadata from 4,813 unique authors across 4,038 submissions, we uncover the social architecture that influences which methodologies gain traction, how knowledge diffuses through practice, and where barriers to participation may exist. The investigation addresses four critical dimensions: geographic distribution patterns, institutional affiliation trends, productivity and collaboration networks, and longitudinal participation dynamics.

These patterns reveal more than merely

who contributes – they illuminate properties of the systems engineering knowledge creation itself. The analysis suggests the dynamic of what might be described as an “hourglass network” of knowledge exchange within systems engineering. This distinctive structure is characterized by broad initial participation at the top, a narrow filtering mechanism through a small core of prolific contributors in the middle, and wide diffusion of established concepts at the bottom.

Through quantitative analysis of author demographics and contribution behavior, we gain insight into the underlying mechanisms that drive the discipline's development during a period of significant methodological transformation. The following provides evidence-based insights into the community structures that both enable and potentially constrain systems engineering's intellectual evolution.

B. Geographic & Affiliation Patterns

This section explores the geographical and institutional composition of systems engineering as reflected in International Symposium contributions, revealing how knowledge development in the field is

shaped by regional concentrations and organizational affiliations.

1. Global Distribution with Regional Concentration

Analysis of author geographic data reveals a discipline with worldwide participation but significant regional imbalances, see Figure 3. The United States dominates the contributor landscape, accounting for approximately 50% of all authors across the study period. European nations collectively form the second major hub, with the United Kingdom (6%), Germany (5%), and France (5%) leading regional participation. The Asia-Oceania region shows more modest but consistent representation, with Australia (3%), Japan (2%), and India (2%) emerging as key nodes in this region.

This geographic distribution creates natural network effects that influence both knowledge diffusion patterns and methodological preferences. The concentration of authors in North America and Western Europe establishes these regions as dominant knowledge production centers – which correspond to conference location preference – potentially creating echo chambers where geographically

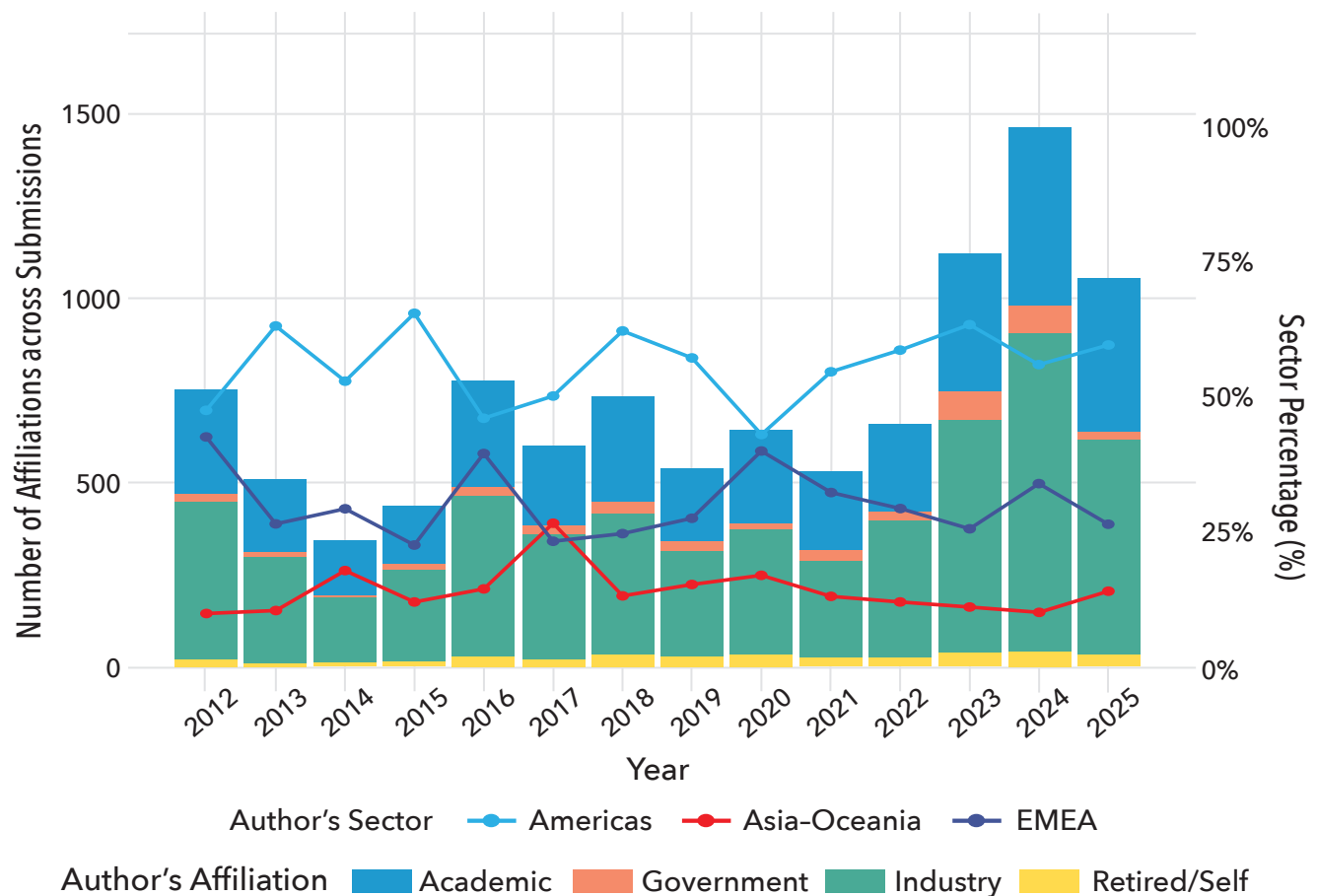


Figure 4. Demographics by affiliation types and regional distribution (2012-2025)

Note: Dual-axis visualization illustrating the evolution of INCOSE author demographics over a 14-year period. The stacked bars represent the absolute number of affiliations categorized (Academic, Government, Industry, and Retired/Self) across all submissions, with industry consistently forming the foundation of contributions. The overlaid lines, referenced on the secondary y-axis, track the percentage of authors by geographic sector (Americas, EMEA, and Asia-Oceania). Notable trends include a

dramatic increase in academic contributions during 2023-2024, with submissions nearly tripling compared to earlier years. The Americas maintain the highest regional representation throughout the period (50-65%), while EMEA shows moderate fluctuation (25-40%), and Asia-Oceania remains a smaller but consistent contributor (10-15%). Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

favorable approaches experience easier acceptance. Meanwhile, regions with lower representation, particularly Eastern Europe, Africa, and parts of Asia, remain at the periphery of formal knowledge networks despite potentially offering unique systems engineering perspectives shaped by different sociocultural contexts.

2. Institutional Affiliation Dynamics

The systems engineering community's institutional composition reveals both remarkable compositional consistency and significant growth during the study period, as illustrated in Figure 4. Industry affiliations form the backbone of the contributor ecosystem (60-70% of authors), reflecting the discipline's foundation in practical application rather than stemming from theoretical investigation. However, a dramatic academic surge emerged during 2023-2025,

with scholarly-affiliated participation nearly tripling compared to earlier years – potentially signaling a burgeoning shift in systems engineering's intellectual landscape.

This institutional shift unfolded across three distinct phases: a modest diversification period (2016-2019) featuring increased government participation; a pandemic-era stabilization (2020-2021) where institutional proportions remained relatively steady despite disrupted conference formats; and finally, the substantial academic expansion (2023-2025) that coincided with accelerated adoption of MBSE approaches, suggesting potential synergy between academic growth and the demands that come from methodological sophistication.

National variations in institutional affiliation reveal distinctive systems engineering ecosystems across countries, detailed in Table 1. France (85.0%) and India

(83.0%) demonstrate pronounced industry dominance, creating knowledge environments focused on implementation rather than scholarly research. Norway presents a contrasting profile with strong academic concentration (60.6%), while Sweden exhibits the most balanced public-private integration with substantial government participation (12.6%) alongside robust academic representation (45.9%). Japan's complete absence of government-affiliated contributors (0.0%) paired with strong industry presence (76.2%) indicates a corporate-driven systems engineering landscape largely disconnected from public sector engagement.

The United States maintains near-equilibrium between industry (50.7%) and academia (41.1%), establishing a balanced knowledge exchange environment where research advances and practical

Table 1. Geographic distribution of authors by affiliation type (2012-2025)

Year	Team Size (%)		
	Solo Author	2-3 Authors	4+ Authors
2012	33.4	49.4	17.2
2013	38.9	42.4	18.7
2014	36.8	41.9	21.3
2015	37.9	39.6	22.5
2016	32.1	43.1	24.8
2017	30.2	46.8	23.0
2018	31.3	47.9	20.8
2019	40.3	40.8	18.9
2020	32.7	51.1	16.2
2021	28.4	51.0	20.6
2022	36.9	46.0	17.2
2023	28.9	46.5	24.7
2024	32.1	47.6	20.4
2025	28.0	48.8	23.3

Notes:

1. Annual distribution of INCOSE submissions across three dimensions: team size, geographic region, and author affiliation. Team composition has shifted moderately over time, with a slight decline in solo authorship (from 33.4% in 2012 to 28.0% in 2025) and a corresponding increase in collaborative submissions, particularly in the 2-3 author category (consistently representing 40-51% of submissions). Geographically, Americas-affiliated authors have maintained dominant representation (averaging approximately 64%), while EMEA participation has fluctuated (26-52%), and Asia-Oceania has maintained a smaller but consistent presence (13-29%). Industry-affiliated authors have consistently contributed to 61-72% of submissions across the period, with academic affiliation showing more variability (35-53%). Government and retired/self-employed authors have maintained minor but steady representation.
2. Team Size Percentage = (Number of Submissions of Team Size X)/(Total Number of Submissions)/100. Sector Percentage = (Number of Submissions with at least one Author from Sector X)/(Total Number of Submissions)/100. Affiliation Percentage = (Number of Submissions with at least one Author from Affiliation X)/(Total Number of Submissions)/100. Because submissions can include authors from multiple sectors and affiliations, percentages within these categories may sum to more than 100% in a given year. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

implementations readily cross-pollinate. This balanced institutional architecture likely contributes to America's dominant position in systems engineering knowledge production.

Regional patterns add further dimension to this institutional landscape. The Americas exhibit the most balanced sectoral composition with steadily increasing academic participation. Europe, Middle East, and Africa (EMEA) demonstrates greater institutional volatility, showing pronounced oscillations between academic and industry dominance that correlate with symposium

location patterns. Asia-Oceania maintains the most stable institutional profile with consistently high industry representation, though subtle trends toward academic growth began emerging around 2020.

3. Symposium Location Effects

The geographic location of the International Symposium demonstrates significant influence on regional participation patterns with an average 6% increase in submissions from the hosting country. The symposium's rotation through the Americas (8 locations), EMEA (3 locations), and Asia-Ocea-

nia (1 location) reveals a distinct proximity effect, where host regions experience an approximately 10% increase in submissions as well. This spatial gradient manifests differently across institutional types – with industry participants showing greater sensitivity to location than their academic counterparts – creating symposium-specific institutional compositions that reflect the interplay between professional travel constraints and regional systems engineering concentrations.

As reported in Figure 1, the symposium's consistent rotation through North America (Seattle, Las Vegas, Washington DC, Orlando, Philadelphia, Detroit, Honolulu, Ottawa), Europe (Edinburgh, Rome, Dublin), and Australia (Adelaide) has helped maintain global engagement. However, the absence of symposium locations in Asia (outside Australia), Africa, South America, and Eastern Europe likely contributes to underrepresentation from these regions.

C. Author Productivity and Collaboration Networks

This section examines the patterns of knowledge creation and collaboration within the systems engineering community, revealing how intellectual contributions are distributed among authors and how collaborative networks evolve to shape the discipline's development through co-authorship relationships.

1. Concentrated Knowledge Production

The systems engineering community displays a typical concentration of intellectual output, with productivity distributed in a classic power-law pattern characteristic of many creative and scientific disciplines. Visualized in Figure 5, this concentration manifests dramatically across the contributor spectrum. Single-submission authors – who represent approximately 70% of all contributors – account for only about 30% of total submissions, creating a 0.5x disproportionality between their numerical presence and intellectual contribution. At the opposite extreme, the most prolific authors (classified as those with >10 submissions over the observed period) constitute a remarkably small fraction of contributors yet generate submissions at a 9.4x disproportionality rate relative to their numbers.

This pattern of concentration becomes even more pronounced when examined through a Lorenz curve of submission concentration across authors, see Figure 6. The curve quantifies how submission output distributes across the author population, revealing that the top 1% of authors account for 13.2% of all submissions pooled across 2012-2025, while the top 10% contribute a remarkable 43.5% of the intellectual output.

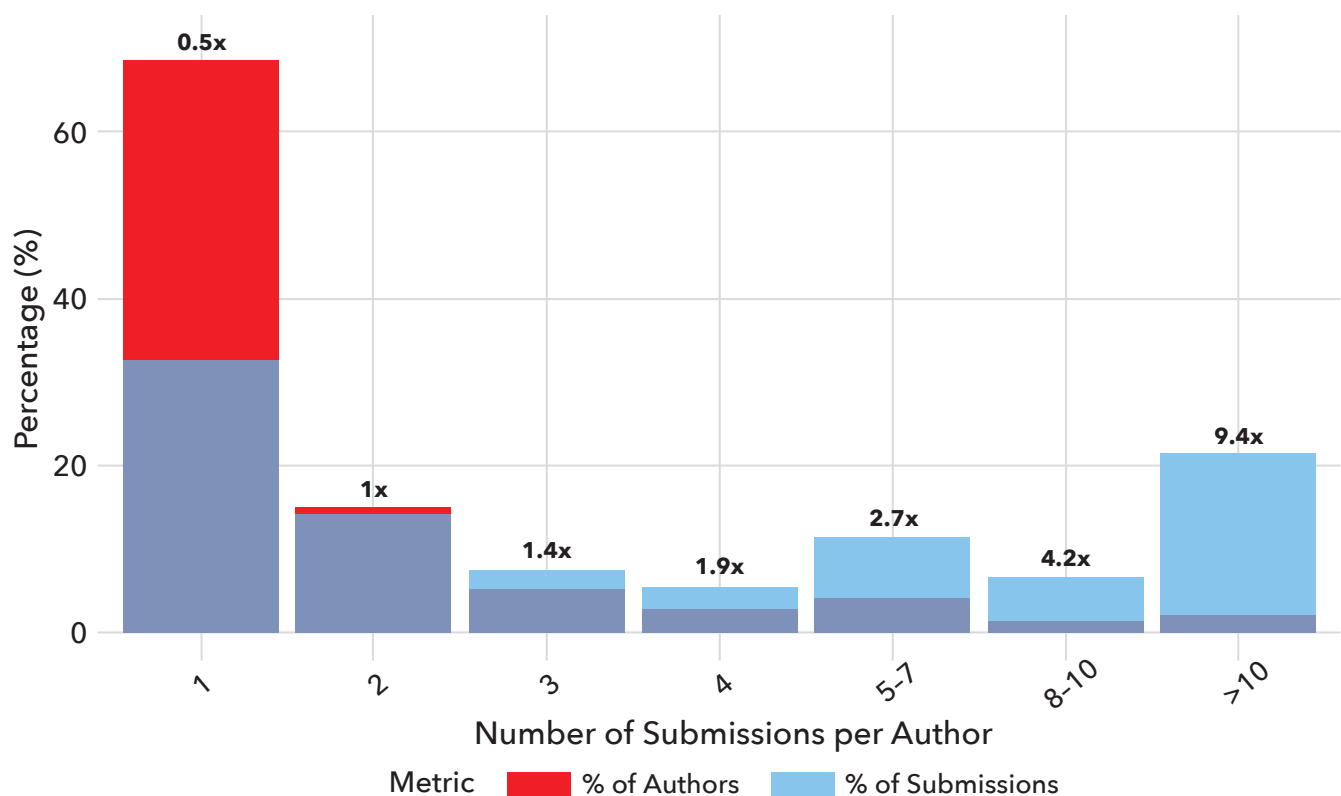


Figure 5. Author productivity distribution in the inverse relationship between submission volume and author count (2012-2025)

Note: The percentage of authors (blue) and the percentage of total submissions (red) across different submission frequency groups. Single-submission authors represent approximately 70% of all contributors but account for only about 30% of total submissions (2012-2025) (0.5x disproportionality). Conversely, the most prolific authors (>10 submissions) represent a tiny fraction of contributors but generate a disproportionately large volume of submissions (9.4x disproportionality). The multipliers above each bar indicate the ratio of submission percentage to author percentage, highlighting how submission output scales non-linearly with author frequency. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations

The most prolific individual author contributed 74 submissions over the fourteen-year period – representing nearly a submission every ten weeks for over a decade – while 3,301 authors (68.6% of the total) submitted only once. The Gini coefficient of 0.45 quantifies this inequality, indicating a high concentration of contributions among a relatively small proportion of authors.

This concentrated production pattern creates a natural “hub-and-spoke” knowledge architecture within the discipline. The small cohort of highly prolific contributors serves as central knowledge nodes who disproportionately influence systems engineering’s intellectual trajectory. After further investigation, this core group not only produces a substantial portion of the discipline’s formal knowledge but also exercises outsized influence through editorial roles, technical committee leadership, partnering organizational leadership, and mentorship relationships – further amplifying their impact on disciplinary development. The nuances of these concentrations

are evident in the data; however, due to confidentiality constraints, these details are not reported here.

2. Experience and Productivity Dynamics

The likelihood of an author contributing to the symposium in any given year exhibits a strong positive correlation with prior participation history. As shown in Figure 7, the frequency of participation rises dramatically from just 5.3% for authors with only one year of previous experience to 67.6% for those with seven or more years of participation. This steep progression suggests a self-reinforcing engagement pattern where longer histories with the symposium translate into deeper community integration and commitment.

Overall, the data reveals a critical bifurcation in participation behavior: despite high attrition rates (as will be discussed in next section), a small core of persistent authors becomes increasingly committed to regular contribution. This cohort develops into the backbone of the publication’s submission pipeline,

explaining the concentration phenomenon observed in the Lorenz curve while providing stability to offset the high turnover among newer contributors. Further, a subsequent section analyzing acceptance rates further substantiates this pattern, demonstrating that experienced authors enjoy significantly higher acceptance rates. That is, submissions with multiple experienced authors exhibit progressively greater probability of their submission being accepted into the program.

3. Collaboration Breadth and Depth

The systems engineering community possess collaborative dynamics that extend beyond simple co-authorship counts. Using Simpson’s diversity indices to quantify the multidimensional nature of collaborative relationships, Figure 8 captures both the breadth (effective number of unique collaborators) and depth (effective distribution of collaborative projects) of knowledge networks within the discipline.

For readers interested in the methodology underlying these findings, details

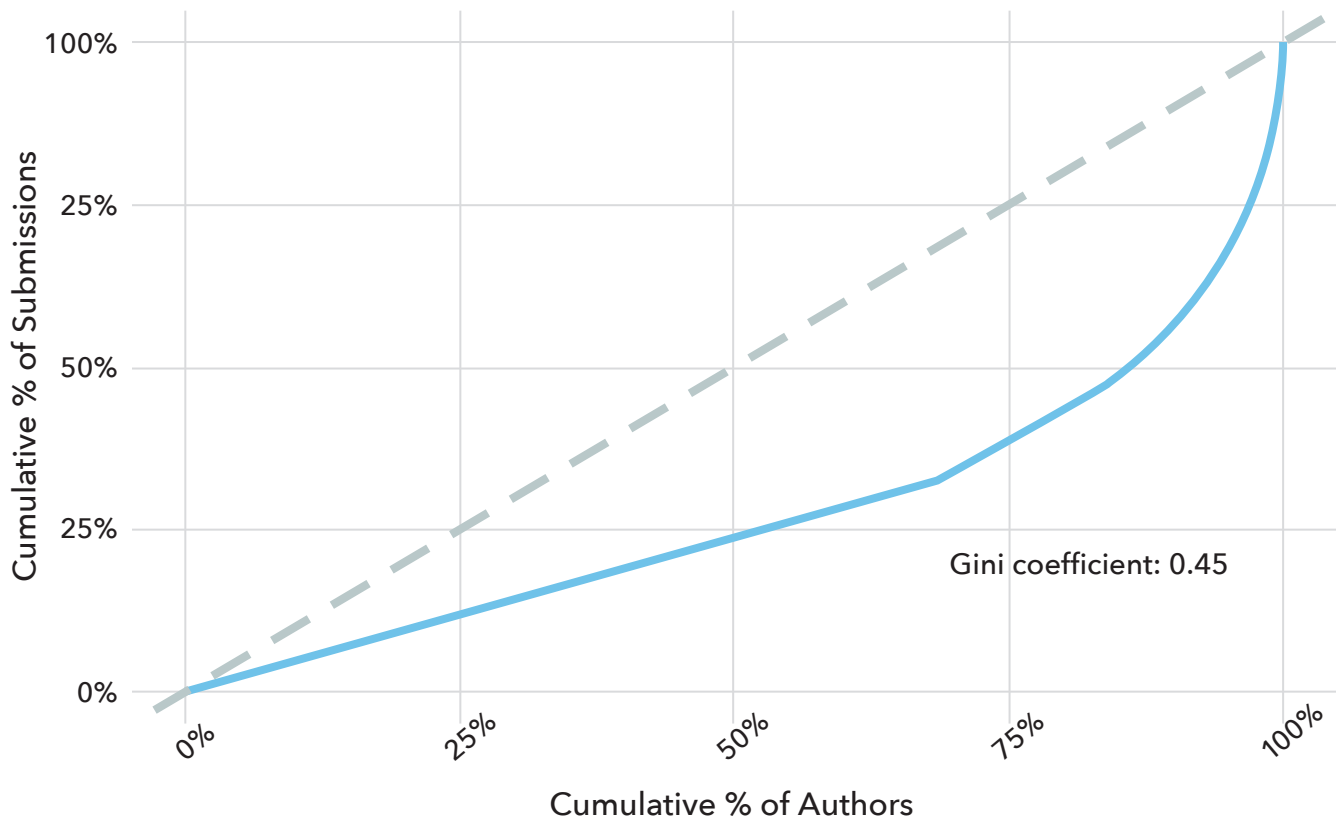


Figure 6. Lorenz curve of submission concentration across authors (2012-2025)

Note: The cumulative distribution of submissions across all authors. The x-axis represents the cumulative percentage of authors (ordered from lowest to highest submission count), while the y-axis shows the cumulative percentage of submissions. The dashed diagonal line represents perfect equality (where each author would contribute equally to the total submission count), while the blue curve shows the actual distribution. Key statistics highlight the concentration pattern: the top 1% of authors account

for 13.2% of all submissions, the top 5% contribute 31.9%, the top 10% contribute 43.5%, the top 20% contribute 56.5%, and the top 50% account for 76.2% of submissions. The most prolific author contributed 74 submissions, while 3,301 authors (68.6% of the total) submitted only once. The Gini coefficient of 0.45 quantifies this inequality—indicating a moderate to high concentration of submissions among a relatively small proportion of authors.

are provided in the Appendix under *Methodological Details: Simpson's Indices for Collaboration-based Network Analysis*.

The visualization illustrates a strong positive relationship between collaboration breadth and depth, revealing a fundamental pattern in systems engineering knowledge networks – researchers who develop connections with diverse collaborators tend to engage in more substantive distributed collaborations across projects. The non-linear regression curve demonstrates that this relationship intensifies at higher values, suggesting a “network effect” where established collaborators unlock exponentially more opportunities for meaningful project engagement.

The Top 10% cohort (n=230) representing researchers demonstrating exceptional connectivity relative to the community, and the Top 5% cohort (n=108) comprising the core network influencers who significantly shape disciplinary knowledge flows. The remarkable outlier in the upper-right quad-

rant (effectively 50 collaborators equally distributed across 40 projects) represents a “super-connector” within the systems engineering knowledge ecosystem.

Point sizing by submission volume adds additional context, revealing how sustained participation correlates with network development. However, the substantial variability across the plot highlights diverse collaboration strategies – from focused specialists who maintain deeper relationships with fewer collaborators to broad connectors who engage across the discipline.

Supporting these patterns, the longitudinal analysis of collaboration network breadth (Figure 9) reveals relatively stable distribution of collaborative network sizes across the fourteen years. Approximately 10-15% of authors work completely solo each year (0 collaborators), while 20-25% collaborate with only one other author. The middle tiers of collaboration (authors with 2-4 collaborators) consistently represent the most common pattern, accounting for

roughly 40-50% of all authorships.

This stability in collaboration breadth suggests an established culture within systems engineering that values moderate-sized teams while maintaining space for both solo practitioners and highly networked contributors. When considered alongside the author retention data, this consistency indicates that even as individual authors enter and exit the community, the underlying collaborative structure maintains remarkably stable patterns of engagement.

While collaboration breadth has remained relatively stable, the depth of collaborative relationships shows more pronounced evolution. As illustrated in Figure 10, there is a clear trajectory toward deepening collaborative ties within the community over time. First-time collaborations have gradually decreased from approximately 85% in 2012 to about 65% by 2025, while repeat collaborations show steady growth – with

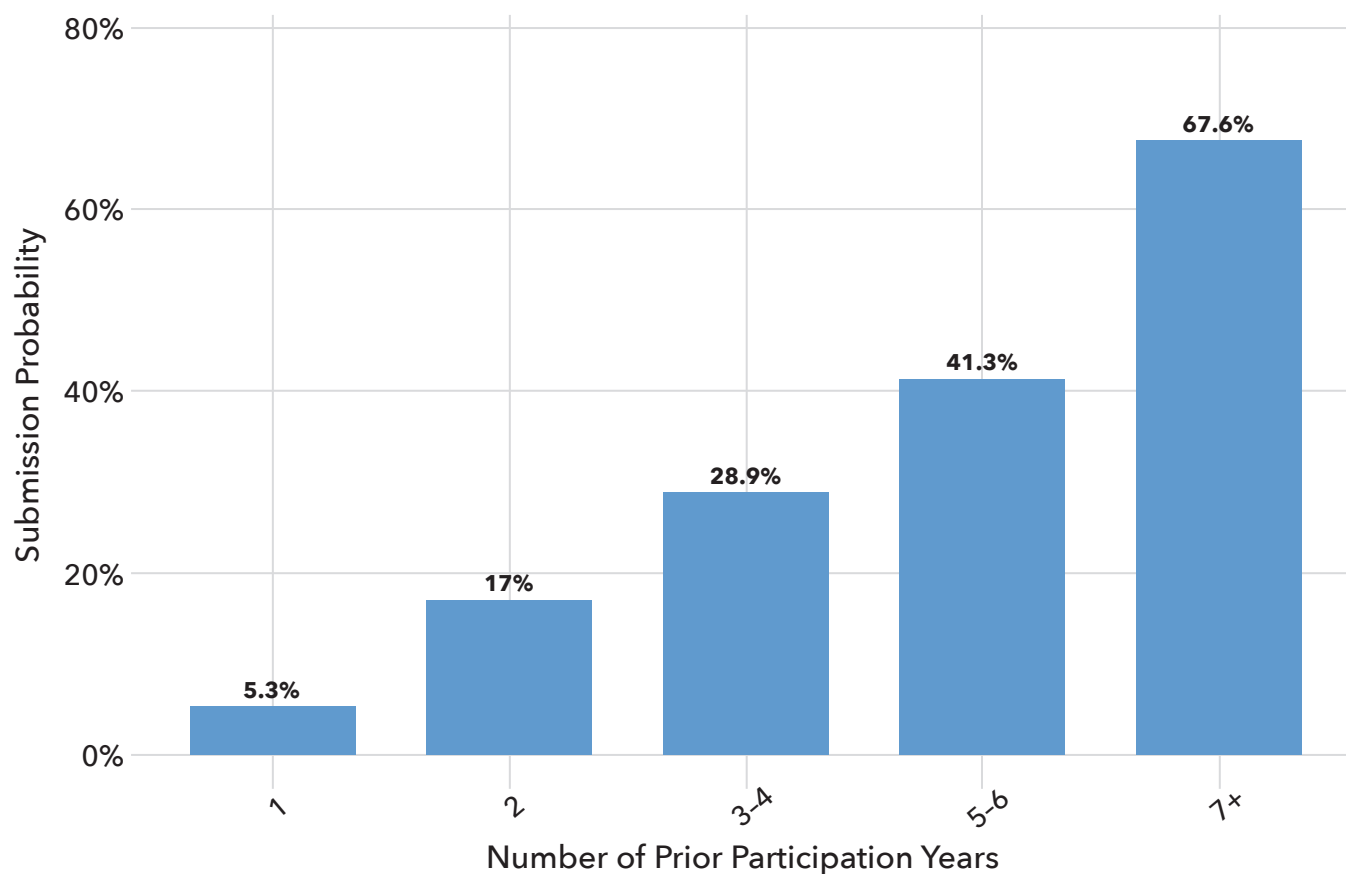


Figure 7. Submission likelihood by author history (2012-2025)

Note: This figure illustrates the strong positive relationship between author experience and submission likelihood. The probability of an author submitting in a given year rises dramatically with their prior participation history, from just 5.3% for authors with only one year of previous experience to 67.6% for those with seven or more years of participation. Despite the high overall attrition rates shown in the author retention analysis, this pattern reveals a critical bifurcation in participation behavior: while most authors leave after initial submissions, those who develop longer histories with the symposium become increasingly committed contributors. The

steep progression suggests a self-reinforcing engagement pattern where a small core of persistent authors become the backbone of the publication's submission pipeline. This dynamic helps explain the concentration phenomenon observed in the Lorenz curve (Figure 8), as the institutional knowledge and continued participation of these experienced authors disproportionately shape the overall submission landscape despite the high turnover among newer contributors. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

the proportion of second collaborations nearly doubling over the period and third and fourth-plus collaborations showing even more pronounced relative increases. Understandably, we observe a rapid pullback from collaboration during the COVID-19 pandemic met with an equally quick resurgence in the years since.

The subtle shift in team composition data from Table 2 further supports this narrative. Solo authorship declined from 33.4% in 2012 to 28.0% in 2025, with corresponding increases in collaborative submissions, particularly in the 2-3 author category (consistently representing 40-51% of submissions). This gradual trend toward increased team size suggests a discipline slowly becoming more integrated, reflecting the growing complexity of systems engineering projects and methodologies.

D. Author Retention and Participation

This section investigates the engagement patterns of authors within the systems engineering community over time, focusing on retention rates, career stage, and the contrasting dynamics between newcomers and established contributors that create a dual system of peripheral fluidity and core stability.

1. The Revolving Door

Analysis of author participation trajectories reveals a consistent “revolving door” pattern within the symposium. As detailed in Table 3, yearly retention rates averaged a modest 43% across the study period, meaning that nearly 57% of authors in any given year did not subsequently submit the following year. This high attrition creates a continuous influx of new perspectives,

with first-time contributors consistently representing approximately 60% of each year's author pool.

This pattern manifests most dramatically at career entry points. Only 5.3% of first-time authors provide a submission the following year – implying a staggering 94.7% immediate departure rate that suggests most initial interactions with the symposium fail to generate sustained engagement. The data reveals a critical vulnerability in the community's knowledge transfer mechanisms: the flagship event for the systems engineering community appears remarkably ineffective at converting initial interest into ongoing participation.

Temporal analysis reveals notable variation in retention rates across the study period. The highest retention occurred in 2016 (66.8%) – coinciding with the

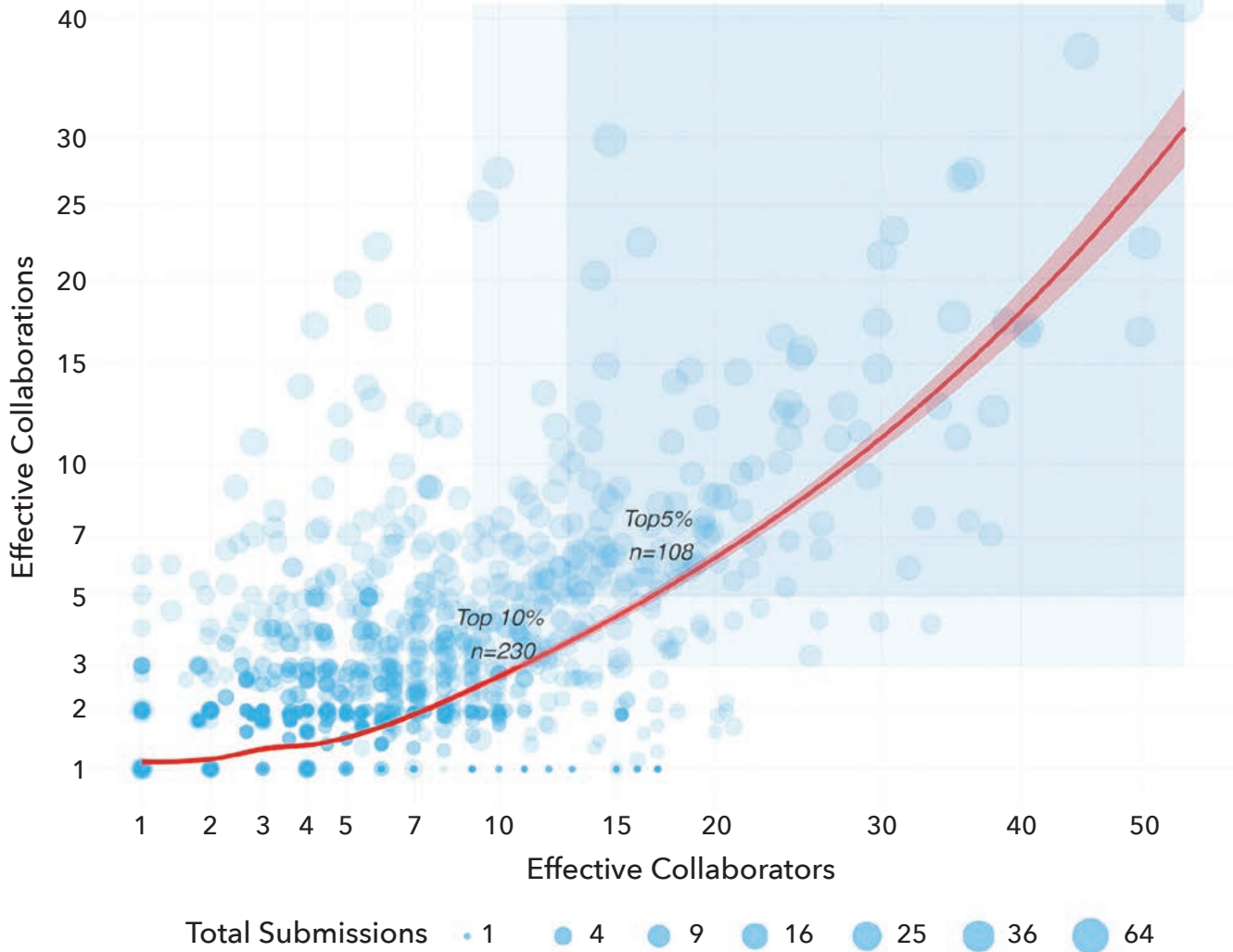


Figure 8. Simpson's indices of collaboration (2012-2025)

Note: This visualization captures the multidimensional nature of collaborative networks within the systems engineering community through the lens of Simpson's diversity indices (see Methodological Details in Appendices for details on metric calculation). Rather than viewing collaboration as a simple count of co-authors, this approach quantifies two complementary dimensions: breadth (the effective number of unique collaborators) and depth (the effective distribution of collaborative projects). For interpretation: a given researcher exhibits X effective collaborators equally distributed across Y effective projects. The strong positive relationship between these dimensions reveals a fundamental pattern in knowledge networks—researchers who develop connections with diverse collaborators tend to engage in more substantive distributed collaborations across projects. The non-linear regression curve (red) demonstrates that this relationship intensifies at higher values, suggesting a “network effect” where established collaborators unlock exponentially more opportunities for meaningful project engagement. The visualization identifies

community connectors through stratified highlight regions: Top 10% cohort (n=230): Researchers demonstrating exceptional connectivity relative to the community. Top 5% cohort (n=108): The core network influencers who significantly shape disciplinary knowledge flows. The outlier in the upper-right quadrant (~50 effective collaborators, ~40 effective projects) represents a particularly noteworthy network hub—functioning as what network theorists might call a “super-connector” within the systems engineering knowledge ecosystem. Point sizing by submission volume adds temporal context, revealing how sustained participation correlates with network development. However, the substantial variability across the plot highlights diverse collaboration strategies—from focused specialists who maintain deeper relationships with fewer collaborators to broad connectors who engage across the discipline. Data source: International Council on Systems Engineering (INCOSSE) International Symposium submission database (2012-2025).

symposium's location in Edinburgh, which may have attracted particularly committed European contributors. The lowest retention was observed immediately after

the initial observation year (17.4% in 2013). However, this anomalously low initial retention stems from a methodological artifact rather than a genuine trend; with

systematic data collection beginning in 2012, the analysis lacks previous historical context to properly identify returning contributors in the early years, thus

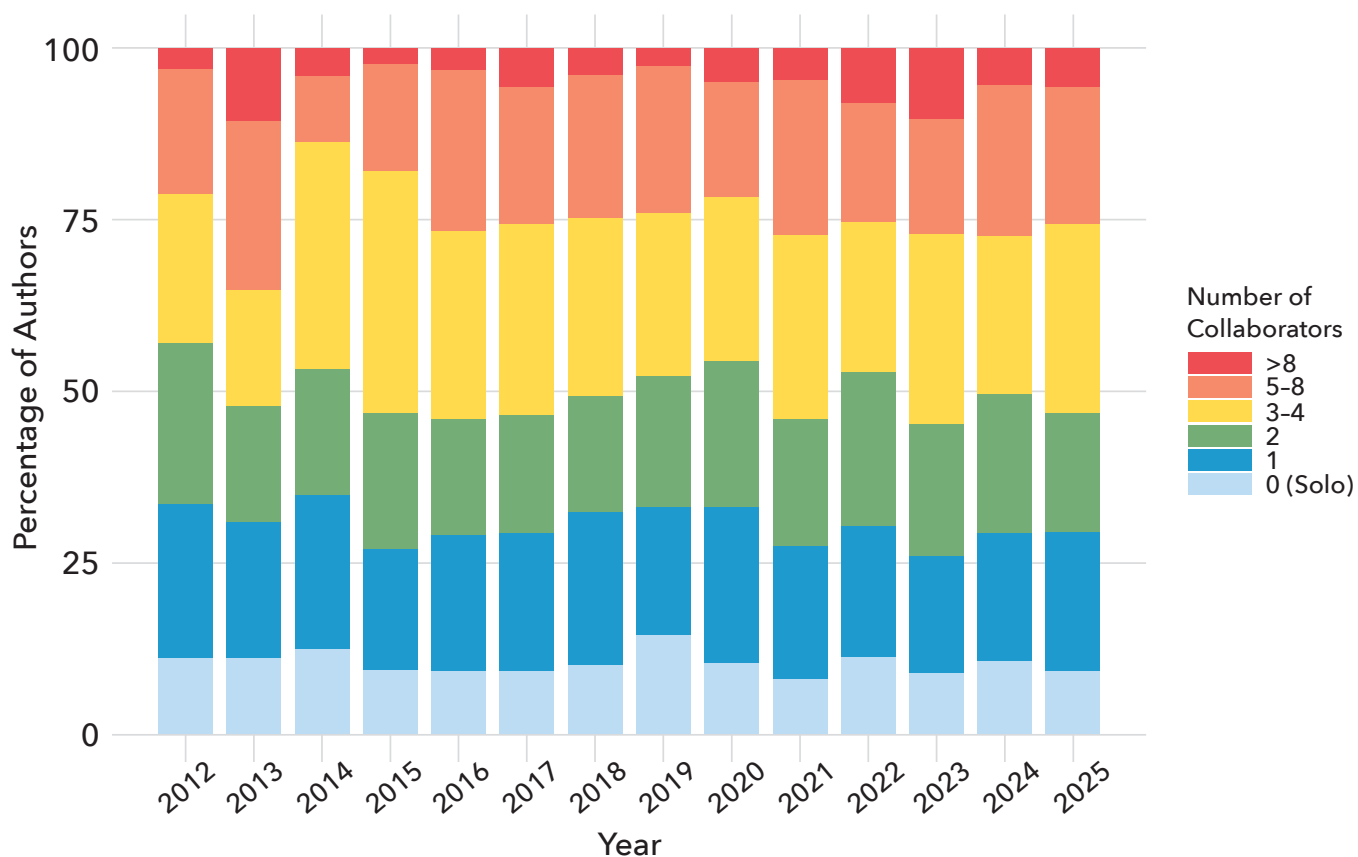


Figure 9. Trends in author collaboration network breadth (2012–2025)

Note: Stacked bar chart of collaboration patterns among INCOSE International Symposium authors from 2012–2025. The distribution reveals a relatively stable collaboration landscape over time, with approximately 10–15% of authors working completely solo each year (0 collaborators), while approximately 20–25% collaborate with only one other author. The middle tiers of collaboration (2–4 collaborators) consistently represent the most common patterns, accounting for roughly 40–50% of all authorships. Most notably, highly networked authors with more than 8 unique collaborators remain a persistent but small minority (5–10%) throughout the

period. These patterns suggest a field that values moderate collaboration, with most authors maintaining connections to a manageable network of 2–4 collaborators in any given year. When considered alongside the author retention data (Table 1), this stability in collaboration breadth indicates that even as individual authors enter and exit the community, the underlying collaborative structure of the systems engineering discipline has maintained consistent patterns of engagement. Data source: International Council on Systems Engineering International Symposium submission database (2012–2025). Author's calculations.

artificially deflating retention metrics until sufficient longitudinal data accumulated (“burn-in”). The virtual conference formats during the COVID-19 pandemic (2020–2021) showed no significant deviation from historical retention patterns, suggesting that participation dynamics are driven more by disciplinary culture and career trajectories than by logistical factors.

In sum, the data reveal the Matthew Effect in systems engineering contributions – where advantage accumulates to those already established in the field. Returning to Figure 7, the likelihood of continued participation rises dramatically with experience, creating a self-reinforcing cycle where established authors become increasingly integrated into the community while newcomers frequently depart. The combined effect creates a powerful filter: newcomers face both lower acceptance rates and higher

subsequent attrition (even when accepted to the program), while experienced contributors enjoy higher acceptance rates and increasing participation frequency.

E. Conclusion

The social architecture found in this analysis presents both strategic opportunities and fundamental challenges for INCOSE's mission to serve as “the world's trusted authority and forum for the practice, science, and art of systems engineering.”

The “hourglass network” structure uncovered here demands critical examination not as a mere descriptive finding, but as a systemic characteristic requiring intentional design intervention. This structure – where knowledge flows through a concentrated core of experts – raises fundamental questions about knowledge democratiza-

tion, innovation diffusion, and institutional resilience that directly impact INCOSE's ability to fulfill its mission.

Knowledge exchange – a cornerstone of INCOSE's purpose – appears constrained by structural barriers evidenced in both collaboration patterns and participation dynamics. The significant disparity between distribution of contributors and intellectual production (Gini coefficient 0.45) suggests not merely uneven participation but a fundamentally different relationship with knowledge creation across the community. This stratification necessitates reimagining knowledge exchange mechanisms beyond traditional symposium formats to create multi-directional flows that leverage concentrated expertise while valuing newcomer perspectives.

The education and application dimensions of INCOSE's mission face particular

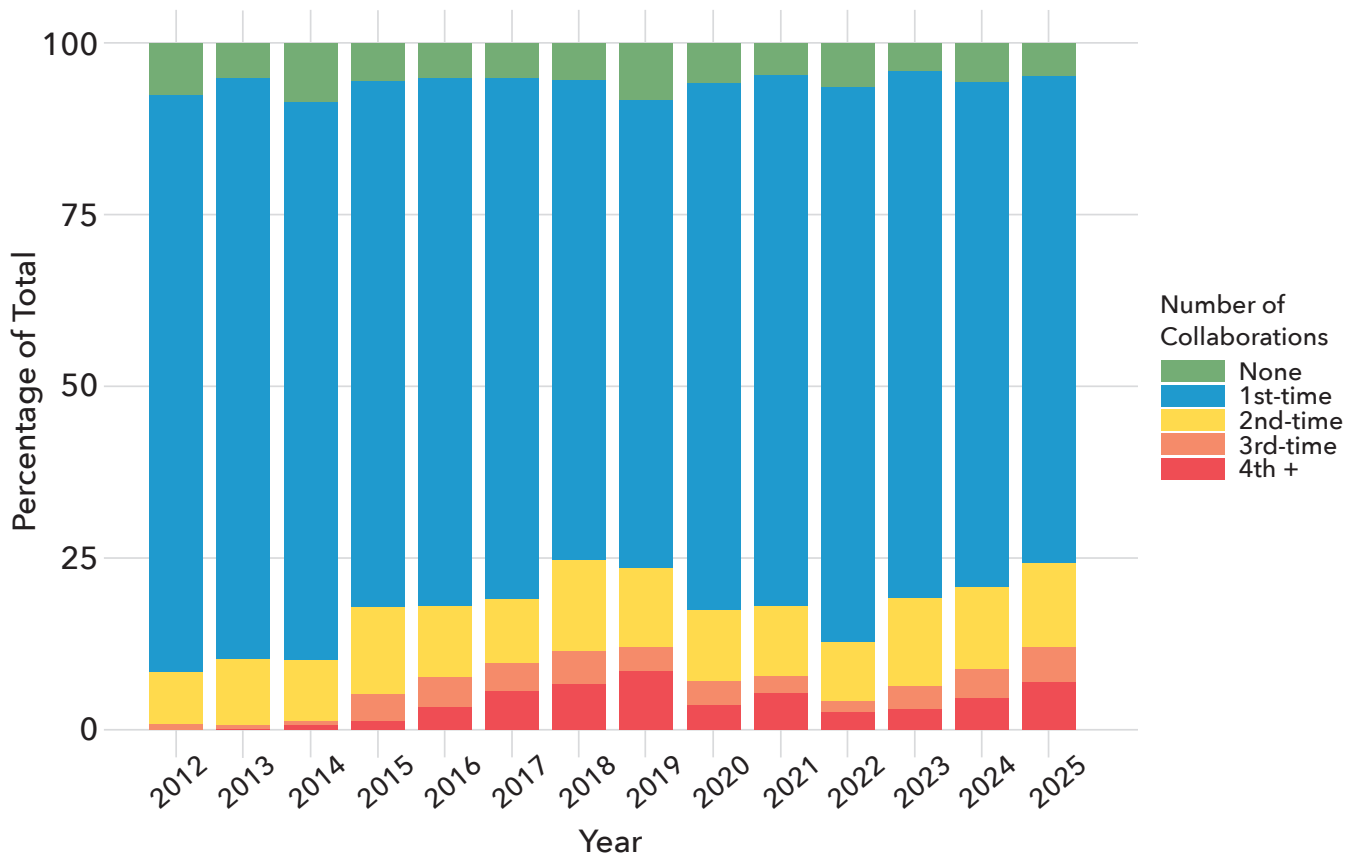


Figure 10. Trends in author collaboration network depth (2012-2025)

Note: The historical depth of collaborative relationships among INCOSE International Symposium authors over the 2012-2025 period. The visualization reveals a clear trend toward deepening collaborative relationships within the community. While first-time collaborations constitute a substantial portion of the activity each year, their relative dominance has gradually decreased from approximately 85% in 2012 to about 65% by 2025. Correspondingly, repeat collaborations have shown steady growth, with the proportion of 2nd collaborations nearly doubling over the period and 3rd and 4+ collaborations showing even more

pronounced relative increases. Most notably, the most established collaborative relationships (4+ collaborations) have expanded from barely visible in 2012 to representing approximately 5% of all collaborations by 2025. This pattern of strengthening collaborative ties suggests an increasingly interconnected core community where authors build upon successful prior working relationships. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

challenges given the 94% first-time contributor attrition rate. This extraordinary drop-out percentage suggests current knowledge transfer mechanisms fail to create sustainable engagement pathways – a critical vulnerability for a discipline requiring both technical depth and broad implementation. Addressing this pattern requires reconceptualizing educational approaches to create progressive engagement strategies that transform passive knowledge recipients into active knowledge creators through deliberate and effective scaffolding.

Research advancement, another key mission element, appears potentially constrained by the identified collaboration patterns. The progression toward deeper but potentially narrower collaborative relationships (Figures 9-10) may inadvertently create intellectual silos that inhibit cross-fertilization of methodologies. This

pattern necessitates deliberate creation of boundary-spanning mechanisms that connect disparate knowledge clusters without disrupting the productive specialization that drives methodological depth.

Rather than viewing these structural characteristics as fixed constraints, INCOSE has opportunity to operationalize them as design parameters for building a more resilient knowledge ecosystem. The current concentrated expertise represents intellectual capital that could be strategically deployed to accelerate newcomer development and mentor innovators. The geographic and institutional variations offer potential for methodological cross-pollination rather than homogenization. The collaboration networks provide a foundation for intentional knowledge bridging rather than accidental knowledge isolation.

Systems engineering itself offers concep-

tual tools for this transformation – applying systems thinking to the very community that champions it. By conceptualizing the INCOSE community as a complex adaptive system with emergent properties, feedback mechanisms, and self-organizing tendencies, leaders can design interventions that work with rather than against these dynamics.

Ultimately, INCOSE's effectiveness as the global authority on systems engineering depends not just on the technical content it produces, but on the knowledge network through which that content flows. By addressing the socio-structural dimensions revealed in this analysis, INCOSE can evolve from primarily a knowledge repository toward a dynamic knowledge network that accelerates innovation, facilitates application, and expands participation – thereby fulfilling its mission to advance the prac-

Table 2. Submission characteristics by team composition, geographic region, and author affiliation (2012-2025)

Sector (%)			Affiliation (%)			
Americas	EMEA	Asia-Oceania	Industry	Academic	Government	Self/Retired
51.0	45.5	13.1	68.8	42.0	4.8	6.1
67.5	32.5	14.3	66.0	50.3	4.4	4.4
56.6	32.4	21.3	62.5	52.2	3.7	6.6
70.3	26.4	15.4	72.0	40.1	4.4	6.6
53.3	47.4	15.9	69.9	47.0	6.3	8.0
60.0	33.2	28.5	66.0	46.8	7.2	8.1
74.3	28.8	14.9	62.9	49.3	7.6	9.4
69.1	29.6	16.7	63.5	47.2	6.0	9.4
47.4	51.8	19.9	61.4	48.9	4.0	9.2
63.2	39.7	17.7	61.8	52.5	8.3	10.3
69.3	32.5	14.6	69.0	35.8	4.7	7.7
74.1	29.3	13.9	68.2	38.6	7.6	8.8
65.7	36.2	13.8	69.2	40.6	6.5	5.9
70.1	29.0	14.1	62.1	46.8	4.0	5.9

Notes:

1. Annual distribution of INCOSE submissions across three dimensions: team size, geographic region, and author affiliation. Team composition has shifted moderately over time, with a slight decline in solo authorship (from 33.4% in 2012 to 28.0% in 2025) and a corresponding increase in collaborative submissions, particularly in the 2-3 author category (consistently representing 40-51% of submissions). Geographically, Americas-affiliated authors have maintained dominant representation (averaging approximately 64%), while EMEA participation has fluctuated (26-52%), and Asia-Oceania has maintained a smaller but consistent presence (13-29%). Industry-affiliated authors have consistently contributed to 61-72% of submissions across the period, with academic affiliation showing more variability (35-53%). Government and retired/self-employed authors have maintained minor but steady representation.
2. Team Size Percentage = (Number of Submissions of Team Size X) / (Total Number of Submissions) / 100. Sector Percentage = (Number of Submissions with at least one Author from Sector X) / (Total Number of Submissions) / 100. Affiliation Percentage = (Number of Submissions with at least one Author from Affiliation X) / (Total Number of Submissions) / 100. Because submissions can include authors from multiple sectors and affiliations, percentages within these categories may sum to more than 100% in a given year. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations

tice, science, and art of systems engineering in an increasingly complex world.

III. TOPICS ANALYSIS

A. Introduction

The intellectual pursuit of a discipline reveals itself through what its researchers and practitioners choose to study, the methodologies they adopt, and the domains where they apply their expertise. This section examines the topical landscape of systems engineering as reflected in INCOSE International Symposium submissions from 2012 to 2025 – tracking methodological shifts, conceptual developments, and application domains during a period of significant transformation in systems development practices.

By analyzing the content of 4,038 submissions across a fourteen-year period,

we look at how systems engineering has matured both conceptually and practically. The core of this analysis employs a three-dimensional classification framework that categorizes submissions by contribution type (what kind of research artifact is being presented), systems engineering approach (what methodological paradigm is being utilized), and application domain (where these approaches are being implemented). Together, these aspects provide a broad portrait of knowledge production and specialization across the discipline.

Beyond merely cataloging and classifying content, this analysis seeks to illuminate the research architecture that shapes systems engineering practice – revealing how certain approaches gain prominence, which domains receive sustained attention, and where knowledge gaps exist today.

The shifting balance between traditional document-centric approaches and emerging model-based methodologies suggests not merely incremental changes in practice, but potentially fundamental realignments in how systems engineering is conceptualized, studied, and executed.

The findings presented here offer a macro-level view that complements the community dynamics observed in the previous section. Where the authors analysis explored who participates in systems engineering knowledge production, this section examines what they choose to create.

For readers interested in the classification methodology underlying these findings, details are provided in the Appendix under *Methodological Details: Submission Classification Analysis*.

Table 3. Author participation dynamics and retention rates (2012-2025)

Year	Active Authors	New Authors	Returning Authors	Leaving Authors	Retention Rate (%)	Attrition Rate (%)
2012	568	568	0	0	0.0	0.0
2013	395	296	99	469	17.4	82.6
2014	272	163	109	321	27.6	81.3
2015	307	184	123	195	45.2	71.7
2016	584	379	205	202	66.8	65.8
2017	430	258	172	443	29.5	75.9
2018	538	343	195	308	45.3	71.6
2019	375	197	178	418	33.1	77.7
2020	472	292	180	273	48.0	72.8
2021	419	230	189	363	40.0	76.9
2022	539	312	227	291	54.2	69.5
2023	828	514	314	366	58.3	67.9
2024	1071	643	428	571	51.7	69.0
2025	775	425	350	799	32.7	74.6

Notes:

1. Annual flow of authors in INCOSE submissions over a 14-year period, tracking new entrants, returning contributors, and those who discontinue participation. Despite substantial growth in active authors from 2022-2024 (peaking at 1,071 authors in 2024), the retention rate has remained relatively modest, fluctuating between 17.4% and 66.8% (average approximately 43%). The consistent influx of new authors (averaging about 60% of each year's contributor pool) indicates both continued interest in the field and significant turnover in the contributor base. The highest retention occurred in 2016 (66.8%), while the lowest was observed immediately after the initial year (17.4% in 2013). This pattern suggests that while INCOSE continues to attract new contributors, maintaining their ongoing participation remains a challenge, with nearly three-quarters of authors typically not returning in subsequent years.
2. Active Authors represents unique authors in a given year. New Authors are first-time submitters. Returning Authors submitted previously (not necessarily in prior year). Leaving Authors were active in previous year but not current year. Retention Rate = (Returning Authors/Previous Year's Active Authors)/100. Attrition Rate = (Leaving Authors/Previous Year's Active Authors)/100. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

B. Track Type

The International Symposium facilitates knowledge exchange through four distinct tracks: papers, presentations, panels, and tutorials. Each track serves a unique role in the systems engineering knowledge ecosystem:

Papers are formal research and practice-focused contributions that undergo rigorous peer review. They form the scholarly foundation of the symposium, requiring comprehensive documentation of methodology, findings, and implications. As part of the official symposium proceedings, papers provide the most thorough and permanent record of systems engineering advancements.

Presentations are designed for sharing emerging ideas, works-in-progress, and practical implementations, presentations

offer a more flexible format without the formal requirements of a full paper. This track enables practitioners to communicate innovations and experiences in an accessible format, often utilizing visual demonstrations to showcase tools, methodologies, or case studies.

Panels are interactive discussions among multiple experts create spaces for debate, knowledge synthesis, and community dialogue. Panels typically explore emerging trends, controversial topics, or complex challenges requiring diverse perspectives.

Tutorials provide structured educational experiences, tutorials offer participants hands-on training in specific methodologies, tools, or practices. They serve as the symposium's most direct knowledge transfer mechanism, transforming abstract concepts into practical skills.

As illustrated in Figure 2, the symposium has undergone a significant transformation in track representation. From 2012 to 2017, papers dominated, establishing the symposium's scholarly foundation. However, a pivotal shift occurred in 2018 with the introduction of the presentations track, which quickly gained momentum and nearly reached parity with papers by 2024. This diversification represents more than an administrative restructuring – it signals a transition in the systems engineering community's approach to content generation and knowledge transfer. The rapid adoption of the presentations format suggests an increasing demand for less formal, demonstration-oriented venues to share emerging practices, experiences, and tools, particularly as model-based approaches gain prominence.

Table 4. Submission characteristics by track type

Category	Panel	Paper	Presentation	Tutorial
Type of Contribution				
Applications	30.1%	10.2%	11.4%	19.8%
Empirical	3.9%	3.6%	1.5%	3.4%
Methodological	27.3%	44.7%	37.7%	39.3%
Review/Synthesis	3.5%	5.8%	5.5%	7.0%
Theory	5.5%	5.4%	4.3%	4.8%
Tools/Technologies	29.7%	30.3%	39.6%	25.7%
Systems Engineering Approach				
Agile & Lean	7.0%	5.6%	5.6%	4.6%
Foundational	50.9%	45.3%	33.2%	40.9%
Generalized	8.1%	6.1%	6.9%	12.1%
Model-Based	18.3%	26.4%	40.1%	29.0%
Simulation-Driven	2.2%	6.5%	7.5%	5.6%
Systems Thinking, Complexity, Sociotech.	13.6%	10.1%	6.8%	7.9%
Application Domain				
Aerospace & Defense	7.0%	14.9%	13.8%	6.9%
Commercial & Industrial Systems	7.0%	11.7%	9.3%	12.5%
Computing, Software, & Intelligent Systems	20.7%	24.4%	42.3%	24.3%
Domain Free	31.4%	27.0%	12.0%	36.9%
Education & Leadership	13.7%	6.2%	6.7%	12.9%
Physical Infrastructure & Services Systems	20.3%	15.9%	15.9%	6.4%

Note: Distribution of submission characteristics across INCOSE's four primary track types (Panel, Paper, Presentation, and Tutorial), revealing distinct focus patterns in each format. Papers show the strongest methodological orientation (44.7%) and highest aerospace & defense representation (14.9%), while maintaining balanced distribution across engineering approaches. Presentations demonstrate the strongest tools/technologies emphasis (39.6%) and overwhelming focus on computing/software/intelligent systems (42.3%) applications, with notably higher Model-Based Systems Engineering adoption (40.1%) compared to other tracks. Panels feature the highest applications content (30.1%), strongest systems thinking/

complexity representation (13.6%), and greatest educational focus (13.7%), suggesting their value for integrative discourse. Tutorials maintain the strongest domain-free orientation (36.9%) and highest generalized approach percentage (12.1%), reflecting their educational function. Notable patterns include the inverse relationship between applications and methodological content across tracks, the consistent concentration of computing applications in presentation formats, and the varying prevalence of Model-Based approaches—ranging from just 18.3% in panels to 40.1% in presentations. Data source: International Council on Systems Engineering International Symposium submission database (2012–2025). Author's calculations.

Table 4 highlights the distinct intellectual profiles across the four tracks, showing how each attracts different types of content: Papers exhibit the strongest methodological orientation (44.7%) and the highest aerospace & defense representation (14.9%), maintaining a balanced distribution across systems engineering approaches. This suggests that papers serve as the primary vehicle for methodological advancement

and foundational development. Presentations emphasize tools and technologies (39.6%) and overwhelmingly focus on computing, software, and intelligent systems applications (42.3%). Notably, presentations show the highest rate of MBSE approaches (40.1%), indicating that emerging modeling methods are best conveyed through visual, demonstration-oriented formats. Panels feature the highest applications content

(30.1%), the strongest systems thinking representation (13.6%), and the greatest educational focus (13.7%), underscoring their role in fostering integrative discourse and cross-disciplinary exploration. Tutorials maintain the strongest domain-free orientation (36.9%) and the highest generalized approach percentage (12.1%), aligning with their educational function and the need for broadly applicable content.

Table 5. Knowledge contribution taxonomy for INCOSE International Symposium submissions

Contribution Type	Description
Methodological	Contributions that provide the structured approaches, frameworks, and procedural innovations that form the backbone of systems engineering practice. These contributions answer the critical "how" questions—establishing the processes, methods, and sequences that guide practitioners through complex system development challenges.
Tools & technologies	Contributions that introduce the instrumental dimension of systems engineering through software platforms, modeling environments, and technical implementations. These contributions operationalize methods and make abstract concepts tangible. They transform analog approaches into workable solutions that practitioners can implement in real-world contexts.
Applications	Contributions that document real-world implementations, practical case studies, and examples demonstrating systems engineering in specific contexts. These submissions showcase practice through concrete implementations.
Review & synthesis	Contributions that create value through integration and critical assessment of existing knowledge. They connect isolated findings into coherent narratives that identify patterns, conflicts, and convergences. These contributions act as knowledge consolidators, helping practitioners navigate the expanding landscape of systems engineering thought.
Empirical	Contributions that generate evidence-based insights through systematic investigation, data collection, and analysis. They validate (or challenge) existing approaches through rigorous testing and statistical evaluation. These contributions form the experimental foundation of the discipline, providing the evidence that either supports or refutes established practices.
Theoretical	Contributions that develop the fundamental conceptual frameworks and abstract principles that underpin systems engineering practice. They focus on the "why" rather than the "how," establishing the intellectual foundations that give meaning to methodologies. These contributions provide the conceptual lenses through which practitioners interpret complex system phenomena.

Note: The contribution type taxonomy highlights the epistemological purpose of International Symposium submissions. These range from process-oriented methodological contributions that establish "how" systems engineering is practiced, to tools that operationalize these methods, to applications that demonstrate

real-world implementation. The framework further captures the discipline's reflective dimensions through review/synthesis contributions, its empirical foundations through data-driven validation, and its conceptual underpinnings through theoretical exploration.

C. Submission Categorization

1. Contribution Type

The first aspect of systems engineering's intellectual landscape examined in our analysis is the fundamental nature of scholarly contributions that shape the discipline. This analysis classifies systems engineering submissions into six fundamental contribution types, each representing a distinct mode of knowledge creation, see Table 5. By categorizing submissions according to their primary intellectual function, we can discern how knowledge is constructed and disseminated across the systems engineering community.

Figure 11 reveals a knowledge contribution architecture that has remained remarkably stable over fourteen years. This stability tells its own story. Despite the

technological revolutions, methodological transformations, and shifting community demographics documented elsewhere in our analysis, the fundamental ways systems engineers create and transmit knowledge remain surprisingly unchanged. The methodological heartbeat of the discipline continues to dominate, consistently accounting for 30-40% of all contributions. Close behind, tools and technologies maintain their steady presence at 25-30% – reflecting the disciplines commitment toward implementation rather than abstraction.

Around 2015, a subtle but meaningful shift appears in the data. Applications-focused submissions begin a gentle decline while methodological contributions see a corresponding uptick. This inflection point

likely signals the community pivoting away from documenting case-by-case implementations toward codifying broader methodological approaches – perhaps anticipating the model-based transformation that would soon accelerate.

What speaks loudest in Figure 11, however, is the conspicuous absence of theoretical and empirical work. Together, these foundation stones of traditional scientific disciplines account for a mere 8% of systems engineering contributions—with theoretical work at approximately 5% and empirical validation studies at just 3%. This creates a significant structural gap in the knowledge architecture of the discipline. While robust methodological development continues apace, the theoretical under-

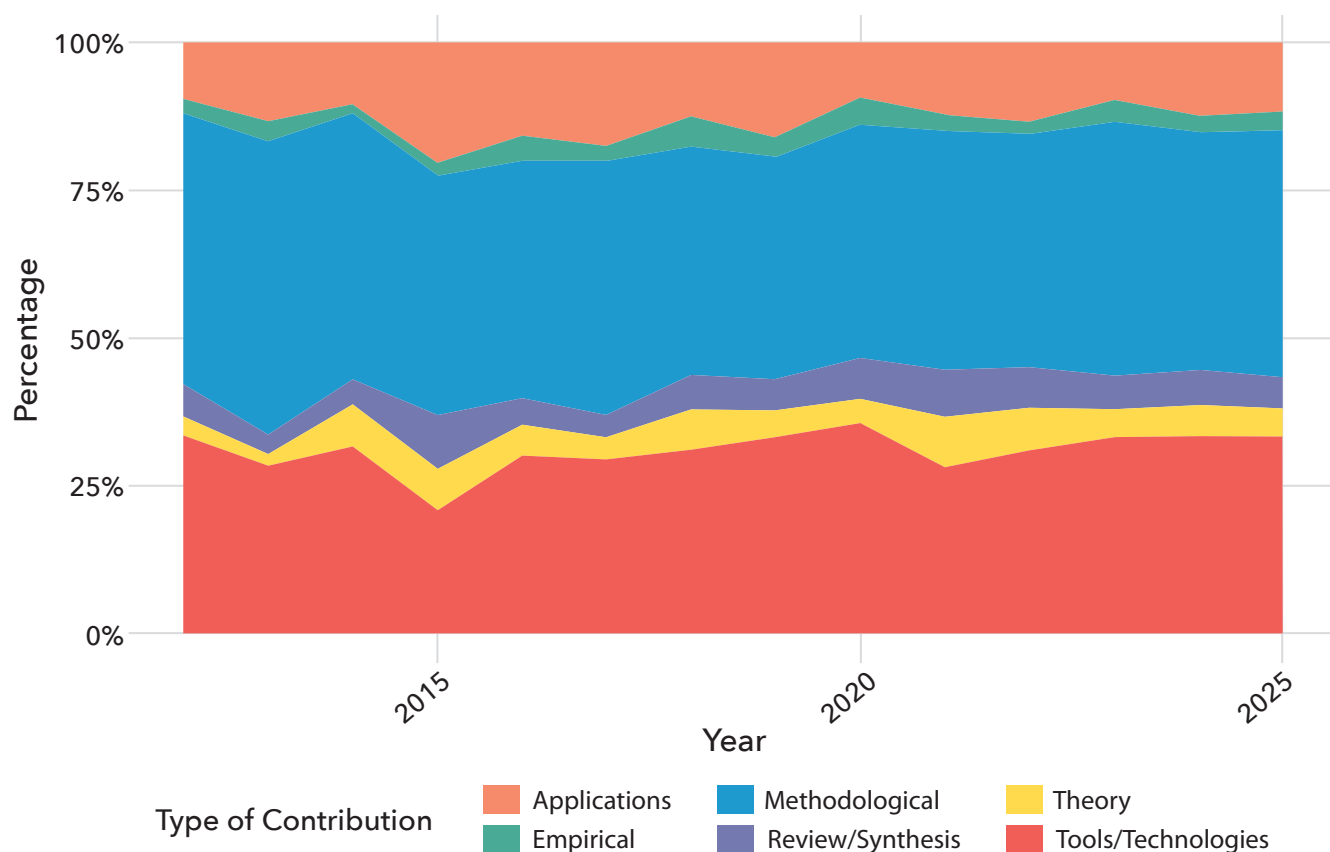


Figure 11. Submissions by contribution type over time

Note: Temporal evolution of contribution types in submissions from 2012-2025. The stacked area chart displays the percentage distribution of six distinct contribution categories (Applications, Empirical, Methodological, Review/Synthesis, Theory, and Tools/Technologies) per year. The visualization reveals relatively stable proportions over time, with Methodological contributions consistently dominating (approximately 30-40% of submissions), followed by Tools/Technologies (roughly 25-30%). Notable is a

slight decrease in Applications around 2015, with a compensating increase in Methodological submissions during the same period. The analysis was performed using submissions classified through manual content review ($n=3,657$), with multi-category contributions disaggregated for analysis. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

pinnings and empirical validation that typically anchor and validate such methods remain conspicuously underdeveloped.

This structural gap presents both immediate challenges and future opportunities. The methodological emphasis has clearly enabled practical advancement across diverse domains. Systems engineers excel at developing processes that work well enough in specific contexts. But without robust theoretical frameworks to provide coherent explanations or rigorous empirical studies to validate effectiveness, the discipline operates with a disconnection between its methodological ambitions and its foundational and empirical base.

As MBSE continues its ascent and systems grow increasingly complex, these research gaps take on new urgency. Can a discipline advancing into ever more complex socio-technical challenges thrive without bridging these knowledge divides? Does systems engineering require more robust

theoretical frameworks and evidence-based validation to advance beyond its current state? Or might this practice-oriented knowledge structure actually represent an adaptive specialization for a field born from and for application?

The answers remain unwritten, yet they will determine whether systems engineering matures as a loosely connected set of practices or as a rigorous, formalized engineering discipline. In either scenario, it must cultivate advanced capabilities to effectively confront the complex systemic challenges facing humanity in the decades ahead.

2. Systems Engineering Approach

The methodological landscape of systems engineering has undergone a meaningful transformation over the past decade, not just in changing tools but a fundamental shift in how practitioners conceptualize complex systems and the task of engineer-

ing systems. Our longitudinal analysis of INCOSE International Symposium contributions (2012-2025) categorized submissions across six distinct methodological paradigms – each representing a different orientation toward system development, as detailed in Table 6.

The most striking narrative emerging from our analysis is the remarkable ascendance of MBSE. As visualized in Figure 12, MBSE approaches have steadily climbed from approximately 30% of submissions in 2012 to dominating nearly 40% of contributions by 2025. This 10-percentage-point shift – representing hundreds of submissions – signals not merely a trending methodology but a fundamental epistemological transformation in how systems knowledge is captured, communicated, and utilized.

The acceleration point after 2020 is particularly noteworthy, suggesting a potential inflection point where MBSE transitioned from specialized application to mainstream

Table 6. Systems engineering methodological taxonomy for INCOSE International Symposium submissions

Methodological Approach	Description
Foundational Systems Engineering	Approaches that encompass traditional document-centric and/or sequential methodologies that formed the discipline's historical bedrock. These approaches emphasize comprehensive documentation, phase-gate processes, and formal configuration management. Think of these as the "classical" systems engineering practices codified in early standards and handbooks—structured, deliberate, process and documentation-driven.
Model-Based Systems Engineering (MBSE)	Approaches that utilize formal modeling languages, digital representations, and executable architectures as primary systems engineering artifacts. MBSE transforms the medium of systems engineering from text to structured, computer-interpretable models that can be analyzed, verified, and transformed more systematically than documents.
Agile & Lean Systems Engineering	Approaches that adopt iterative, incremental, and value-stream oriented practices to systems development. These approaches emphasize rapid feedback cycles, minimal documentation, and continuous delivery—prioritizing adaptation over prediction and customer collaboration over comprehensive planning.
Simulation-Driven Systems Engineering	Approaches that leverage computational simulation, virtual environments, and predictive modeling to drive systems development decisions. These approaches use dynamic system representations to explore behavior before physical implementation, enabling virtual experimentation and validation.
Systems Thinking, Complexity, and Sociotechnical Systems Engineering	Approaches that examine how interconnected elements create emergent properties beyond simple cause-effect relationships, focusing on non-linear dynamics and feedback loops rather than isolated components. These frameworks recognize that technical systems exist within social contexts where boundaries, relationships, human factors, and differing perspectives critically influence outcomes.
Generalized Systems Engineering	Cross-cutting, methodology-agnostic approaches applicable across multiple paradigms. These approaches provide framework-neutral principles and practices that transcend specific methodological schools.

Note: This taxonomy captures the distinctive methodological approaches that characterize systems engineering practice as reflected in International Symposium contributions. Foundational approaches represent the document-centric, sequential methodologies that established the discipline's historical foundations, while Model-Based approaches transform engineering artifacts into structured, computer-interpretable models. The framework encompasses the dynamic adaptation of Agile & Lean methodologies, the predictive power of Simulation-Driven

approaches, and the holistic perspective of Systems Thinking that addresses emergent properties and sociotechnical integration. Generalized approaches provide cross-cutting principles that transcend specific methodological schools. This classification reveals how systems engineering's intellectual toolkit has evolved beyond singular paradigms toward a complementary ecosystem of approaches that practitioners integrate to address increasingly complex system challenges.

practice. This timing coincides with broader digital transformation initiatives across industries and maturing computational capabilities that make model-based approaches increasingly accessible and powerful.

What makes this transition historically significant is its zero-sum relationship with traditional approaches. As MBSE has ascended, foundational systems engineering approaches (as defined in Table 6) have experienced a corresponding decline – suggesting not peaceful coexistence but a paradigmatic replacement underway. This shift represents more than just changing documentation practices but structurally alters how knowledge is represented within

the discipline itself: Traditional approaches encode systems knowledge in natural language – inherently ambiguous, challenging to interpret consistently, and resistant to automated analysis whereas model-based approaches transform this knowledge into formal, computable representations – precise, analyzable, and transformable through algorithmic means.

This transition from natural language to formal models parallels earlier transformations in other engineering disciplines, such as the shift from drafting boards to computer-aided design (CAD) systems in mechanical engineering. Just as CAD fundamentally changed what was possible in

design, MBSE is redefining the boundaries of systems engineering practice.

While MBSE and foundational approaches engage in their zero-sum competition, the other methodological categories defined in Table 6 maintain relatively stable representation throughout the period. Agile/lean, simulation-driven, systems thinking, complexity, and sociotechnical, and generalized approaches consistently appear but show no dramatic growth trends. This stability suggests these approaches serve complementary rather than competitive roles in the systems engineering toolkit.

The systems thinking category deserves

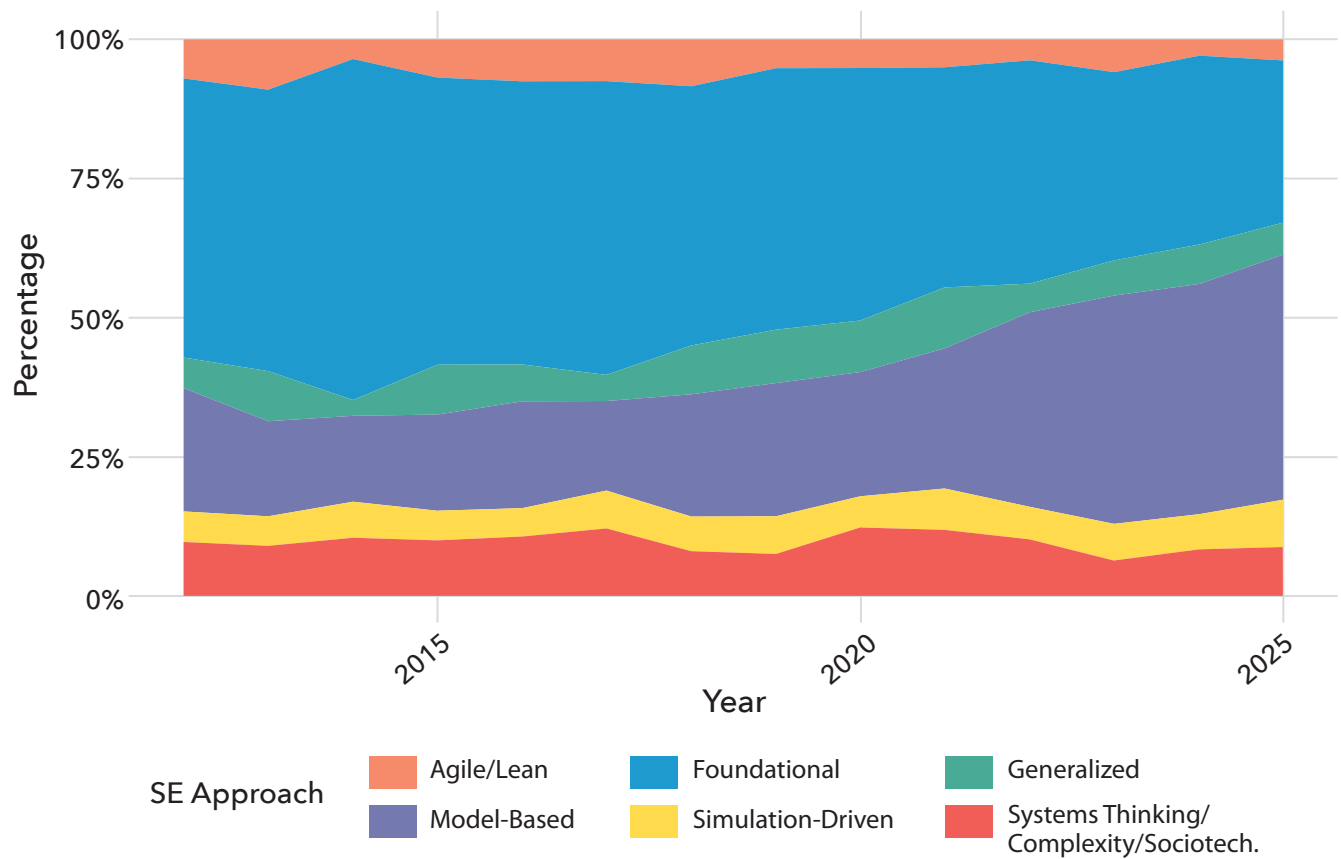


Figure 12. Submissions by systems engineering methodological approach over time

Note: The evolution of systems engineering approaches from 2012–2025. This stacked area chart depicts the proportional distribution of six distinct methodological categories: Foundational, Model-Based, Generalized, Agile/Lean, Simulation-Driven, and Systems Thinking/Complexity/Sociotechnical. The visualization reveals a significant shift in the field, with Model-Based approaches showing substantial growth (increasing from approximately 30% to 40% of submissions), particularly after 2020. Meanwhile, Foundational

approaches declined proportionally over the same period. The data suggests a gradual maturation of the discipline toward more sophisticated modeling techniques and specialized methodologies. The analysis was conducted using submissions with identifiable engineering approaches ($n=3,421$), with multi-approach submissions disaggregated. Data source: International Council on Systems Engineering International Symposium submission database (2012–2025). Author's calculations.

particular attention. Despite maintaining a modest proportional presence (approximately 8–12% of submissions), this approach demonstrates the highest acceptance rates (67.6%) among all methodological categories. This suggests that while not dominant in volume, these holistic perspectives are particularly valued by the discipline's gatekeepers – perhaps reflecting recognition that as technical approaches grow more sophisticated, the need for integrative thinking becomes more critical.

The trend toward MBSE also signals deeper alignment between systems engineering and software disciplines. As systems become increasingly software-intensive and digitally controlled, model-based approaches provide natural interfaces to software engineering methods and tools. This alignment facilitates integration across disciplines that were previously separated by incompatible representations and processes.

The growing prominence of computing, software, and AI in the application domain analysis (reaching 42.3% in presentations) further reinforces this narrative of convergence. Systems engineering is increasingly operating in digital contexts, and its methodological evolution reflects this new reality.

The shifting methodological landscape captured in our taxonomy carries profound implications for the discipline. The clear migration toward MBSE suggests that building competency in these approaches has become less optional and more essential for career longevity. Educational programs must not only teach MBSE techniques but help students understand the epistemological shift underlying them – moving from document-based reasoning to model-based reasoning about complex systems. Organizations that successfully navigate the shift from document-centric to model-centric approaches can gain

competitive advantages in efficiency and system quality, while those that hesitate may find themselves at a methodological disadvantage.

As systems engineering continues its methodological evolution, these trends suggest not just changing techniques but a fundamental transformation in how the discipline thinks about, represents, and communicates systems knowledge. This shift toward more formal, computable representations positions systems engineering to better address the increasingly complex, software-intensive systems that define our technological landscape.

3. Application Domain

The final dimension of this analysis explores where systems engineering methodologies are applied – the sectors, industries, and contexts that shape how systems approaches are implemented and evolved. The analysis employs a

Table 7. Systems engineering application domain taxonomy for INCOSE International Symposium submissions

Application Domain	Description
Aerospace & Defense	Systems engineering applications in aircraft, spacecraft, military, and national security contexts. These domains typically involve high reliability requirements, complex integration challenges, and strict regulatory compliance in mission-critical environments.
Physical Infrastructure & Services Systems	Applications in transportation, utilities, energy, telecommunications, and built environment sectors. These domains feature long lifecycle infrastructures with significant physical components, operational constraints, and public service requirements.
Commercial & Industrial Systems	Applications in manufacturing, retail, financial services, governance, and business operations. These domains emphasize competitive advantage, market responsiveness, and operational efficiency in profit-driven environments.
Computing, Software & Intelligent Systems	Applications focused on information technology, software development, artificial intelligence, and digital systems. These domains feature rapid innovation cycles, virtual components, and increasing autonomy in computational environments.
Education & Leadership	Applications addressing learning environments, knowledge transfer, professional development, and organizational leadership. These domains emphasize human capital development, organizational transformation, and systems thinking competencies.
Domain Free	Approaches and methodologies applicable across multiple domains without specific sectoral constraints. These approaches prioritize general systems principles, cross-cutting methodologies, and transferable frameworks.

Note: This taxonomy organizes the systems engineering landscape into six distinct domains, designed to capture both traditional strongholds and emerging application areas. The categorization emerged from analyzing submission patterns across fourteen years (2012–2025) and reflects natural clustering of methodological approaches, stakeholder environments, and technical challenges rather than arbitrary divisions. Aerospace & Defense and Physical Infrastructure & Services represent systems engineering's historical foundations, distinguished by their differing lifecycle characteristics and regulatory environments. Commercial & Industrial Systems were separated as a distinct category due to their unique emphasis on market dynamics

and competitive pressures not present in public infrastructure contexts. Computing, Software & Intelligent Systems emerged as a standalone classification reflecting the growing prominence of digital systems with fundamentally different verification challenges and development cycles than physical systems. Education & Leadership applications were distinguished by their focus on human capital and organizational development rather than technical artifacts. The Domain Free category captures methodological contributions with cross-cutting applicability, revealing systems engineering's evolution toward domain-agnostic frameworks.

six-category classification system that captures the primary application contexts for systems engineering approaches as reflected in International Symposium contributions, see Table 7. This taxonomy provides a lens through which to analyze how systems engineering practices manifest across diverse application contexts. The framework captures traditional strongholds like aerospace and defense alongside burgeoning areas like artificial intelligent systems, offering a comprehensive view of the discipline's application landscape.

The changing application domain landscape reflects the greater shifts happening in the technological and market environment. As depicted in Figure 13, the most pronounced transformation occurs within computing, software, and intelligent systems—domains that have exhibited sus-

tained growth over the study period, with a marked acceleration after 2020, culminating in their emergence as the predominant application area.

This rise aligns with, and likely propels, the methodological transition toward MBSE. The growing dominance of software-intensive systems necessitates advanced modeling techniques capable of managing the complexity, interconnectivity, and dynamic behavior inherent to digital environments.

Equally notable is the relative decline in domain-agnostic approaches since 2020. In the earlier phases of the study, generalized methodologies intended to transcend specific domains comprised a substantial proportion of submissions. Their subsequent decrease suggests a field moving from broadly applicable principles toward

more domain-specialized implementations, indicative of a natural maturation as methods become increasingly tailored to distinct application contexts.

Legacy strongholds of systems engineering, namely aerospace and defense, as well as commercial and industrial systems, have maintained stable representation throughout the period, jointly accounting for approximately 15–25% of submissions. This consistency highlights their continued relevance as foundational sectors that shape and sustain core systems engineering practices, even as emerging domains gain prominence.

The interplay between digital systems and domain-agnostic applications merits particular attention. Beginning around 2018–2019, these two categories exhibit an inverse trend, suggesting a shift in which

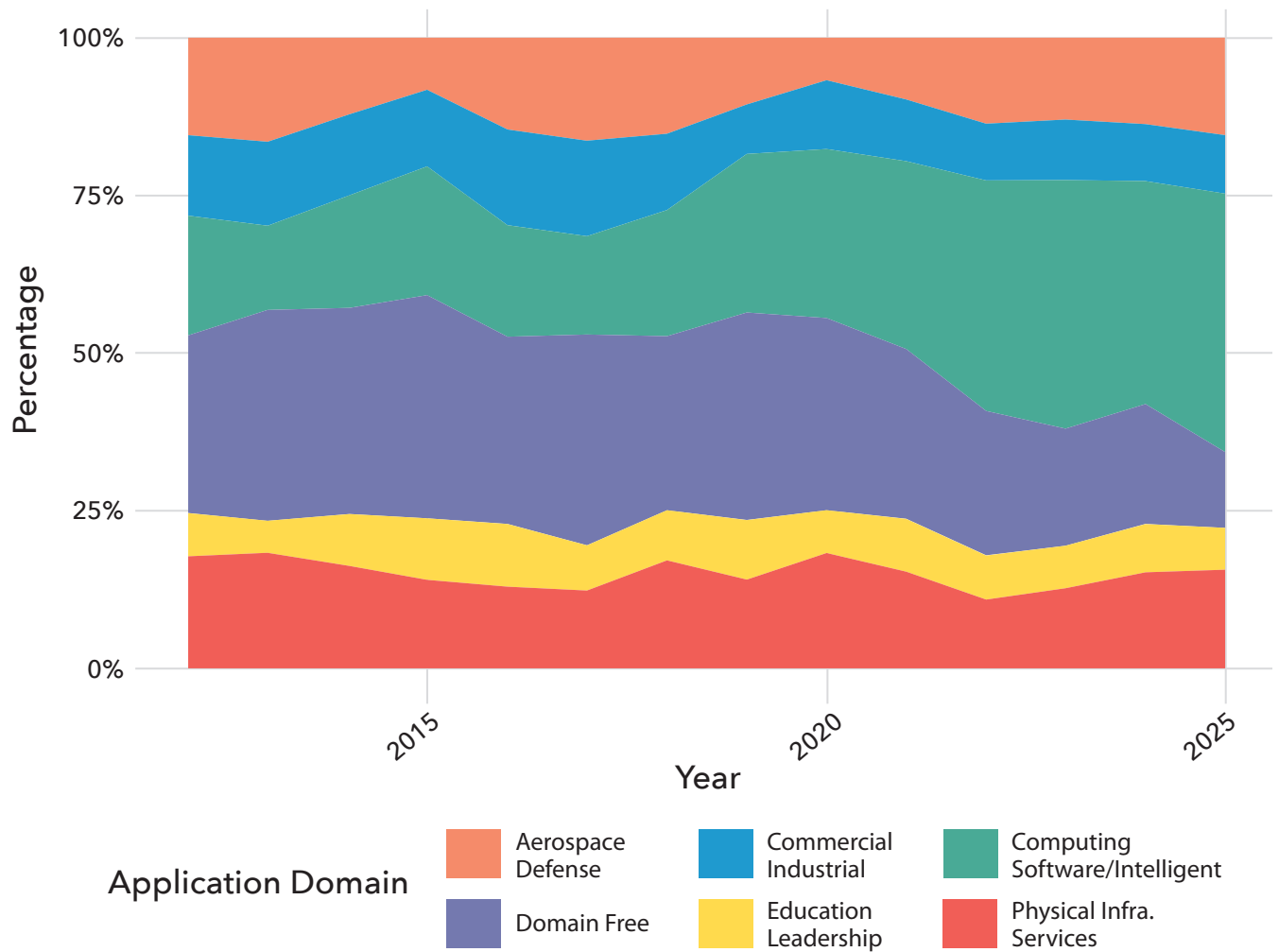


Figure 13. Submissions by application domain over time

Note: The evolution of systems engineering application domains from 2012–2025. This stacked area chart displays the proportional distribution of systems engineering publications across six application domains over a 15-year period. The visualization reveals significant shifts in domain focus, with Computing/Software/Intelligent Systems showing notable growth in recent years while Domain Free approaches have proportionally declined

since 2020. Aerospace & Defense and Commercial & Industrial Systems maintain relatively stable representation throughout the period. Physical Infrastructure/Services Systems and Education/Leadership categories show the smallest but consistent presence. Data source: International Council on Systems Engineering International Symposium submission database (2012–2025). Author's calculations.

generalized systems engineering principles are increasingly adapted to the unique demands of computational environments. The crossover point, observed between 2020 and 2021, coincides with the onset of pandemic-induced virtual conferences, potentially reflecting how global disruption hastened pre-existing trajectories of digital transformation.

In contrast, physical infrastructure and service systems have maintained a steady 15–16% share of submissions. This temporal stability stands in stark contrast to their critical societal and economic importance, raising questions about a possible disconnect between the field's formal knowledge production and the pressing needs of real-world infrastructure development. Such a pattern invites further inquiry into

whether these sectors are underutilizing advanced systems methodologies or applying them in ways not captured within formal symposium contributions.

Perhaps most unfortunate is the persistently low representation of education and leadership applications, which have consistently accounted for only 6–8% of submissions. Despite their fundamental role in cultivating the systems engineering workforce and enabling organizational transformation, their limited presence suggests a potential constraint on the field's capacity to extend its impact across institutional boundaries and to nurture future generations of systems engineers.

D. Gap Analysis

The gap analysis presented here provides

a comprehensive analysis of knowledge gaps within the systems engineering discipline, utilizing the taxonomic framework to identify both areas of intellectual concentration and critical deficiencies across the field's knowledge landscape, thereby revealing strategic opportunities for targeted research investment and disciplinary advancement.

As illustrated in Table 8, the systems engineering discipline exhibits pronounced knowledge concentrations. The most heavily populated intersections – accounting for the highest percentages of submissions – cluster primarily within two methodological approaches: foundational systems engineering and MBSE. These approaches, when combined with specific contribution types and application domains, form

Table 8. Cross-classification of engineering submissions by approach, domain, and contribution type (2012-2025)

SE Approach	Application Domain	Applications		Empirical	Methodology		Review & Synthesis		Theory	Tools & Technology	
Foundational	Aerospace & Defense	41 (0.8%)		6 (0.1%)	127 (2.6%)	**	15 (0.3%)		13 (0.3%)	63 (1.3%)	*
	Commercial & Industrial	16 (0.3%)		6 (0.1%)	99 (2.0%)	**	12 (0.2%)		11 (0.2%)	60 (1.2%)	*
	Computing, Software, & Intelligent	35 (0.7%)		14 (0.3%)	156 (3.2%)	**	19 (0.4%)		19 (0.4%)	191 (3.9%)	**
	Domain Free	128 (2.6%)	**	28 (0.6%)	240 (4.9%)	**	48 (1.0%)	*	36 (0.7%)	103 (2.1%)	**
	Education & Leadership	45 (0.9%)		6 (0.1%)	58 (1.2%)	*	16 (0.3%)		11 (0.2%)	26 (0.5%)	
	Physical Infrastructure & Services	54 (1.1%)	*	13 (0.3%)	159 (3.3%)	**	19 (0.4%)		7 (0.1%)	96 (2.0%)	**
Model-Based	Aerospace & Defense	17 (0.3%)		2 (0.0%)	94 (1.9%)	*	10 (0.2%)		5 (0.1%)	99 (2.0%)	**
	Commercial & Industrial	18 (0.4%)		2 (0.0%)	73 (1.5%)	*	4 (0.1%)		4 (0.1%)	56 (1.1%)	*
	Computing, Software, & Intelligent	50 (1.0%)	*	10 (0.2%)	238 (4.9%)	**	25 (0.5%)		18 (0.4%)	282 (5.8%)	***
	Domain Free	18 (0.4%)		7 (0.1%)	145 (3.0%)	**	17 (0.3%)		7 (0.1%)	83 (1.7%)	*
	Education & Leadership	5 (0.1%)		4 (0.1%)	14 (0.3%)		2 (0.0%)		3 (0.1%)	33 (0.7%)	
	Physical Infrastructure & Services	11 (0.2%)		1 (0.0%)	66 (1.3%)	*	5 (0.1%)		4 (0.1%)	58 (1.2%)	*
Generalized	Aerospace & Defense	2 (0.0%)		2 (0.0%)	15 (0.3%)		1 (0.0%)		3 (0.1%)	9 (0.2%)	
	Commercial & Industrial	5 (0.1%)		1 (0.0%)	18 (0.4%)		1 (0.0%)		2 (0.0%)	7 (0.1%)	
	Computing, Software, & Intelligent	9 (0.2%)		1 (0.0%)	30 (0.6%)		6 (0.1%)		8 (0.2%)	35 (0.7%)	
	Domain Free	11 (0.2%)		3 (0.1%)	30 (0.6%)		9 (0.2%)		30 (0.6%)	15 (0.3%)	
	Education & Leadership	17 (0.3%)		0 (0.0%)	10 (0.2%)		6 (0.1%)		5 (0.1%)	4 (0.1%)	
	Physical Infrastructure & Services	9 (0.2%)		1 (0.0%)	18 (0.4%)		4 (0.1%)		8 (0.2%)	18 (0.4%)	
Agile & Lean	Aerospace & Defense	2 (0.0%)		1 (0.0%)	18 (0.4%)		1 (0.0%)		1 (0.0%)	8 (0.2%)	
	Commercial & Industrial	2 (0.0%)		2 (0.0%)	17 (0.3%)		1 (0.0%)		0 (0.0%)	14 (0.3%)	
	Computing, Software, & Intelligent	6 (0.1%)		2 (0.0%)	37 (0.8%)		1 (0.0%)		4 (0.1%)	36 (0.7%)	
	Domain Free	10 (0.2%)		1 (0.0%)	35 (0.7%)		0 (0.0%)		3 (0.1%)	19 (0.4%)	
	Education & Leadership	3 (0.1%)		1 (0.0%)	7 (0.1%)		1 (0.0%)		2 (0.0%)	2 (0.0%)	
	Physical Infrastructure & Services	5 (0.1%)		2 (0.0%)	20 (0.4%)		0 (0.0%)		0 (0.0%)	11 (0.2%)	
Simulation-Driven	Aerospace & Defense	4 (0.1%)		2 (0.0%)	25 (0.5%)		1 (0.0%)		2 (0.0%)	10 (0.2%)	
	Commercial & Industrial	4 (0.1%)		1 (0.0%)	10 (0.2%)		4 (0.1%)		0 (0.0%)	10 (0.2%)	
	Computing, Software, & Intelligent	8 (0.2%)		2 (0.0%)	35 (0.7%)		5 (0.1%)		7 (0.1%)	43 (0.9%)	
	Domain Free	5 (0.1%)		8 (0.2%)	25 (0.5%)		7 (0.1%)		3 (0.1%)	20 (0.4%)	
	Education & Leadership	1 (0.0%)		1 (0.0%)	5 (0.1%)		1 (0.0%)		1 (0.0%)	6 (0.1%)	
	Physical Infrastructure & Services	7 (0.1%)		6 (0.1%)	21 (0.4%)		3 (0.1%)		1 (0.0%)	21 (0.4%)	

Table 8. Cross-classification of engineering submissions by approach, domain, and contribution type (2012-2025) [continued]

SE Approach	Application Domain	Applications	Empirical	Methodology	Review & Synthesis	Theory	Tools & Technology
Thinking, Complexity, & Sociotechnical	Aerospace & Defense	3 (0.1%)	3 (0.1%)	22 (0.4%)	6 (0.1%)	3 (0.1%)	17 (0.3%)
	Commercial & Industrial	10 (0.2%)	2 (0.0%)	34 (0.7%)	1 (0.0%)	9 (0.2%)	25 (0.5%)
	Computing, Software, & Intelligent	7 (0.1%)	2 (0.0%)	27 (0.6%)	3 (0.1%)	6 (0.1%)	23 (0.5%)
	Domain Free	14 (0.3%)	0 (0.0%)	49 (1.0%)	8 (0.2%)	13 (0.3%)	26 (0.5%)
	Education & Leadership	9 (0.2%)	4 (0.1%)	29 (0.6%)	8 (0.2%)	1 (0.0%)	6 (0.1%)
	Physical Infrastructure & Services	15 (0.3%)	0 (0.0%)	42 (0.9%)	4 (0.1%)	4 (0.1%)	26 (0.5%)

Notes:

1. This table presents a cross-classification analysis of INCOSE submissions by engineering approach (vertical axis) and application domain (horizontal axis), further segmented by six contribution types (columns).
2. Cell values represent frequency counts with percentages in parentheses, where percentages reflect the proportion of each combination within the total dataset (n=4,038). Asterisks indicate contribution percentile: * q > 90th percentile, ** q > 95 percentile, *** q > 99th percentile.
3. The highest concentration of submissions appears in the Model-Based/Computing, Software, and Intelligent/Tools & Technologies category (282 submissions, 5.8%), followed by Foundational/Domain Free/Methodological (240 submissions, 4.9%).
4. Methodological contributions dominate across most approach-domain combinations, with particularly strong representation in Foundational approaches (240 submissions in Domain Free) and Model-Based approaches (238 submissions in Computing/Software).
5. Sparse areas include Theory contributions (<0.1% across most cells), Empirical research, and combinations involving Education & Leadership domains, suggesting potential knowledge gaps in the engineering literature.
6. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025). Author's calculations.

distinct “knowledge hotspots” that signal where the discipline’s intellectual energy is most intensely focused.

The most significant knowledge concentration appears at the intersection of MBSE methods and tools applied to computing, software, and intelligent systems (238+282 submissions). This represents nearly one in every eight submissions to the symposium – a remarkable concentration that reflects the growing prominence of computational modeling tools for software-intensive systems. Not far behind, the foundational systems engineering approaches, when applied to domain-free contexts through methodological contributions, account for 240 submissions (4.9%), establishing this as another major intellectual focus area.

These concentrations reveal not merely popular topics but potentially mature knowledge areas where methods, tools, and concepts have been thoroughly explored and documented. The pattern of asterisks highlights this concentration visually—the triple asterisks (***) marking the 99th percentile appears exclusively in the Model-Based × Computing/Software × Tools/Technologies cell, while double asterisks (**) cluster predominantly in methodological contributions across foundational and MBSE approaches.

What makes this gap analysis particularly

valuable is how it illuminates the extensive “white space” in the knowledge landscape. The table’s broad swaths of minimal activity (<0.2% representation) aren’t merely null findings but rather a systematic mapping of unexplored intellectual territory. These patterns reveal critical gaps across multiple dimensions.

Empirical contributions are severely underrepresented across nearly all methodological approaches and application domains, never exceeding 0.6% in any combination. This systemic lack of validation studies creates a concerning disconnect between methodological claims and evidence-based practice. Additionally, with few exceptions, theoretical contributions remain sparse across the taxonomy (typically below 0.3% per intersection), suggesting limited attention to foundational conceptual frameworks that could unify and advance the discipline. Nearly all intersections involving education & leadership domains exhibit low representation (most below 0.3%), revealing a potentially critical blind spot in systems engineering knowledge related to teaching, learning, and organizational leadership. And, despite widespread industry adoption, studies on agile and lean approaches show minimal representation across most domains and contribution types, with no

intersection exceeding 0.8%.

Addressing these gap areas presents significant strategic opportunities for advancing the systems engineering discipline. Targeted investment in empirical validation research could substantially strengthen the evidence base for systems engineering practices, enabling practitioners to confidently select methodologies with demonstrated effectiveness across different contexts. Such validation would transform systems engineering from a largely anecdotally based practice into one grounded in measurable outcomes and statistically proven approaches.

Developing more robust theoretical frameworks would provide the intellectual scaffolding needed to connect disparate methodological islands into a coherent knowledge archipelago. This theoretical foundation could unlock entirely new methodological innovations at the intersection of previously disconnected approaches, potentially catalyzing breakthrough capabilities in addressing increasingly complex systems challenges.

The education and leadership gap represents perhaps the most immediately actionable opportunity. By developing sophisticated knowledge transfer mechanisms and leadership development approaches specifically tailored to systems

engineering contexts, the discipline could dramatically accelerate practitioner development, reduce implementation failures, and create more resilient systems engineering organizations. Given the growing complexity of systems engineering methods, particularly in model-based approaches, educational innovation becomes not merely beneficial but essential for sustaining disciplinary advancement.

The gap analysis ultimately offers a strategic roadmap for high-impact research investment. By targeting these underrepresented intersections – particularly those involving empirical validation, theoretical foundations, and educational approaches – the systems engineering community stands to dramatically increase its intellectual coherence, practical effectiveness, and long-term resilience in addressing increasingly complex technological challenges. Rather than merely identifying deficits, this analysis illuminates the most promising frontiers for systems engineering advancement.

E. Conclusion

Systems engineering is rapidly shifting its techniques while its fundamental knowledge architecture remains surprisingly constant. The taxonomic analysis of INCOSE International Symposium submissions (2012-2025) reveals not just what systems engineers are working on, but how the discipline itself is evolving as a knowledge ecosystem.

The most apparent finding emerges at the methodological level: MBSE is steadily displacing document-centric approaches. However, this hints at not just a trend but a fundamental epistemological shift in how systems knowledge is represented and manipulated. Where engineers once reasoned through natural language artifacts – inherently ambiguous and resistant to computation – they increasingly leverage formal models that enable algorithmic analysis and transformation.

Yet amid this methodological revolution, the discipline's knowledge production effort shows remarkable stability. The persistent dominance of methodological contributions (30-40%) and tools/technologies (25-30%), coupled with the chronic underrepresentation of theoretical (5%) and empirical validation studies (3%), suggests a discipline more focused on developing new approaches than on rigorously validating their effectiveness. This imbalance creates a potentially fragile foundation – a wealth of methodological innovation built atop sparse theoretical scaffolding and limited empirical evidence.

The gravitational pull toward computing, software, and intelligent systems applications reveals another dimension of trans-

formation. Digital systems now form the dominant application context for systems engineering approaches, particularly for presentation-format submissions (42.3%). This signals not just changing marketplace demands but a converging relationship between systems and software engineering disciplines that had historically maintained separate epistemological traditions.

Perhaps most revealing is the disciplinary “white space” – gaps in the knowledge landscape where important intersections remain unexplored. The scarcity of empirical studies validating methodological effectiveness across different domains represents a critical vulnerability. Similarly, the persistent underrepresentation of education and leadership applications suggests a discipline more focused on developing new technical approaches than developing the people to utilize them.

A more balanced knowledge production ecosystem could fundamentally transform systems engineering's impact and resilience. Imagine a discipline where methodological innovation flows from robust theoretical frameworks and is continuously refined through rigorous empirical validation – creating a virtuous cycle of evidence-based practice. This balanced approach would generate not just more effective methods but greater confidence in their application across diverse domains.

Targeted investment in the identified knowledge gaps could yield disproportionate returns. Empirical validation research would transform systems engineering from a largely experience-based practice into one with demonstrable efficacy metrics, allowing organizations to select approaches based on validated outcomes rather than methodological fashion. Meanwhile, expanded research in education and leadership applications would accelerate knowledge transfer, reducing the steep learning curves associated with sophisticated methodologies like MBSE and creating more resilient systems engineering organizations capable of navigating complex project environments.

The future of systems engineering lies in cultivating regular validation mechanisms and knowledge transfer approaches alongside methodological innovation, the discipline could evolve from a collection of competing frameworks, processes, tools, procedures, approaches, etc. into a coherent, evidence-based practice capable of addressing the unprecedented sociotechnical complexity of modern systems challenges. This rebalanced future represents not just an academic ideal but a strategic imperative for a discipline whose relevance depends on its ability to deliver demonstrable value in increasingly demanding environments.

IV. ACCEPTANCE ANALYSIS

A. Introduction

Beyond examining who participates in systems engineering discourse and what topics they address; a comprehensive understanding of the discipline requires investigating what the community truly values – and the acceptance patterns of submissions to the INCOSE International Symposium (2012-2025) offer a revealing window into this “demand side” of knowledge production. The symposium's technical review process serves as a critical filtering mechanism that determines which ideas gain legitimacy within the discipline's formal knowledge base. By analyzing which submissions achieve acceptance, we can identify methodological preferences, valued knowledge types, and potential biases that may accelerate certain perspectives while impeding others. In other words, for this analysis to accurately reflect community priorities, the review process must operate with reasonable consistency and fairness, rather than through arbitrary judgments or entrenched preferences. Only then can the acceptance patterns serve as meaningful signals of disciplinary values – signals that don't merely reflect current priorities but actively shape future knowledge production by indicating to researchers and practitioners which directions merit continued exploration.

This analysis addresses three fundamental questions about systems engineering's knowledge validation architecture:

(1) What systematic patterns emerge in acceptance rates across different submission characteristics, such as track types, methodological approaches, and application domains? (2) Which factors most strongly predict acceptance, and how have these predictors changed over the 14-year study period? (3) What do these acceptance patterns reveal about the technical review process – its consistency, potential biases, and effectiveness as a quality control mechanism?

Major findings suggest an unbiased review process coupled with a dramatic temporal decline in overall acceptance rates from approximately 90% in 2012 to 40% by 2025, independent of changes in submission quality or composition – suggesting increasing selectivity and standards as the symposium has matured. Such insights provide stakeholders, from symposium organizers to contributors, with evidence-based understanding of how the field is developing and what factors most significantly impact a submission's likelihood of entering the formal knowledge base.

B. Acceptance Patterns

The distribution of acceptance rates

Table 9. Acceptance rates by submission characteristics (2012-2025)

Category	Attribute	Submissions		
		Count	% of Total	Acceptance Rate (%)
Track	Paper	2516	62.3	67.4
	Presentation	794	19.7	42.8
	Panel	252	6.2	54.8
	Tutorial	476	11.8	38.9
Engineering Approach	Foundational	1834	42.7	56.2
	Model-Based	1246	29.0	57.8
	Agile/Lean	240	5.6	59.2
	Simulation-Driven	271	6.3	59.0
	Thinking/Complexity/Sociotech.	404	9.4	67.6
	Generalized	304	7.1	62.8
Contribution Type	Methodological	1760	41.6	59.4
	Tools/Technologies	1337	31.6	57.4
	Applications	541	12.8	54.7
	Review/Synthesis	243	5.7	60.9
	Empirical	133	3.1	55.6
	Theory	217	5.1	60.4
Application Domain	Domain Free	1113	25.4	56.1
	Computing/Software/Intelligent	1215	27.7	55.7
	Aerospace & Defense	580	13.2	63.6
	Physical Infrastructure & Services	658	15.0	60.9
	Commercial & Industrial	482	11.0	60.0
	Education/Leadership	331	7.6	61.0
Academic Status	Non-Academic	2234	55.3	53.1
	Academic	1804	44.7	65.0

Notes:

1. Data represents aggregated INCOSE submission observations (2012-2025, n = 4,038).
2. Acceptance rates are presented as percentages (accepted submissions/total submissions/100) for each category level.
3. Sample sizes vary substantially across category levels (min: 133 for Empirical contributions; max: 2,516 for Paper track), which should be considered when interpreting percentage differences.
4. Key findings: (a) Papers have significantly higher acceptance

rates (67.4%) than other tracks; (b) Thinking/Complexity/Sociotechnical approaches show the highest acceptance rate (67.6%) among engineering approaches; (c) Review/Synthesis work (60.9%) has the highest acceptance rate among contribution types; (d) Aerospace & Defense (63.6%) leads acceptance rates among application domains; and (e) Academic submissions enjoy substantially higher acceptance rates (65.0%) compared to Non-Academic submissions (53.1%).

across submission characteristics reveals distinct patterns in how systems engineering knowledge is validated and integrated into the discipline. This section examines these patterns across multiple attributes, providing clarity on both the explicit and

implicit selection mechanisms that shape the discipline's intellectual trajectory.

Table 9 reports aggregated acceptance data from 2012-2025 and finds pronounced differences across submission tracks, reflecting their distinct roles in the IS

program. Papers demonstrate substantially higher average acceptance rates (67.4%) compared to other formats, while also constituting the majority of submissions (62.3%). This preferential acceptance affirms the papers track's position as the

symposium's scholarly backbone, channeling methodological advancements into the permanent proceedings.

In contrast, presentations – despite their growing popularity noted in previous sections – maintain substantially lower acceptance rates (42.8%), creating a more selective filter for this increasingly prominent knowledge-sharing format, particularly among practitioners. Panels occupy a middle ground with an average acceptance rate of 54.8% acceptance, while tutorials face the most stringent acceptance threshold (38.9%), reflecting the heightened scrutiny applied to educational content that directly shapes practitioner capabilities as well as their limited inclusion in the program.

When examined through the lens of systems engineering approaches, acceptance patterns reveal subtle but significant disciplinary preferences. Systems thinking, complexity, sociotechnical approaches achieve the highest acceptance rates (67.6%) – markedly above the overall average – despite representing only 9.4% of submissions. This subtly disproportionate acceptance suggests the symposium's technical reviewers and organizers likely place particularly high value on holistic perspectives that integrate complex technical and social dimensions.

Similarly, generalized approaches enjoy elevated acceptance rates (62.8%), contrasting with more modest rates for both foundational (56.2%) and model-based approaches (57.8%). This pattern presents two potential interpretations: First, though MBSE represents a growing proportion of submissions (as documented in the Section III), its contributions may not receive preferential treatment in the peer review process, reflecting a natural quality distribution across methodological approaches. Second, and perhaps more significantly, the pattern may indicate intentional higher selectivity by reviewers and conference organizers to maintain methodological balance amid the proliferation of MBSE submissions. In either case, the data suggests the review process ultimately favors methodological breadth over depth – perhaps reflecting the discipline's demand for integrative frameworks that bridge increasingly specialized approaches within systems engineering practice.

Contribution types exhibit more moderate variations in acceptance rates, with work on reviews and syntheses achieving the highest acceptance (60.9%), closely followed by theory (60.4%) and methodological contributions (59.4%). The relatively strong performance of theoretical contributions is particularly noteworthy given their limited representation in the overall submission pool (5.1%), suggesting

reviewers highly value these foundational contributions despite their rarity.

Application-oriented submissions demonstrate the lowest acceptance rates (54.7%), creating a potential barrier for practical implementation knowledge entering the formal record. This likely reflects how domain-specific applications resonate less broadly – reviewers naturally favor content transferable to their own practice areas. However, this preference for methodologies carries risk: systematically favoring abstract frameworks over implementation specificity may privilege process ideation over the practical insights that help validate them.

Moving down the table, application domains reveal meaningful acceptance disparities that reflect both historical disciplinary roots and emerging interests. Aerospace and defense submissions maintain the highest domain-specific acceptance rates (63.6%), affirming this sector's continued influence as systems engineering's traditional stronghold. Meanwhile, computing, software, AI submissions – despite their growing representation documented in previous sections – achieve more modest acceptance rates (55.7%), suggesting that while this domain has gained prominence in submission volume, it may face a more critical evaluation threshold. This domain-based acceptance hierarchy creates natural feedback loops that shape domain representation in the discipline's formal knowledge base. Aerospace's higher acceptance rates naturally amplify its visibility and influence, while emerging domains may face greater challenges in establishing their legitimacy within the systems engineering corpus.

Perhaps most striking is the substantial acceptance rate gap between academic (65.0%) and non-academic submissions (53.1%). This 11.9 percentage point differential represents a significant advantage for scholarly contributions over practitioner-generated knowledge, potentially reinforcing separation between scholarly and practice knowledge streams within the discipline. This disparity presumably reflects underlying incentive misalignments – academics build careers on publication while industry practitioners rarely receive professional recognition or advancement for symposium contributions and often face organizational barriers to knowledge sharing. This academic advantage merits particular attention given the findings in the Authors Analysis section regarding institutional affiliations. The industry-dominated author demographics (60-70% of contributors) combined with lower acceptance rates for non-academic submissions suggests that a substantial portion of potential industry

knowledge fails to enter the formal systems engineering record. This systematic filtering creates a disciplinary knowledge base that may over-represent academic perspectives relative to industry practice – potentially limiting the discipline's ability to incorporate practical innovations and implementation insights.

Further examining annual acceptance rates from 2012-2025 reveals significant year-over-year variations in the symposium's selectivity. The raw acceptance data, as shown in Figure 2, demonstrates a general downward trend in acceptance percentages across the fourteen-year period, though with notable fluctuations.

The early years (2012-2017) maintained relatively high acceptance rates, typically between 70-85%. A transition period then emerged around 2018-2019 with acceptance rates settling in the 60-70% range, indicating increasing selectivity even as submission volumes remained relatively stable. The pandemic years (2020-2021) temporarily disrupted this trend, with virtual-format symposia demonstrating distinct acceptance patterns compared to the predominant trajectory – an anomaly suggesting external factors beyond submission quality influenced the review process during this exceptional period. Most striking is the dramatic shift in the post-pandemic period (2022-2025), where acceptance rates dropped significantly to approximately 45-55% due to substantial increases in overall submission volume.

The progressive tightening of the acceptance filter across the study period reflects a maturing symposium transitioning from a primarily inclusive knowledge-sharing venue toward a more discriminating arbitrator of systems engineering contributions. The transformation seems to be establishing progressively higher thresholds for what constitutes significant advancement worthy of integration into the formal knowledge base, ultimately curating the discipline's intellectual landscape.

C. Statistically Modeling Acceptance Rates

While descriptive patterns provide valuable insights into acceptance trends, a more sophisticated statistical approach allows us to disentangle the complex, interrelated factors that influence submission outcomes. This section employs logistic regression to identify which characteristics most strongly predict acceptance to the INCOSE International Symposium, how these predictors interact, and what they reveal about the underlying technical review process.

Logistic regression proves particularly suitable for this analysis because it effectively models binary outcomes (accept/reject) while accommodating the multiple

Table 10. Logistic regression of submission acceptance indicators

	Coefficient		Standard Error	Odds Ratio
Intercept	-2.478	**	(.803)	0.084
Event				
Year	-0.167	*	(.072)	0.846
Virtual Only Event (Yes/No)	1.168	*	(.487)	3.216
Event in USA (Yes/No)	0.893	.	(.492)	2.443
Team Composition				
Total Authors	0.032		(.043)	1.033
0 Active Author	–		–	–
1 Active Author	0.061		(.123)	1.063
2-3 Active Authors	0.462	*	(.182)	1.588
4+ Active Authors	0.460	.	(.268)	1.584
Affiliations				
Industry	–		–	–
Academic	0.254	.	(.142)	1.290
Government	-0.100		(.222)	0.905
Retired/Self Representing	0.269		(.344)	1.308
Americas	–		–	–
Asia Oceania	0.119		(.285)	1.126
Europe, the Middle East and Africa	-0.101		(.116)	0.904
Track				
Paper	–		–	–
Presentation	-1.942	.	(1.102)	0.143
Panel	-2.520	**	(.794)	0.080
Tutorial	-3.536	***	(.990)	0.029
Submission Characteristics				
Systems Engineering Approach				
Foundational	-0.404	**	(.125)	0.668
Model-Based Systems Engineering	-0.253	**	(.078)	0.776
Generalized	0.054		(.229)	1.055
Simulation-Driven Engineering	-0.128		(.185)	0.880
Agile/Lean	-0.317	*	(.144)	0.728
Systems Thinking, Complexity, Sociotechnical	–		–	–
Type of Contribution				
Methodological	0.039		(.176)	1.039
Applications	0.074		(.135)	1.077
Tools/Technologies	-0.065		(.155)	0.937

Type of Contribution (continued)				
Review/Synthesis	-0.027		(.210)	0.973
Theory	–		–	–
Empirical	-0.014		(.262)	0.986
Application Domain				
Education/Leadership	0.137		(.146)	1.147
Commercial & Industrial Systems	0.057		(.139)	1.058
Computing/Software/Intelligent Systems	0.082		(.100)	1.085
Aerospace & Defense	0.035		(.118)	1.036
Physical Infrastructure & Services Systems	-0.010		(.160)	0.990
Domain-Free	–		–	–
Reviewer Outcomes				
Total # of Reviews	0.285	*	(.136)	1.329
Avg Reviewer Confidence	0.092		(.082)	1.096
Avg Overall Evaluation	2.175	***	(.478)	8.801
Avg Acceptance Recommendation	0.662	*	(.329)	1.938
N = 4,038				

Notes:

1. Coefficients are presented in log-odds. Odds ratios (OR) represent the multiplicative change in odds for a one-unit increase in the predictor.
2. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, otherwise $p < 0.10$.
3. Reference category (baseline) for categorical variables are indicated by a long dash (–) across row values.
4. All variable VIF values < 5 , indicating no problematic multicollinearity. AIC = 3,003.76. BIC = 3224.38.
5. Variables excluded to improve model parsimony and avoid detected multicollinearity: Submission has at least one author in Top 5th Percentile of Submitters; Total Number of Lifetime Submissions; First Submission's Year; Count of Authors from Sector 1; Count of Authors from Sector 2; Count of Authors from Sector 3; Count of Academic Affiliated Authors; Count of Industry Affiliated Authors, Count of Government Affiliated Authors; Count of Retired/Self-Employed Authors, interactions between Year and Track, and interactions between topic classifications.
6. The analysis indicates a generally robust technical review process for International Symposium submissions with some systematic patterns worth noting. As expected, reviewer evaluations strongly predict acceptance (Avg Overall Evaluation: OR=8.801, $p < 0.001$), suggesting reviewers' assessments carry substantial weight. Authors with academic affiliations and more experienced authors possibly show a modest positive effect, while track selection significantly impacts outcomes. MBSE approaches receive disfavorable outcomes (OR=0.776, $p < 0.01$), as do Foundational contributions (OR=0.668, $p < 0.01$). Virtual-only events (during COVID-19; 2020-21) show higher acceptance rates (OR=3.216, $p < 0.05$). The model's exceptionally high explanatory power (McFadden $R^2=0.465$; AUC: 0.848 at probability threshold 0.69) demonstrates that acceptance decisions follow consistent evaluation patterns rather than arbitrary judgments, though temporal trends suggest slightly decreasing acceptance rates over time (Year: OR=0.846, $p < 0.05$).
7. Data source: International Council on Systems Engineering International Symposium submission database (2012-2025).

predictor variables of different types that characterize symposium submissions. Unlike machine learning approaches focused primarily on predictive accuracy, this modeling approach prioritizes interpretability – seeking to parse out the systematic relationships between submission attributes and acceptance decisions.

1. Logistic Regression and Model Fit

The statistical model incorporates four conceptual clusters of predictors that potentially influence acceptance decisions:

event characteristics (year, location, format), author attributes (experience, institutional affiliation, geographic origin), submission attributes (track type, methodological approach, contribution type, application domain), and review outcomes (evaluation scores, confidence levels, recommendation strength). This comprehensive approach allows us to estimate the relative importance of each factor while controlling for others.

As detailed in Table 10, the model demonstrates exceptional explanatory

power, with a McFadden R^2 of 0.465 – extraordinarily high for social science applications – and an area under the ROC curve (AUC) of 0.848. These performance metrics indicate that acceptance decisions follow consistent, identifiable patterns rather than random outcomes, suggesting a largely structured, systematic technical review process underpins the symposium's gatekeeping function.

The model's classification performance metrics, presented in Table 11, further underscore its robustness. With 83.9%

Table 11. Classification performance metrics for acceptance prediction model

Metric	Value	Formula	Description
Classification Distribution Summary			
Total Population	4038	$P + N$	Total number of observations
Positive (P)	1678		Total actual positive instances (class 0)
Negative (N)	2360	—	Total actual negative instances (class 1)
Predicted Positive (P*)	1994	—	Model predicted positive (class 0)
Predicted Negative (N*)	2044	—	Model predicted negative (class 1)
Confusion Matrix			
True Positive (TP)	1511		Correctly predicted positive (class 0)
False Negative (FN)	167		Incorrectly predicted negative
False Positive (FP)	483		Incorrectly predicted positive
True Negative (TN)	1877		Correctly predicted negative (class 1)
Classification Performance Metrics			
Prevalence	0.416	$P / (P + N)$	Proportion of positive instances in dataset
Accuracy (ACC)	0.839	$(TP + TN) / (P + N)$	Overall correctness of the model
Balanced Accuracy (BA)	0.848	$(TPR + TNR) / 2$	Average of sensitivity and specificity
True Positive Rate (TPR)	0.900	TP / P	Also known as Sensitivity or Recall
True Negative Rate (TNR)	0.795	TN / N	Also known as Specificity
Positive Predictive Value (PPV)	0.758	$TP / (TP + FP)$	Also known as Precision
F1 Score	0.879	$2 * (PPV * TPR) / (PPV + TPR)$	Harmonic mean of precision and recall
Matthews Correlation Coefficient (MCC)	0.686	$\text{sqrt}(TPR * TNR * PPV * NPV) - \text{sqrt}(FNR * FPR * FOR * FDR)$	Correlation coefficient between actual and predicted classifications

Notes:

- Class 0 is designated as the "Positive" class in this analysis, which affects the interpretation of all metrics. True Positive Rate (TPR) and Positive Predictive Value (PPV) reference correct identification of class 0.
- The model demonstrates statistically significant performance above the No Information Rate ($p < 2.2e-16$), with an Accuracy of 0.839 (95% CI: 0.827, 0.850).
- McNemar's Test ($p < 2.2e-16$) indicates significant differences in the proportions of false positives and false negatives, suggesting asymmetric error distributions.
- With Prevalence of 0.416, the model achieves balanced performance across classes as evidenced by Balanced Accuracy (0.848), addressing potential bias from class imbalance.
- The Matthews Correlation Coefficient (MCC = 0.686) indicates strong agreement between predictions and actual values, with values ranging from -1 (perfect disagreement) to 1 (perfect agreement).
- Key performance indicators show the model excels at identifying class 0 instances (Sensitivity = 0.848) while maintaining good specificity (0.795), with harmonic balance between precision and recall (F1 Score = 0.879). The high Negative Predictive Value (0.918) indicates particular reliability when predicting submission rejections.

overall accuracy (95% CI: 0.827, 0.850), the model correctly identifies 90.0% of accepted submissions (sensitivity) and 79.5% of rejected submissions (specificity). This balanced performance across both acceptance and rejection classification

indicates the model captures the underlying decision mechanisms with remarkable fidelity.

Particularly noteworthy is the Matthews Correlation Coefficient of 0.686, which quantifies the correlation between pre-

dicted and actual classification outcomes. Values ranging from -1 (perfect disagreement) to 1 (perfect agreement) make this 0.686 value indicative of strong agreement between model predictions and actual acceptance decisions.

This modeling approach provides three critical advantages over descriptive analysis alone: it isolates the independent effect of each predictor while controlling for others; it quantifies the relative strength of various predictors, revealing which factors matter most; and it enables examination of interaction effects between predictors, uncovering how different submission characteristics may amplify or diminish each other's influence on acceptance outcomes. This analysis also benefits from having the entire population of submission data from 2012-2025, therefore these are not sample estimates, increasing confidence in interpretation.

For readers interested in additional methodological details underlying the development of the logit model, see the Appendix under *Methodological Details: Statistical Modeling*.

2. Evaluating the Technical Review Process

The logistic regression results offer a compelling window into the dynamics of the INCOSE International Symposium's technical review process. The model reveals a filtration mechanism that operates with remarkable consistency while exhibiting distinct patterns of preference across submission characteristics.

The results demonstrate that reviewer evaluations appropriately serve as the strongest determinants of acceptance decisions. The average overall evaluation score demonstrates an extraordinary odds ratio of 8.801 ($p < 0.001$), indicating that submissions receiving strongly positive evaluations experience dramatically higher acceptance probabilities. Similarly, reviewer acceptance recommendations carry substantial weight ($OR = 1.938$, $p < 0.05$), confirming that the technical review process fundamentally respects expert judgment rather than following predetermined formulas or quotas.

In logistic regression models, the odds ratio (OR) represents the change in odds of the outcome occurring for a one-unit increase in the predictor variable, while holding all other variables constant.

This reviewer-centric decision making suggests a healthy review ecosystem where individual expertise meaningfully shapes outcomes. However, the model also reveals systematic patterns that transcend individual reviewer judgments, indicating structural factors that influence acceptance beyond submission quality alone.

Most striking is the pronounced temporal trend in acceptance rates. Controlling for all other variables, the year coefficient reveals a significant negative effect ($OR = 0.846$, $p < 0.05$), translating to a decline from approximately 90% acceptance probability in 2012 to nearly 40% by 2025 – a 3.5-4% decrease in acceptance probability

per year. This dramatic shift represents increasing selectivity independent of submission quality, reviewer evaluations, or compositional changes in the submission pool. Rather than merely reflecting growing submission volume, this temporal effect suggests a elevation in evaluation standards – a maturation process where the symposium has progressively raised its threshold for what constitutes contribution-worthy knowledge.

The virtual-only event format during COVID-19 (2020-2021) demonstrates a significant positive effect on acceptance probability ($OR = 3.216$, $p < 0.05$). This finding suggests that these turbulent circumstances influenced review dynamics, perhaps reflecting adjusted expectations, the sudden drop in submission volume, or recognition of the pandemic's challenges for contributors. This temporal pattern reveals the technical review process as both consistent in its fundamental mechanisms yet remains responsive to exogenous factors.

All in all, the model indicates a fundamentally fair review process without evidence of deliberate manipulation. While various factors influence acceptance outcomes, none suggest improper handling of submissions. The strongest predictors of acceptance remain reviewer evaluations ($OR = 8.801$, $p < 0.001$) and reviewer recommendations ($OR = 1.938$, $p < 0.05$), confirming that expert assessment – not arbitrary decisions – drives inclusion into the technical program. Though structural factors like track type and year do show statistical significance, these represent natural selection pressures rather than systematic bias. Importantly, other potential areas of concern such as geographic representation (Asia-Oceania: $OR = 1.126$, $p > 0.05$; EMEA: $OR = 0.904$, $p > 0.05$) and US-based events ($OR = 2.443$, $p > 0.05$) show no statistically significant effect on acceptance outcomes once other variables are controlled. This evidence portrays a technical review process that maintains intellectual rigor while naturally increasing in its selectivity and standards over time.

3. Key Predictors of Acceptance

Leveraging the model presented in Table 10, Figure 14 offers a nuanced portrait of the factors that shape INCOSE Symposium acceptance outcomes. This visualization captures the probabilistic effects of key predictors while holding all other variables constant, transforming complex statistical relationships into intuitive probability scales that reveal the relative importance of different submission characteristics.

Track selection emerges as perhaps the most consequential initial decision for

prospective contributors. Papers demonstrate substantially higher acceptance rates (approximately 80%) compared to presentations (40%), panels (27%), and tutorials (11%) – a nearly 70 percentage point difference between the most and least favored formats. This extreme disparity suggests that contributors seeking to maximize acceptance probability might strategically package their work as formal papers rather than interactive formats, potentially creating misalignment between content and presentation medium.

Engineering approaches reveal particularly intriguing patterns that contradict simple narratives about methodological preferences. “Generalized” and “Systems Thinking, Complexity, and Sociotechnical” approaches demonstrate the highest acceptance rates (approximately 70%), while both traditional foundational and increasingly prevalent model-based approaches show more modest performance near the baseline rate. This counters what might be expected if the symposium simply favored either established or emerging methodologies, instead suggesting preference for relatively more rare, integrative approaches that transcend specific methodological paradigms.

Author characteristics exert substantial influence on acceptance outcomes, with submissions featuring more experienced authors (those with multiple years of symposium participation) showing progressively higher acceptance probabilities. This experience advantage creates a reinforcing cycle where established contributors enjoy easier access to the knowledge base, potentially creating barriers for newcomers with novel perspectives. The data suggests that even one experienced co-author significantly enhances acceptance probability – offering a potential collaborative pathway for new contributors to navigate the experience barrier.

Perhaps most revealing is what doesn't strongly predict acceptance decisions: After controlling for other factors, the statistical model shows neither application domain nor contribution type significantly impacts the probability of acceptance. Similarly, author geographic origin and institutional affiliation demonstrate little to no influence once other variables are accounted for.

4. Implications

The logistic regression analysis reveals a technical review process that combines meritocratic evaluation with systematic structural influences – a finding with profound implications for how systems engineering knowledge is created, validated, and disseminated.

The dramatic temporal decline in

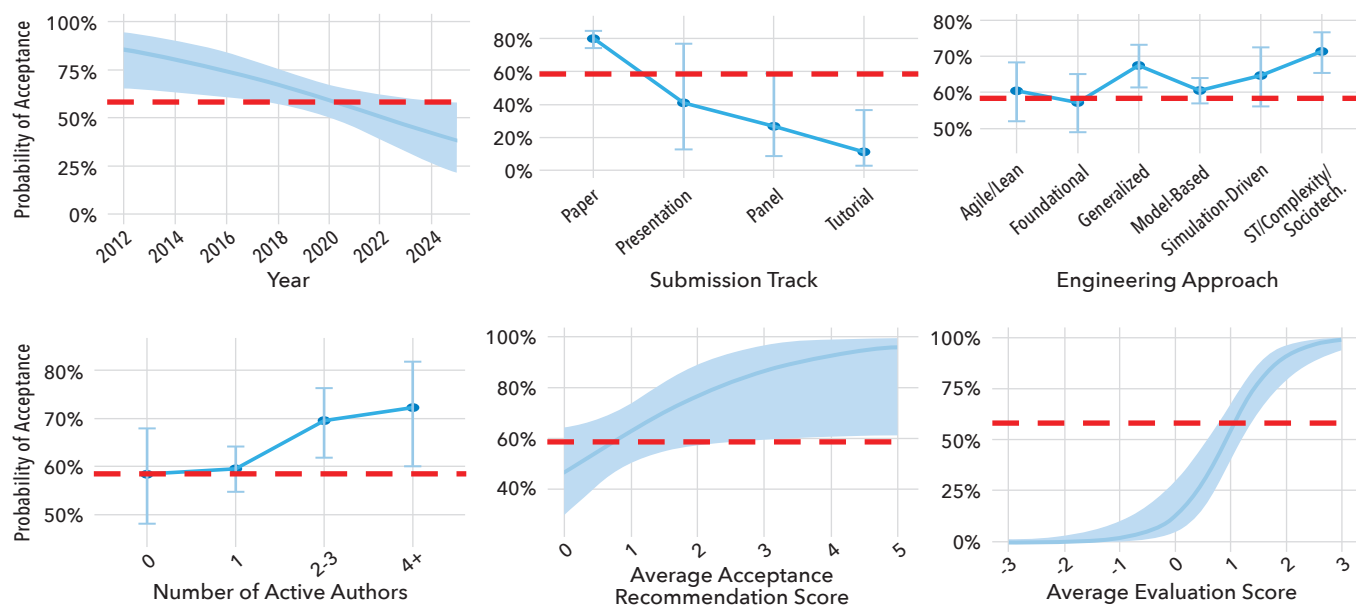


Figure 14. Predictors of acceptance in INCOSE Symposium submissions

Note: Figures report the probabilistic effects of key predictors from a logistic regression model of submission acceptance. These represent marginal effects, holding all other variables in the model constant. The red dashed lines indicate baseline acceptance rates for the International Symposium (2012-2025). (Top Left) Year: Acceptance rates show a declining trend over time from 2012 to 2025, with the probability of acceptance decreasing from approximately 90% to 40%. (Top Middle) Submission Track: Papers have substantially higher acceptance rates (around 80%) compared to presentations (40%), panels (27%), and tutorials (11%)—a nearly 70 percentage point difference between paper and tutorial track submissions. (Top Right) Engineering Approach: “Generalized” and “STS/Complexity/Sociotech” approaches demonstrate the highest acceptance rates (around 70%), while other approaches

show rates perform near the baseline rate. (Bottom Left) Number of Active Authors: Submissions with more active authors (authors with multiple years of submissions) show progressively higher acceptance probabilities, with acceptance rates increasing steadily as the number grows from 0 to 4+. (Bottom Middle) Average Acceptance Recommendation Score: Higher recommendation scores positively correlate with acceptance probability, showing a steady increase as scores rise from 0 to 5. (Bottom Right) Average Evaluation Score: Each increase in evaluation score dramatically increases acceptance probability, with the effect being most pronounced between scores of -1 and 2 (that is, from weakly negative to positive review). Data source: International Council on Systems Engineering (INCOSE) International Symposium submission database.

acceptance rates signals a discipline in transition from knowledge aggregation toward knowledge curation. Early symposia (2012-2017) functioned primarily as inclusive knowledge-sharing venues, accepting 70-90% of submissions and emphasizing broad participation. The current trajectory toward 40% acceptance rates in 2025 represents a fundamental shift toward a more selective arbitration model that exercises stronger judgment about what constitutes meaningful contribution. This creates both benefits and challenges: increased selectivity likely elevates average content quality but risks excluding novel or unorthodox perspectives that might drive disciplinary innovation.

The persistent advantage for paper submissions over other formats creates potential misalignment between content and medium. Contributors facing a nearly 40 percentage point acceptance advantage for papers compared to presentations may strategically package work as formal papers even when other formats might better serve

the material. This misalignment potentially diminishes the effectiveness of knowledge transfer, particularly for practice-oriented innovations that might be better demonstrated through interactive formats.

The statistical advantage for submissions with experienced authors (OR=1.588 for teams with 2-3 active authors) creates a reinforcing cycle that potentially limits intellectual diversity. While experienced author advantages likely reflect genuine quality differences in some cases, this pattern creates structural barriers for newcomers whose perspectives might challenge established thinking. Particularly concerning is how this dynamic intersects with the high first-year attrition documented earlier (94.7% of first-time authors never return) – together creating a dynamic that may systematically exclude innovative outliers who could drive the discipline forward.

The preference for generalized and systems thinking approaches over both traditional and model-based methodologies suggests the review process may function

as a counterbalance to submission trends. While MBSE submissions have increased dramatically (from 30% to 40% of submissions), they receive no corresponding preference in the review process. This suggests technical reviewers may consciously or unconsciously apply more stringent standards to trending methodologies, perhaps serving as a quality control mechanism that moderates methodological enthusiasm with critical assessment.

These findings have practical implications for multiple stakeholder groups. For contributors, they highlight strategic submission approaches that optimize acceptance probability: focusing on formal papers, building teams that include experienced authors, and framing methodological approaches through integrative rather than specialized lenses. For symposium organizers, the results suggest potential interventions to mitigate structural biases, particularly addressing the experience barrier through mentorship programs or dedicated newcomer tracks.

D. Conclusion

The comprehensive analysis of INCOSE International Symposium acceptance patterns reveals a sophisticated knowledge validation architecture that shapes both what enters the systems engineering corpus and how the discipline evolves over time. This filtering mechanism combines meritocratic technical assessment with systematic structural influences that collectively determine which ideas gain legitimacy within the field.

The striking temporal pattern – declining acceptance rates from approximately 90% in 2012 to 40% by 2025 – represents more than mere statistical fluctuation. It signals a fundamental transformation in the symposium's role from an inclusive knowledge-sharing forum toward a selective arbitrator of systems engineering contributions. This evolution reflects a maturing discipline progressively raising standards for what constitutes meaningful advancement.

The model's exceptional explanatory power demonstrates that acceptance decisions follow consistent, identifiable patterns rather than arbitrary judgments. This consistency provides reassurance that the technical review process operates as a robust evaluation system rather than a capricious gatekeeper. Yet within this structured framework, systematic preferences emerge across submission characteristics, creating differential access to the knowledge base that likely shapes disciplinary development.

The dramatic advantage for paper submissions creates potential misalignment between content and presentation medium, while the substantial experience premium potentially limits intellectual diversity by favoring established contributors. Meanwhile, methodological preferences favor integrative approaches over both traditional and trending methodologies, suggesting the review process may function as a moderating influence on methodological enthusiasm.

The systems engineering discipline's knowledge validation mechanism operates as a remarkably self-reflective complex adaptive system – one that doesn't merely filter submissions but actively shapes the discipline's intellectual evolution through sophisticated feedback loops and emergent behaviors. This creates an elegant irony: a discipline dedicated to understanding complex systems has organically developed its own complex knowledge ecosystem with pronounced concentration patterns (10% of authors producing 43.5% of contributions), consistent filtering mechanisms, and persistent structural tensions (academic submissions enjoying 12% higher acceptance rates than industry contributions). By recognizing these patterns, systems engineering leaders gain unprecedented op-

portunity to intentionally design interventions that could transform the discipline's intellectual architecture to create a more balanced knowledge production system.

V. DISCUSSION AND FUTURE DIRECTIONS

A. Synthesis of Key Findings

The longitudinal analysis of INCOSE's International Symposium from 2012-2025 finds a discipline amidst a pivotal time of transformation – shaped by interconnected forces of social structure, methodological evolution, and knowledge validation. When viewed holistically, these fourteen years tell a story not of isolated trends, but of a complex adaptive ecosystem responding to change while maintaining surprising stability in its fundamental architecture.

At the core of this story is what might be called an "hourglass network" of knowledge creation. This distinctive social architecture features thousands of contributors at the broad top who engage briefly with the discipline, a narrow middle where just 10% of authors generate over 43% of intellectual output, and a wide bottom where this concentrated knowledge diffuses into global practice. The Lorenz curve quantifying this concentration (with a Gini coefficient of 0.45) illustrates not merely unequal participation but a fundamental knowledge filtering where ideas must survive expert scrutiny before being endorsed for mainstream adoption.

This social structure creates both resilience and vulnerability. The stable core of prolific contributors ensures continuity of expertise and methodological refinement. However, the "94% problem" – where nearly 94% of first-time contributors never return to the symposium – represents a critical vulnerability in the discipline's knowledge transfer pipeline. This remarkably consistent attrition rate, persisting across virtual and in-person formats, different geographic locations, and various methodological trends, suggests deep structural barriers to sustained participation that transcend circumstantial factors.

Against this backdrop of social stability, a profound methodological revolution has unfolded. The rise of MBSE – growing from 30% to 40% of submissions – represents more than a trending fad. It signals a fundamental epistemological shift in how systems knowledge is represented and manipulated. Where traditional approaches encoded information in inherently ambiguous natural language, MBSE transforms this knowledge into formal, computable representations amenable to algorithmic analysis. This parallels earlier transformations in other engineering disciplines, such as the shift from drafting boards to CAD systems in mechanical engineering.

The inflection point around 2020 marks a critical acceleration in this transformation, coinciding with three converging developments: a surge in computing, software, and AI systems applications, increased academic participation, and the post-pandemic return to in-person events. This confluence suggests a potential threshold moment where modeling methodologies achieved sufficient maturity and accessibility to drive widespread adoption.

Given this methodological revolution, one might suppose a shift in intellectual focus. However, the discipline's knowledge architecture shows remarkable continuity: Persistent dominance of methodological contributions (30-40%) and tools/technologies (25-30%) throughout the study period, coupled with chronic underrepresentation of theoretical foundations (5%) and empirical validation (3%). This knowledge architecture creates a potentially upside-down pyramid – a wealth of methodological innovation built atop sparse theoretical development and limited empirical evidence.

This imbalance is made explicit in the gap analysis, which reveals extensive "white space" in the knowledge landscape. Particularly concerning is the scarcity of empirical studies validating methodological effectiveness across different domains, creating uncertainty about which approaches truly deliver value in which contexts. Similarly, the persistent underrepresentation of education and leadership applications suggests a discipline focused more on developing new technical approaches than developing the workforce to implement them.

The acceptance analysis reveals how knowledge validation mechanisms have evolved alongside these developments. The dramatic temporal decline in acceptance rates represents more than increasing competition; it signals a fundamental transition from knowledge aggregation to knowledge curation. The systems engineering community has progressively raised its standards for what constitutes meaningful contribution, creating a more selective filter that emphasizes methodological sophistication and demonstrated expertise. This increasing selectivity interacts with author experience in revealing ways: Submissions from experienced authors have a significantly higher probability of acceptance, creating a self-reinforcing cycle where established contributors maintain privileged access to the knowledge base – an example of "first-mover advantage." When combined with the high first-year attrition rate, this experience advantage creates a system that potentially limits intellectual diversity by favoring established perspectives.

Geographic and institutional patterns add further dimension to this landscape.

The persistent North American dominance (approximately 50% of contributors) creates natural “knowledge gravity wells” that concentrate and amplify certain methodological preferences. Meanwhile, countries exhibit distinctive systems engineering ecosystems – from France’s overwhelmingly industry-dominated landscape (85% industry affiliation) to Norway’s academically concentrated environment (60.6% academic representation). The United States maintains a near-equilibrium between industry (50.7%) and academia (41.1%), establishing a balanced knowledge exchange environment where research advances and practical implementations readily cross-pollinate. This balanced institutional architecture likely contributes to America’s anchor position in systems engineering knowledge production.

Perhaps most surprising is the dramatic academic surge during 2023-2025, with scholarly participation nearly tripling compared to earlier years. This substantial shift suggests a potential rebalancing of who produces knowledge, with increased academic influence offering to potentially drive more theoretical and empirical contributions to address the discipline’s knowledge gaps.

Collaboration patterns add another layer to this complex portrait. The longitudinal analysis reveals a community increasingly building on established relationships rather than forming new connections. First-time collaborations have steadily decreased from approximately 85% in 2012 to about 65% by 2025, while repeat collaborations show corresponding growth. When viewed alongside the collaboration network analysis – which demonstrates a strong positive relationship between collaboration breadth and depth – this suggests the formation of increasingly specialized “knowledge tribes” with distinctive methodological orientations and application focuses.

In sum, these findings suggest systems engineering is transitioning from a practice-driven craft toward a more formalized discipline.

The increasing methodological sophistication, growing academic participation, and tightening acceptance standards all point toward a field maturing from experiential knowledge toward more rigorous, formalized approaches. Yet, the persistent underrepresentation of theory and empirical validation suggests this maturation remains incomplete – a discipline still seeking a diversified scientific investigation even as its methodologies continue to advance. The path forward requires strategic interventions that preserve the practical wisdom embedded in the discipline’s industrial origins while building stronger foundations

across the full spectrum of systems engineering research.

The system of knowledge production – with its concentrated influence, experience-based advantages, and networked collaboration – creates both opportunities and challenges for systems engineering’s future development. The same mechanisms ensuring intellectual stability may inadvertently stifle transformative innovation. The core of prolific contributors can act as an immune system, safeguarding against untested ideas but potentially rejecting groundbreaking shifts that challenge established paradigms.

Rather than simply expanding symposium participation, the 94% dropout rate suggests that focusing on early-career retention could yield disproportionate benefits – creating pathways for newcomers to develop into the next generation of knowledge hubs who can shepherd the discipline through its continuing evolution.

B. Future Research Opportunities

The following are a list of possible research opportunities that follow from the identified knowledge gaps, methodological transitions, and community dynamics documented in this analysis.

1. Empirical Validation of Methodological Efficacy

Perhaps the most critical research opportunity lies in addressing the pronounced scarcity of empirical studies. The gap analysis reveals that empirical contributions represent merely 3% of submissions across the fourteen-year period – creating a discipline rich in methodological innovation but poor in validated outcomes. This deficiency creates three specific research pathways:

First, comparative studies that systematically evaluate the relative effectiveness of traditional document-centric versus model-based approaches across different application domains. Rather than assuming MBSE’s superiority based on supposed advantages, such research establishes quantifiable metrics (cost, schedule performance, defect rates, etc.) to determine where and when modeling approaches deliver demonstrable value. These studies shift the MBSE conversation from adoption evangelism toward evidence-based implementation guidance.

Second, longitudinal case studies quantifying organizations through methodological transitions illuminate the organizational learning curves, implementation barriers, and adaptation strategies that determine transformation success. Such studies move beyond technical capabilities to address the sociotechnical dimensions of systems engineering practice – revealing how methodological changes interact with organiza-

tional culture, workforce development, and knowledge management systems.

Third, meta-analytical research synthesizing implementation outcomes across diverse contexts help identify contingency factors that determine methodology effectiveness. This research aids organizations in selecting and tailoring systems engineering approaches based on project characteristics, organizational capabilities, and stakeholder environments – moving beyond one-size-fits-all methodological prescriptions toward contextually optimized implementations.

2. Knowledge Transfer and Community Development Mechanisms

The striking 94% first-year contributor attrition rate identified in the analysis represents both a critical vulnerability and a compelling research opportunity. This pattern suggests fundamental flaws in how systems engineering knowledge is transferred and how new practitioners are integrated into the community. Three specific research directions emerge from this challenge:

First, educational research exploring the cognitive and social dimensions of systems engineering expertise development could transform how we prepare new practitioners. By identifying the specific learning barriers that differentiate successful from unsuccessful professional development trajectories, this research could inform curriculum design, mentoring programs, and organizational onboarding strategies that accelerate expertise acquisition and community integration.

Second, comparative studies examining knowledge transfer models across related engineering disciplines could identify potential approaches for systems engineering to adapt. Fields like software engineering have developed robust mechanisms for integrating newcomers – from open-source communities to coding bootcamps – that might offer transferable models for the systems engineering ecosystem.

Third, action research aimed at designing and testing interventions to improve newcomer retention could directly address the 94% problem. Experimental approaches – such as structured mentorship programs, progressive engagement pathways, or recognition systems that incentivize sustained participation – could be implemented at conferences and within organizations, with outcomes tracked to identify effective retention strategies.

3. Cross-Disciplinary Integration at Methodological Boundaries

The analysis reveals systems engineering as a discipline in methodological transformation, with emerging intersections between traditional systems approaches and

adjacent fields like artificial intelligence, complexity science, and software engineering. These boundary areas represent particularly fertile ground for innovative research:

First, at the MBSE-AI intersection, continued and deepened research that explores how machine learning approaches might augment or transform model-based techniques. From automated model generation based on requirements to intelligent verification of model consistency, this research frontier could significantly accelerate modeling capabilities while reducing the cognitive load of model maintenance.

Second, the systems thinking-complexity boundary offers rich territory for developing methodologies that bridge formal modeling rigor with systemic sociotechnical understanding. Research in this space could develop hybrid approaches that leverage both the computational precision of models and the adaptive, emergent perspectives of systems thinking – creating more robust approaches to wicked problems that resist presupposed technical solutions.

Third, the educational-methodological nexus presents opportunities for research on knowledge codification and transfer. As systems engineering methodologies grow more sophisticated, research on pedagogical innovations – from simulation-based learning to virtual reality (VR) / augmented reality (AR) visualization techniques – could transform how complex modeling approaches are taught, learned, and mastered across organizational contexts.

4. Methodological Synthesis and Integration

The gap analysis reveals a fragmented methodological landscape, with limited research synthesizing disparate approaches into cohesive frameworks. This fragmentation creates three specific integration research opportunities:

First, theoretical research could develop more robust conceptual foundation that connect methodological islands into coherent archipelagos. By identifying fundamental principles that transcend specific approaches, this research could create a stronger theoretical foundation for systems engineering – moving beyond process prescriptions toward deeper understanding of what it truly means to engineer systems.

Second, integration research could develop frameworks that bridge methodological divides – particularly between model-based and agile approaches. As both paradigms gain traction, research on their complementary strengths could yield hybrid methodologies that combine the formalism of modeling with the adaptability of iterative development – creating

more responsive yet rigorous approaches to complex systems challenges.

Third, longitudinal research tracking methodological development across multiple domains could uncover patterns in how approaches migrate, adapt, and hybridize across different application contexts. This research would move beyond static methodological comparison toward understanding systems engineering as a living knowledge environment with its own evolutionary dynamics.

C. Recommendations for the Systems Engineering Discipline

In concluding this comprehensive longitudinal analysis of the INCOSE International Symposium from 2012-2025, I find myself reflecting on the discipline as a whole. Systems engineering has evolved remarkably since INCOSE's establishment in 1990, growing from a specialized practice within aerospace and defense to a global discipline addressing complex sociotechnical challenges across diverse domains. The patterns revealed in this analysis offer strategic insights not just for researchers or practitioners, but for the stewards of the discipline's future.

The methodological shift toward model-based approaches, the growing integration with computational domains, and the increasing academic participation all signal a discipline formalizing. Building upon the results of this analysis, the following strategic recommendations may help INCOSE leadership guide the systems engineering discipline through this time of transition, strengthen the discipline's knowledge ecosystem, enhance its impact in addressing complex systems challenges:

1. Implement a Strategic Retention Initiative

Given the key finding that 94% of first-time contributors never return represents both a challenge and an extraordinary opportunity. Even modest improvements in early-career retention could dramatically increase intellectual diversity and knowledge production capacity. Recommendations include:

- Establishing a structured "First Time Contributors" resource that provides mentorship, guidance, and recognition for new symposium participants
- Creating dedicated "newcomer tracks" with modified acceptance criteria that balance quality standards with developmental opportunities
- Implementing longitudinal tracking of participant engagement to measure retention outcomes and identify effective intervention points.

These offer to transform the community's structure to a more flexible knowledge network with gradual pathways for contribution development.

2. Balance Knowledge Validation with Innovation

The declining year-over-year acceptance rate reflect increasing rigor but risk creating barriers to novel perspectives. To maintain quality while fostering innovation, consider:

- Establishing specialized innovation tracks explicitly designed for emerging topics or unconventional approaches
- Utilize the call for submissions to target research gaps while maintaining quality standards
- Creating structured feedback mechanisms that provide developmental guidance even for rejected submissions.

Such balanced validation would maintain the discipline's intellectual standards while creating space for transformative ideas that might challenge established paradigms.

3. Bridge the Academic-Industry Divide

The meaningful acceptance gap between academic (65%) and industry (53%) submissions suggests a concerning disconnect between research and practice. To strengthen this crucial bridge:

- Develop collaborative submission formats that explicitly reward academic-industry partnerships
- Create recognition mechanisms that value practical implementation alongside scholarly innovation
- Establish knowledge translation initiatives that transform academic research into practitioner-oriented frameworks.

These bridges would leverage the recent surge in academic participation while maintaining the discipline's crucial connection to industrial practice.

4. Cultivate Global Knowledge Networks

While geographic distribution is improving, the community remains dominated by North American and Western European perspectives. To develop truly global systems engineering knowledge:

- Implement targeted development programs for underrepresented regions with demonstrated systems engineering potential
- Create regional innovation hubs that cultivate locally relevant approaches while connecting to global knowledge networks
- Target symposium locations that enable increased physical participation for those overcome by geographic barriers.

These efforts would continue to transform systems engineering from a predominantly Western discipline to a truly global knowledge ecosystem.

5. Address Critical Knowledge Gaps

The systematic “white space” identified in the gap analysis – particularly in empirical validation, theoretical foundations, and educational approaches – represents strategic opportunities for disciplinary advancement. To address this, consider:

- Establishing targeted research initiatives that directly address identified knowledge gaps
- Creating specialized publication pathways for underrepresented contribution types, for example empirical validation studies
- Developing collaborative frameworks that connect practitioners implementing methodologies with researchers studying their effectiveness.

Such initiatives would strengthen the discipline’s intellectual foundation, creating a more balanced knowledge architecture capable of supporting continued methodological innovation.

D. A Vision for Systems Engineering's Future

As INCOSE crosses the threshold into its fourth decade, systems engineering finds itself at a pivotal juncture – one rich with possibility. The discipline has evolved remarkably, developing methodological sophistication, attracting deeper academic engagement, and increasingly interweaving with computational domains. This maturation hasn’t happened by chance but through the deliberate efforts of a committed community confronting ever more intricate challenges.

What might systems engineering become in the decades ahead? The data suggests a discipline poised to address the most complex sociotechnical puzzles of our time: from autonomous systems that blur traditional boundaries to healthcare networks that must balance human touch with technological precision to climate interventions that require unprecedented systems thinking across global scales.

The path forward requires intentional cultivation. By addressing the structural challenges revealed in this research, INCOSE can steward the discipline through its next developmental phase. This isn’t about wholesale reinvention but thoughtful refinement, honoring the practical wisdom embedded in industrial heritage while nurturing the depth and rigor that can amplify its future impact.

We stand on solid ground. The extraordinary dedication of INCOSE’s core contrib-

utors has established a robust foundation for what comes next. Their concentrated expertise forms a launchpad rather than a ceiling.

From here, systems engineering must expand outward and upward. Not through revolutionary disruption but through intentional, balanced growth – weaving together continuity with innovation, rigor with accessibility, and specialized knowledge with integrative thinking. The patterns identified in this analysis aren’t merely historical artifacts but guideposts for strategic leadership that can help the discipline fulfill its essential role in navigating the increasingly complex sociotechnical landscape of the twenty-first century.

VI. APPENDIX

A. Methodological Details

1. International Symposium Submission Database

This analysis draws upon a comprehensive dataset of submissions to the INCOSE International Symposium spanning fourteen years (2012-2025). The primary data source comprises detailed records of 4,038 symposium submissions collected from INCOSE’s conference management system EasyChair. Submission years prior to 2012 were not available. Each submission record ($n=4,039$) contains content information such as submission number, title, authors, abstract, track type (paper, presentation, panel, tutorial), year, and final decision (accept/reject). Author information ($n=4,813$) includes author names, affiliations, countries, and corresponding status. Correspondently, each submission with reviews contains reviewer evaluations ($n=15,146$) which includes reviewer confidence levels, technical scores, acceptance recommendations, and textual feedback. Conference-wide metadata ($n=14$) includes location, dates, and format (in-person vs. virtual, hybrid).

The data preprocessing methodology addressed multifaceted challenges inherent in transforming disparate submission records into a coherent analytical dataset. The primary data integration obstacles centered on three critical domains of complexity: geographic and institutional mapping, submission track normalization, and decision status standardization. Geographic and institutional mapping required algorithmic approaches to reconcile inconsistent representations of author identities, institutional affiliations, and national origins. Mapping techniques standardized variations in country names – resolving discrepancies between entries such as “USA,” “United States,” and “United States of America”. Probabilistic name matching algorithms

were developed to identify and merge potential duplicate author entries, accounting for variations in name formats, institutional affiliations, and career transitions. The conference’s introduction of new tracks, most notably the presentations track in 2018, required a classification framework that accounted for evolving submission types. Conference submission decisions exhibited some variability, ranging from unambiguous accept/reject determinations to more nuanced classifications like “probably accept” or “Panel is accepted.” The research methodology implemented a clear binary classification system by converting varied decision indicators into a consistent accept/reject framework.

Comprehensive validation included cross-referencing submissions across multiple data sources, verifying submission counts and author participation patterns with conference proceeding, and conducting consistent manual spot-checks to ensure data integrity.

The final dataset represents a complete census of all formal submissions to the International Symposium during the study period rather than a sample, which eliminates sampling bias concerns and allows for definitive rather than inferential conclusions about submission patterns.

2. Simpson's Indices for Collaboration-based Network Analysis

The quantification of collaborative patterns within systems engineering networks requires metrics that capture both the breadth and depth of researcher interactions. This study adapts Simpson’s diversity indices from ecological and social sciences to characterize the multidimensional nature of collaborative relationships within the INCOSE community from 2012-2025. The index (S) provides a robust metric for quantifying the effective number of categories in a distribution. For network analysis, this index is formulated as:

$$S = \frac{1}{\sum_{i=1}^n p_i^2}$$

where p_i represents the proportional abundance of category i in the distribution, and n is the total number of categories. This calculation yields the “effective number” of equally abundant categories that would produce the same diversity value – a more intuitive interpretation than traditional diversity metrics.

For this study, two complementary Simpson’s indices were developed to capture distinct dimensions of an author’s collaborative behavior within the systems engineering community. The Breadth Index measures the effective number of collabo-

rators by analyzing how evenly an author's collaborative relationships are distributed across their network of co-authors over all submissions. The Depth Index complements this by measuring how effectively an author distributes collaborative engagement across different submissions, distinguishing between concentrated collaboration patterns (multiple co-authors on few papers) and distributed patterns (collaborations spread across many projects).

The Breadth Index (B) quantifies the distribution of an author's collaborations across unique collaborators:

$$B_j = \frac{1}{\sum_{i=1}^{c_j} \left(\frac{n_{ij}}{N_j} \right)^2}$$

B_j is the Breadth Index for author j , c_j is the number of unique collaborators for author j , n_{ij} is the number of submissions author j has co-authored with collaborator i , and N_j is the total number of collaborations for author j . Unlike simple collaborator counts, this metric accounts for the distribution pattern of collaborations. An author with five equally distributed collaborations would have a Breadth Index of 5.0, while an author with five collaborators but heavily skewed collaboration patterns might have a Breadth Index closer to 2.0 or 3.0, reflecting the effective number of collaborators.

The Depth Index (D) measures the distribution of collaborative relationships across distinct submissions:

$$D_j = \frac{1}{\sum_{k=1}^{s_j} \left(\frac{m_{kj}}{M_j} \right)^2}$$

D_j is the Depth Index for author j , s_j is the number of unique submissions (with collaborators) for author j , m_{kj} is the number of collaborators for author j on submission k , and M_j is the total number of collaborative instances across all submissions. This metric identifies authors who maintain distributed collaborative relationships across multiple projects versus those who concentrate collaborative efforts on fewer submissions. For example, a value of 7.0 suggests that an author's collaborative projects are distributed as if they had exactly 7 submissions with equal collaborative engagement.

3. Submission Classification Analysis

The research methodology began with the development and implementation of a three-dimensional classification taxonomy to categorize submissions across core systems engineering dimensions: type of research contribution, systems engineering approach, and application domain. This classification architecture, detailed in Tables 5-7,

defines six research contribution types that distinguish the intellectual nature of systems engineering artifacts, six systems engineering approaches that characterize methodological paradigms, and six application domains that contextualize contributions within specific sectoral implementations. The framework serves to facilitate consistent bibliometric analysis for the longitudinal study of systems engineering development and knowledge dissemination within the discipline.

Specialized natural language processing techniques, adapted for systems engineering terminology, incorporated both title and abstract content with weighting coefficients prioritizing title keywords. The classification algorithm integrated tokenized contextual analysis to distinguish between superficial terminology matches and substantive orientations, ensuring reliability through review-based validation protocols. The computational approach then combined probabilistic keyword matching with contextual analysis to refine classification accuracy. Submissions underwent systematic normalization, including case standardization, preservation of critical punctuation such as hyphens, and whitespace normalization to enhance pattern recognition consistency. Title and abstract content were analyzed independently, with a 3:1 title-to-abstract weighting ratio reflecting the greater classificatory significance of title terminology.

The classification system employed a multi-tiered keyword matching process with word-boundary detection to differentiate between embedded substrings and genuine terminological matches. For multi-word terms, proximity-based pattern matching with configurable word-distance parameters enabled recognition of concept clusters, even when separated by modifier terms. Beyond simple keyword matching, complex pattern recognition identified archetypal phrasal structures such as "a framework for...", "a method for...", and "a review of..." applying classification heuristics accordingly.

A probabilistic classification scoring mechanism assigned normalized scores across all potential categories within each dimension. When primary and secondary category scores exhibited high proximity (threshold ratio >0.8), dual classification was applied to reflect genuine methodological hybridization rather than enforcing discrete categorization – ultimately resulting in 740 submissions total receiving more than one tag across all categories. In cases where keyword matching yielded insufficient signal, a sophisticated default classification subsystem analyzed broader contextual patterns and structural indica-

tors to assign the most probable category.

4. Statistical Modeling

This study employed a carefully constructed modeling framework to identify key factors influencing submission acceptance to the INCOSE International Symposium. Logistic regression was selected as the primary analytical method due to its suitability for modeling binary outcomes (accept/reject) while accounting for multiple predictor variables of different types. Since the analysis included the entire population of submissions from 2012-2025 rather than a sample, the modeling focused on parameter estimation and effect quantification rather than statistical inference.

The model incorporated four conceptual clusters of predictors: event characteristics, author attributes, submission attributes, and review metrics. Continuous predictors were mean-centered to improve interpretability of coefficients. Categorical variables were identified using the submission classification analysis and were transformed into binary indicators for each category level, and establishing appropriate reference levels for interpretation.

Unlike prediction-focused machine learning approaches, this analysis prioritized understanding the systematic relationships between predictors and acceptance decisions. The model was estimated using maximum likelihood methods with particular attention to multicollinearity, correlations within annual events, and non-linear effects, see Table 10. Variance inflation factor (VIF) analysis confirmed absence of problematic multicollinearity among predictors (all VIF values below critical thresholds, <5), ensuring coefficient stability. Robust standard errors (clustered by year) were calculated using the sandwich estimator to account for potential correlation within submission years. Probability scales enable intuitive interpretation of marginal effects while preserving the non-linear nature of the relationship.

The model's performance was evaluated through multiple metrics, see Table 11. The model achieved 83.9% overall accuracy, with 90.0% sensitivity (correctly identifying accepted submissions) and 79.5% specificity (correctly identifying rejected submissions) at an optimal threshold determined through threshold optimization. The area under the ROC curve (AUC) – a measure of overall performance of a binary classification model by summarizing its ability to distinguish between positive and negative instances across all possible thresholds – demonstrated excellent discrimination ability with a value of 0.848, substantially exceeding the no-information rate. The Matthews Correlation Coefficient value of

0.686 confirmed strong alignment between predicted and actual acceptance decisions across the dataset.

The evidence from this comprehensive statistical approach supports the conclusion that acceptance decisions at the International Symposium follow systematic patterns driven by submission attributes, reviewer evaluations, and contextual factors, rather than arbitrary assessment processes. These patterns reflect the underlying evaluation criteria and priorities of the systems engineering community as expressed through the technical review process.

5. Limitations and Assumptions

This research, while comprehensive, operates within several methodological constraints that warrant acknowledgment to properly contextualize its findings. The limitations stem from data availability, classification methodology, and analytical boundaries inherent in meta-analytical approaches to disciplinary evolution.

First, submission abstracts serve as primary data for classification, creating an inherent limitation in classification depth. While abstracts typically encapsulate core concepts, they necessarily compress complex methodological nuances and theoretical frameworks that might be fully elaborated in complete manuscripts, presentations, and live tutorial or panel discussions. This compression effect potentially introduces classification imprecision, particularly for submissions that employ hybrid approaches or novel methodological integrations that resist traditional categorization. The classification taxonomy, while developed through iterative refinement, remains a constructed lens through which we interpret disciplinary evolution rather than an absolute representation of systems engineering knowledge structures.

Second, the longitudinal dataset presents several temporal challenges that affect analytical resolution. Though

comprehensive within its fourteen-year span (2012–2025), the absence of pre-2012 data creates a historical blind spot that potentially obscures important structural differences and foundational developments in the discipline's evolution. Within the available timeframe, significant heterogeneity exists in data quality and standardization. Early-period submissions (2012–2015) contain notably less structured metadata and reviewer information compared to later entries, creating what might be described as a resolution gradient across the time series – higher definitional clarity in recent years contrasted with somewhat hazier characterizations in the dataset's early period. This temporal inconsistency is further complicated by the unprecedented disruption of the COVID-19 pandemic (2020–2021), which fundamentally altered the symposium's operational paradigm. The shift to virtual conference formats during this period likely introduced systematic variations in submission patterns, author participation dynamics, and review processes that cannot be considered mere statistical noise. Although our regression models incorporate year-fixed effects to control for these temporal discontinuities, the pandemic represents a significant confounding variable that potentially masks or amplifies certain trends in ways that complicate straightforward longitudinal interpretation. These combined temporal factors necessitate appropriate caution when drawing conclusions about the trajectory of systems engineering's development across the study period.

Third, the study's definitional boundaries create inherent blind spots regarding disciplinary integration. Systems engineering increasingly overlaps with adjacent fields including artificial intelligence, complexity science, and sustainability engineering. Submissions that position themselves primarily within these adjacent disciplines but incorporate "systems" methodologies may

be underrepresented in INCOSE's focused symposium. Similarly, practice-based innovations in systems engineering that haven't been formalized into submissions remain invisible to this analysis, creating a potential gap between documented and real-world systems engineering.

Fourth, the methodological approach to author identification assumes relative name stability across submissions. While algorithms address common name variations, fundamental identity tracking challenges persist when authors change institutional affiliations, legal names, or use inconsistent naming conventions across submissions. Consequently, author continuity metrics and collaboration network analyses likely slightly underestimate actual collaborative relationships.

Finally, the interpretive framework assumes that INCOSE's International Symposium represents a meaningful proxy for broader systems engineering disciplinary development. While the symposium constitutes a significant knowledge exchange platform, it exists within a complex ecosystem of journals, specialized conferences, and industry practices. The degree to which symposium evolution mirrors broader disciplinary trajectories remains an open question requiring complementary research methodologies.

These limitations notwithstanding, the comprehensiveness of the dataset – incorporating 14 years of submissions, 4,813 authors, and 15,146 reviewer evaluations – provides unprecedented insight into systems engineering's intellectual ecosystem. These methodological frameworks seek to balance analytical rigor with practical interpretability, creating a foundation for understanding disciplinary development that acknowledges the inherent complexity of knowledge formation in a maturing field. ■

WATCH THE WEBINAR >>>



PREDICT, ANALYZE OPTIMIZE:

SYSTEMS SIMULATION WITH
INNO SLATE'S MBSE TOOLS



The INCOSE Professional Development Portal (PDP) is a comprehensive solution for Systems Engineers and other professionals who want to enhance their systems engineering knowledge and skills.

www.incose.org/pdp

Supported by



UCONN | SCHOOL OF ENGINEERING
PRATT & WHITNEY INSTITUTE FOR
ADVANCED SYSTEMS ENGINEERING



THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON, DC



INCOSE

International Council on Systems Engineering

A better world through a systems approach / www.incose.org

Systems Engineering: The Journal of The International Council on Systems Engineering

Call for Papers

The *Systems Engineering* journal is intended to be a primary source of multidisciplinary information for the systems engineering and management of products and services, and processes of all types. Systems engineering activities involve the technologies and system management approaches needed for

- definition of systems, including identification of user requirements and technological specifications;
- development of systems, including conceptual architectures, tradeoff of design concepts, configuration management during system development, integration of new systems with legacy systems, integrated product and process development; and
- deployment of systems, including operational test and evaluation, maintenance over an extended life-cycle, and re-engineering.

Systems Engineering is the archival journal of, and exists to serve the following objectives of, the International Council on Systems Engineering (INCOSE):

- To provide a focal point for dissemination of systems engineering knowledge
- To promote collaboration in systems engineering education and research
- To encourage and assure establishment of professional standards for integrity in the practice of systems engineering
- To improve the professional status of all those engaged in the practice of systems engineering
- To encourage governmental and industrial support for research and educational programs that will improve the systems engineering process and its practice

The journal supports these goals by providing a continuing, respected publication of peer-reviewed results from research and development in the area of systems engineering. Systems engineering is defined broadly in this context as an interdisciplinary approach and means to enable the realization of successful systems that are of high quality, cost-effective, and trustworthy in meeting customer requirements.

The *Systems Engineering* journal is dedicated to all aspects of the engineering of systems: technical, management, economic, and social. It focuses on the life-cycle processes needed to create trustworthy and high-quality systems. It will also emphasize the systems management efforts needed to define, develop, and deploy trustworthy and high quality processes for the production of systems. Within this, *Systems Engineering* is especially concerned with evaluation of the efficiency and effectiveness of systems management, technical direction, and integration of systems. *Systems Engineering* is also very concerned with the engineering of systems that support sustainable development. Modern systems, including both products and services, are often very knowledge-intensive, and are found in both the public and private sectors. The journal emphasizes strategic and program management of these, and the information and knowledge base for knowledge principles, knowledge practices, and knowledge perspectives for the engineering of

systems. Definitive case studies involving systems engineering practice are especially welcome.

The journal is a primary source of information for the systems engineering of products and services that are generally large in scale, scope, and complexity. *Systems Engineering* will be especially concerned with process- or product-line-related efforts needed to produce products that are trustworthy and of high quality, and that are cost effective in meeting user needs. A major component of this is system cost and operational effectiveness determination, and the development of processes that ensure that products are cost effective. This requires the integration of a number of engineering disciplines necessary for the definition, development, and deployment of complex systems. It also requires attention to the lifecycle process used to produce systems, and the integration of systems, including legacy systems, at various architectural levels. In addition, appropriate systems management of information and knowledge across technologies, organizations, and environments is also needed to insure a sustainable world.

The journal will accept and review submissions in English from any author, in any global locality, whether or not the author is an INCOSE member. A body of international peers will review all submissions, and the reviewers will suggest potential revisions to the author, with the intent to achieve published papers that

- relate to the field of systems engineering;
- represent new, previously unpublished work;
- advance the state of knowledge of the field; and
- conform to a high standard of scholarly presentation.

Editorial selection of works for publication will be made based on content, without regard to the stature of the authors. Selections will include a wide variety of international works, recognizing and supporting the essential breadth and universality of the field. Final selection of papers for publication, and the form of publication, shall rest with the editor.

Submission of quality papers for review is strongly encouraged. The review process is estimated to take three months, occasionally longer for hard-copy manuscript.

Systems Engineering operates an online submission and peer review system that allows authors to submit articles online and track their progress, throughout the peer-review process, via a web interface. All papers submitted to *Systems Engineering*, including revisions or resubmissions of prior manuscripts, must be made through the online system. Contributions sent through regular mail on paper or emails with attachments will not be reviewed or acknowledged.

All manuscripts must be submitted online to *Systems Engineering* at ScholarOne Manuscripts, located at:

<https://mc.manuscriptcentral.com/SYS>

Full instructions and support are available on the site, and a user ID and password can be obtained on the first visit.



IS2025 KEYNOTE SPEAKERS



Langdon Morris

Senior Partner at
InnovationLabs.
Award-winning
innovator, futurist,
and world-
renowned strategy
consultant.



Jon Reijneveld

Co-Founder
and Chief
Engineer at The
Exploration
Company (TEC)



Robert Thirsk

Astronaut on two
past missions: the
shuttle Columbia
and an expedition
aboard the
International
Space Station



William Donaldson

Associate
Professor of
Management at
Christopher
Newport
University

#INCOSEIS 2025



www.incose.org/symp2025

www.incose.org

INCOSÉ Career Center



Scan QR code to visit www.careers.incose.org

The INCOSÉ Career Center connects top talent with leading organizations in the field. Explore job listings tailored for systems engineering professionals, post your résumé, and find the perfect role to match your skills and aspirations.

Whether you're a job seeker or recruiter, the INCOSÉ Career Center is your gateway to opportunities in the systems engineering community.

Connecting talent with opportunity

