35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada

July 26 - 31, 2025

TLI Cohort 9

Technical Leadership Institute

A global learning network of active INCOSE members seeking to improve their leadership skills in an open, collaborative environment

Established in 2015, the Technical Leadership Institute (TLI) is a global learning network of INCOSE members committed to improving technical leadership skills to better address today's product, enterprise, and societal complexity. Following nomination by an INCOSE leader, participants embark on an initial two-year experience designed to increase their self-awareness, improve their understanding of complexity, and provide experience in leading through influence in the presence of ambiguity and uncertainty.

Throughout the experience, coaching and mentoring help participants maximize the benefits derived from their experiences. Upon completion of the initial two-year experience, participants are inducted as full members of the TLI, after which they continue their journey of learning together, making their own contributions as members of a vibrant, diverse and growing network for the benefit of their organizations, INCOSE, and the world at large.

Enhancing Shared Understanding in Multidisciplinary Teams

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Research Question

- "*How can systems engineering effectively facilitate a common, shared understanding within multidisciplinary teams*?"

Abstract

- Modern projects tackling complex challenges benefit from the creativity stemming from multidisciplinary teams, yet can find it difficult to achieve shared understanding across the team.
- The team found that systems engineering can act as a *bridge of effective collaboration,* bridging gaps across disciplines
- 5 key challenges that inhibit the development of a shared understanding were identified, and strategies proposed to mitigate the effects of these challenges.

Introduction

- Complex projects, from short-term fixes to sustainable infrastructure, require multidisciplinary collaboration to address intricate issues.
- Systems engineering is a "*transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems…"* (ISO/IEC/IEEE 15288:2023)
- A transdisciplinary approach can enhance shared understanding, transitioning communication from separate multidisciplinary goals to shared transdisciplinary objectives.
- The study explores how this can improve team effectiveness across diverse disciplines.

Key Findings

- Multidisciplinary teams offer diverse perspectives, but this diversity also creates challenges in achieving shared understanding.
- Successful collaboration requires acknowledging and addressing the needs of all stakeholders, including non-technical members.
- Unlike unidisciplinary teams, multidisciplinary collaboration demands greater effort to align goals, perspectives, and communication styles.
- A mixed-methods approach (literature review, interviews, and workshops) revealed insights into the barriers and enablers of shared understanding.

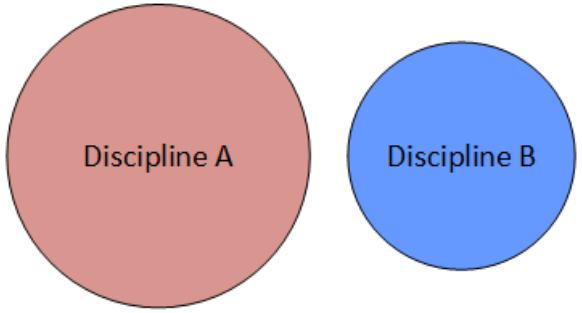
Recommendations

- Engage all stakeholders early, especially those from non-technical backgrounds, to ensure inclusive communication.
- Apply systems engineering practices to serve as a bridge across disciplines and support alignment.
- Use personal reflection and stakeholder input to shape strategies tailored to real-world multidisciplinary contexts.
- Continue using interactive workshops and interviews to gather diverse experiences and test collaborative tools

Implications

- Without intentional alignment, multidisciplinary teams risk miscommunication, fragmented efforts, and reduced effectiveness.
- Systems engineers can play a critical role as facilitators of shared understanding in complex, global projects.
- The study sets a foundation for future research into measurable indicators of shared understanding, validation techniques, and the role of AI and power dynamics in team collaboration.

Multidisciplinary

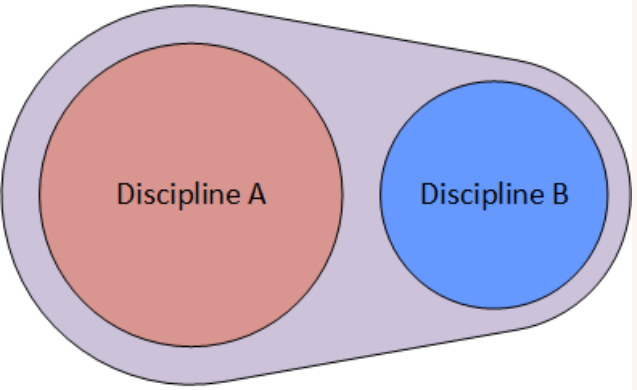


A mode of collaboration where professionals from different disciplines work side by side, each applying their own disciplinary knowledge to a common problem, but maintaining distinct roles and perspectives.

Key Characteristics:

- Each discipline contributes independently within its own boundaries.
- Limited integration between disciplines.
- Focus is on parallel contributions, not synthesis or co-creation.
- Often coordinated by a project manager or systems engineer to align efforts

Interdisciplinary

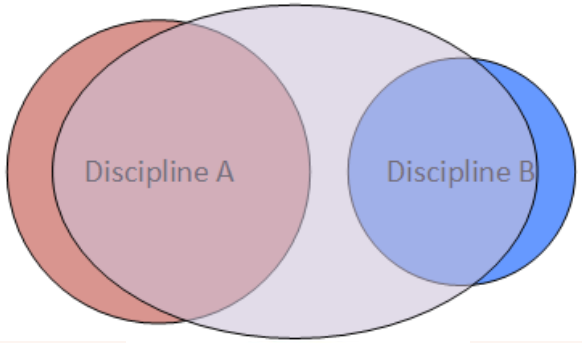


An approach where professionals from different disciplines actively integrate their methods, perspectives, and knowledge to address a complex problem collectively.

Key Characteristics:

- Emphasizes collaboration and integration across disciplines.
- Team members work interdependently, blending expertise.
- Encourages the development of shared frameworks and mutual understanding.
- Aims to generate new insights that go beyond the scope of a single discipline.

Transdisciplinary



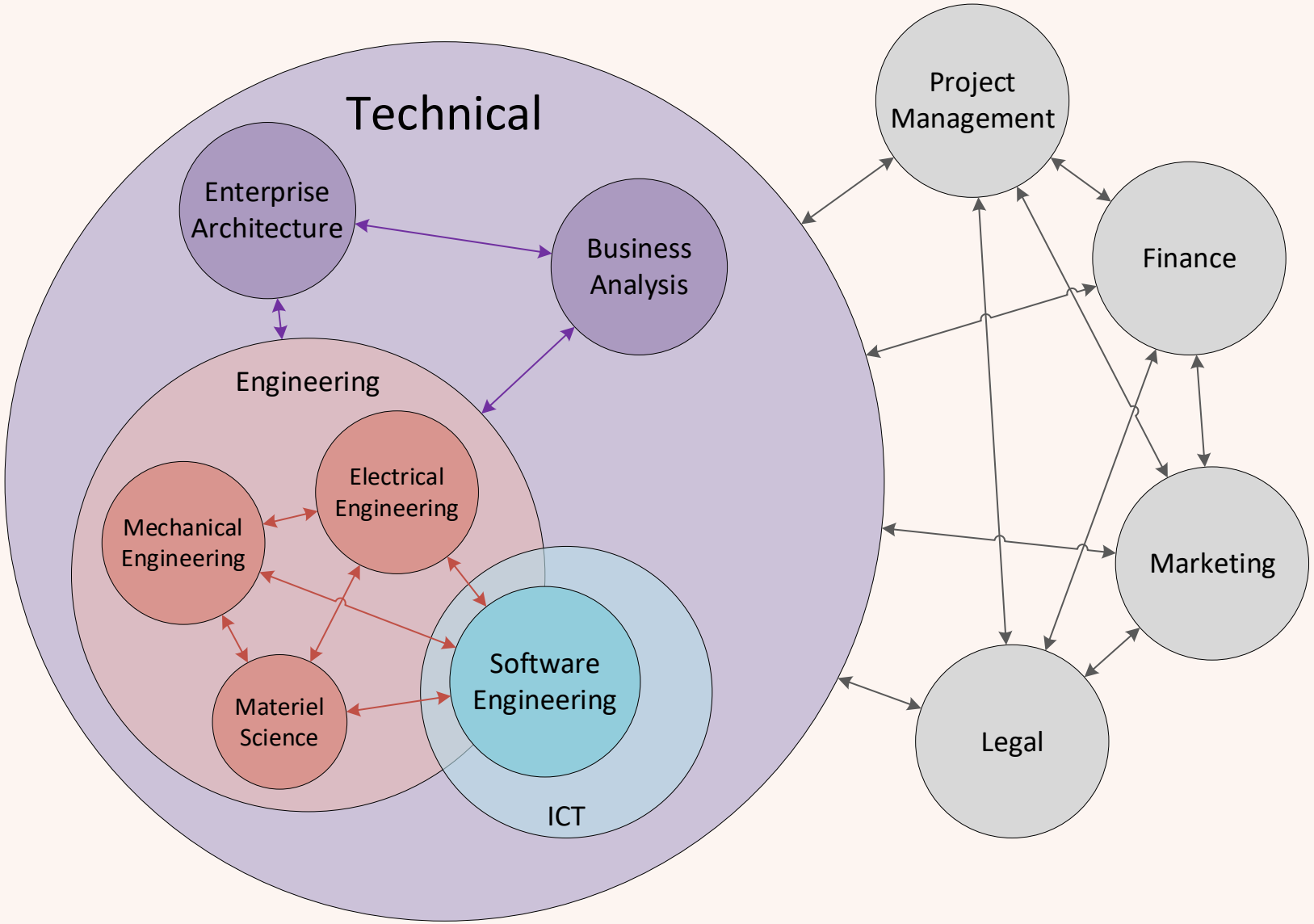
An approach where professionals from multiple disciplines, along with non-academic stakeholders (e.g., users, community members), collaboratively create new frameworks, knowledge, or solutions that transcend traditional disciplinary boundaries.

Key Characteristics:

- Blurs boundaries between disciplines — creates new integrated approaches.
- Includes non-disciplinary contributors, such as end-users or communities.
- Focuses on co-creation of knowledge and solutions.
- Aims for a holistic understanding that reshapes how the problem is defined and solved.

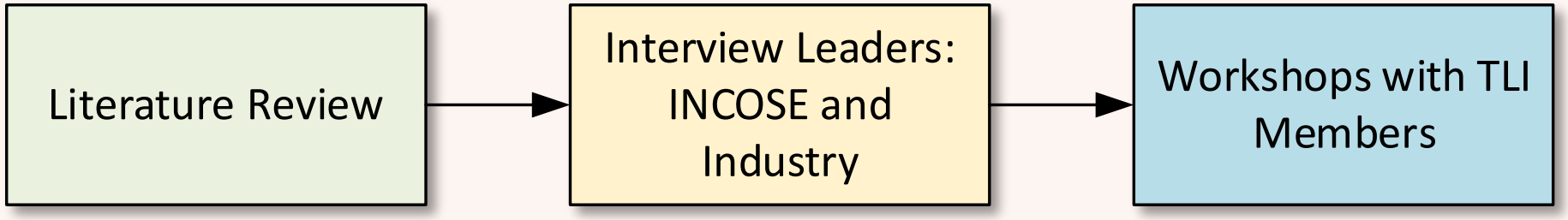
Disciplines

- “Unidisciplinary” used to describe when the team members all share a single discipline, to contrast with multidisciplinary teams
- SEs generally start as other disciplines
- SE is a discipline in its own right, so unifies SEs
- Research was limited to industry and INCOSE leaders (who were known to the researchers) which introduced a bias towards systems engineering understanding



Methodology

- To address the research question, the methodology included a literature review; interviews with industry and INCOSE leaders; and INCOSE workshops.
- TLI coaches helped define the project scope, focusing on team dynamics across various disciplines.
- Semi-structured interviews identified key themes and strategies for shared understanding, analysed using Microsoft CoPilot.



Workshop Demographics

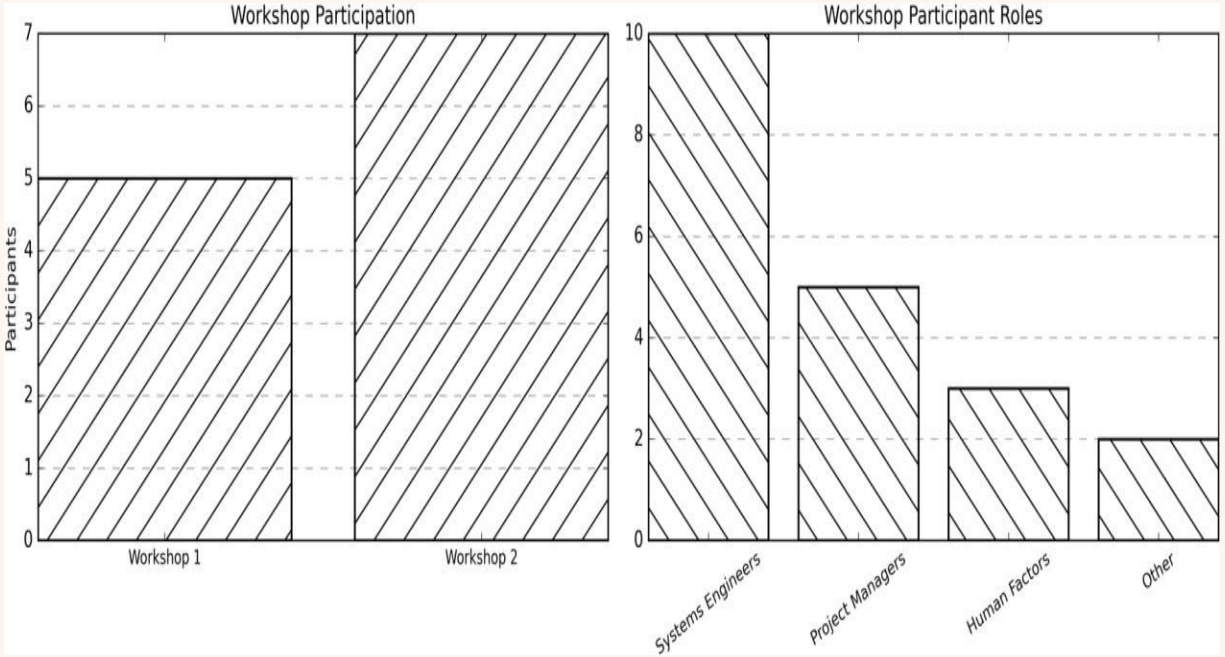


Figure 2. Workshop participants.

Figure 2 summarizes the workshop participation, showing both the number of participants across sessions and their professional roles. The inclusion of systems engineers, project managers, and specialists from other disciplines added to the richness of the discussions.

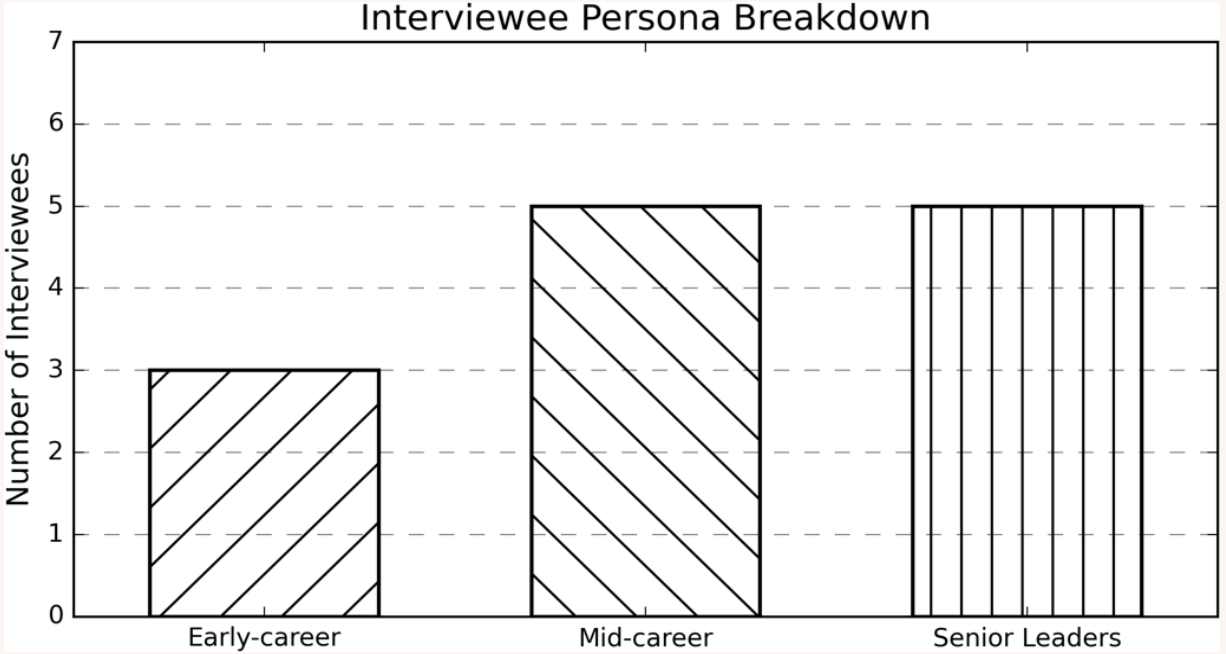


Figure 1. Composition of interviewees.

Figure 1 illustrates that the interviewees were evenly distributed across early-career, mid-career, and senior leadership levels, guaranteeing a diverse range of perspectives

Results - Challenges

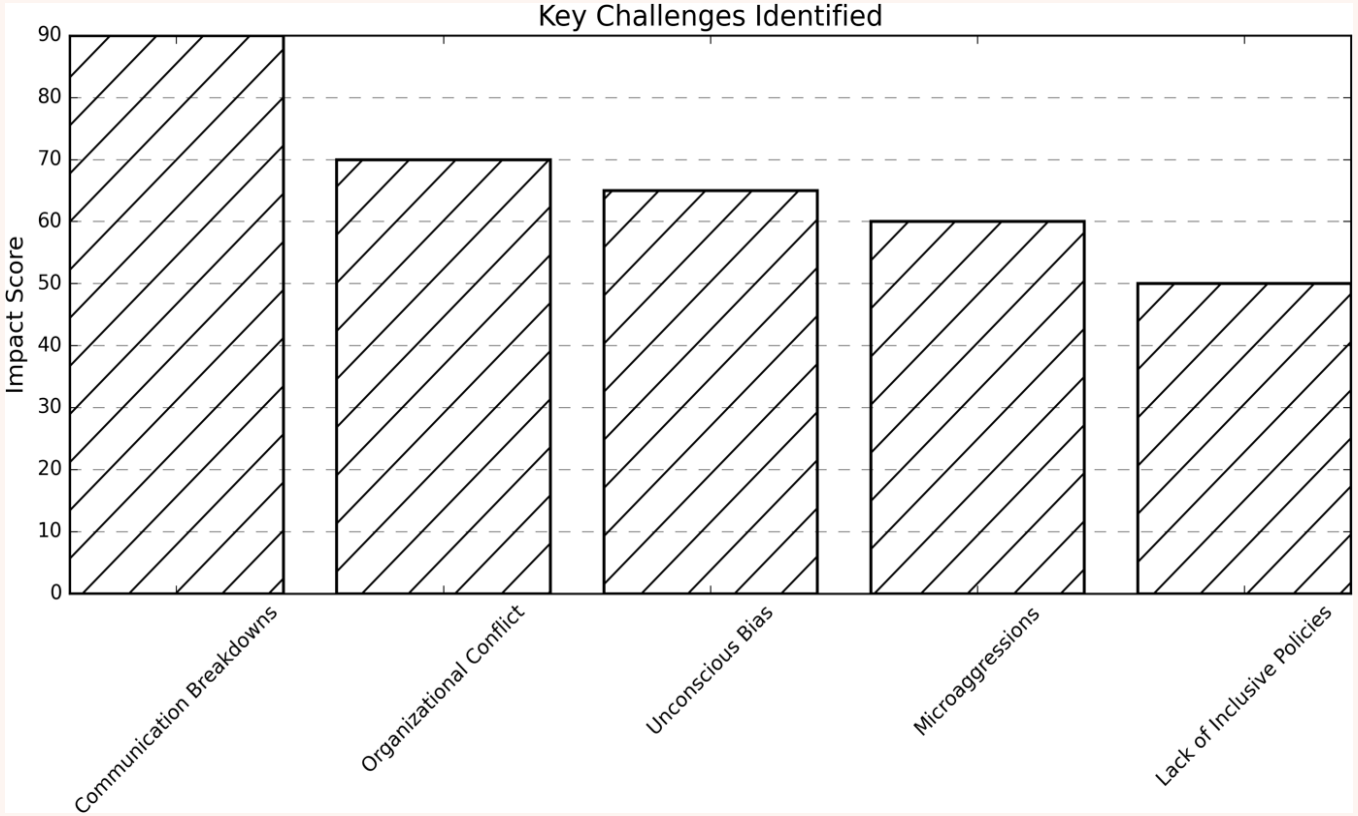


Figure 3. Key challenges identified for shared understanding.

The literature review and interviews reveal five challenges hindering team understanding: communication breakdowns, organizational conflict, unconscious bias, microaggressions, and lack of inclusive policies, with communication breakdowns being the most cited barrier as shown in Figure 3.

Literature Review

Communication breakdowns in diverse teams can delay projects and cause organizational conflict, while unconscious bias, microaggressions, and lack of inclusive policies further impact team cohesion and morale.

Interviews

Interviews showed multidisciplinary teams consist of diverse members, affecting communication; facilitators play a key role in managing dynamics and ensuring clarity using strategies like verbal repetition and collaboration tools.

Workshops

Workshops addressed five key challenges in multidisciplinary team understanding, with solutions focusing on enhancing communication, mediating conflict, and fostering inclusivity. (see Figure 4.)

Workshops suggested adjusting team structures, tailoring communication culturally, prioritizing in-person meetings, documenting assumptions, regular check-ins, and empowering junior members to overcome regional coordination challenges and miscommunication. (see Figure 4.)

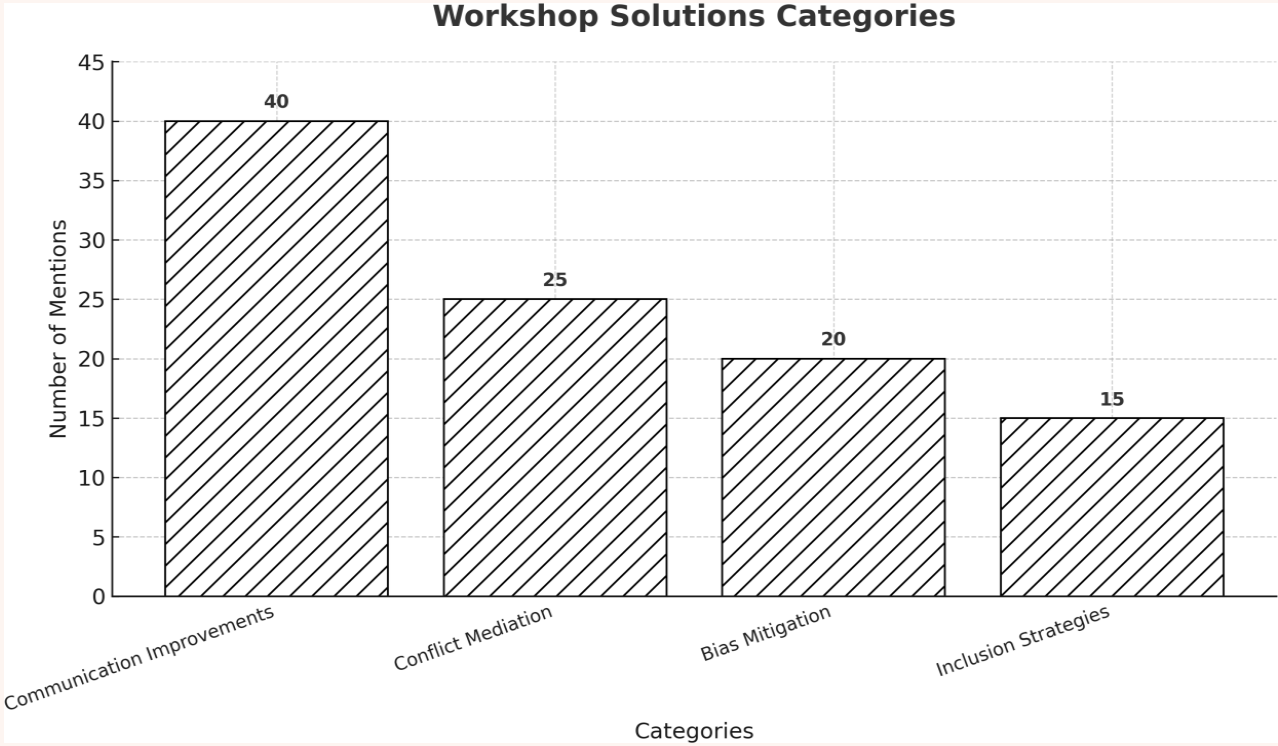


Figure 4. Workshop solution categories suggestions.

Discussion

Communication breakdowns are frequent; implementing regular catchups, face-to-face meetings, documentation, early subcontractor inclusion, neutrality in management, and inclusive policies can enhance alignment and collaboration while reducing bias and microaggressions.

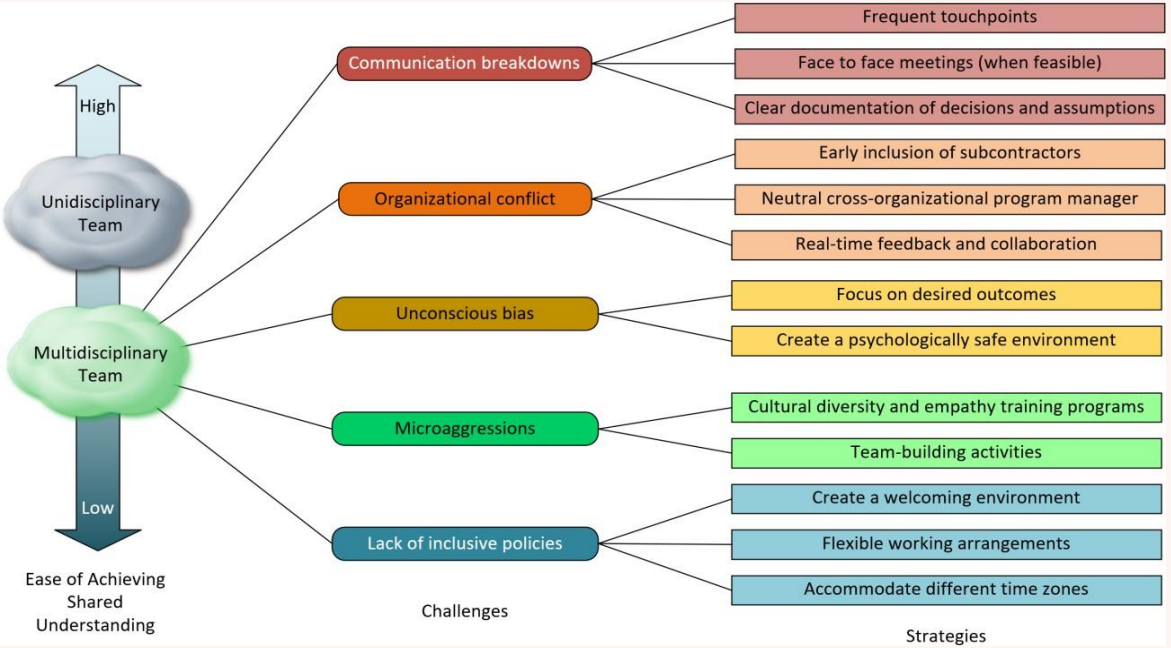
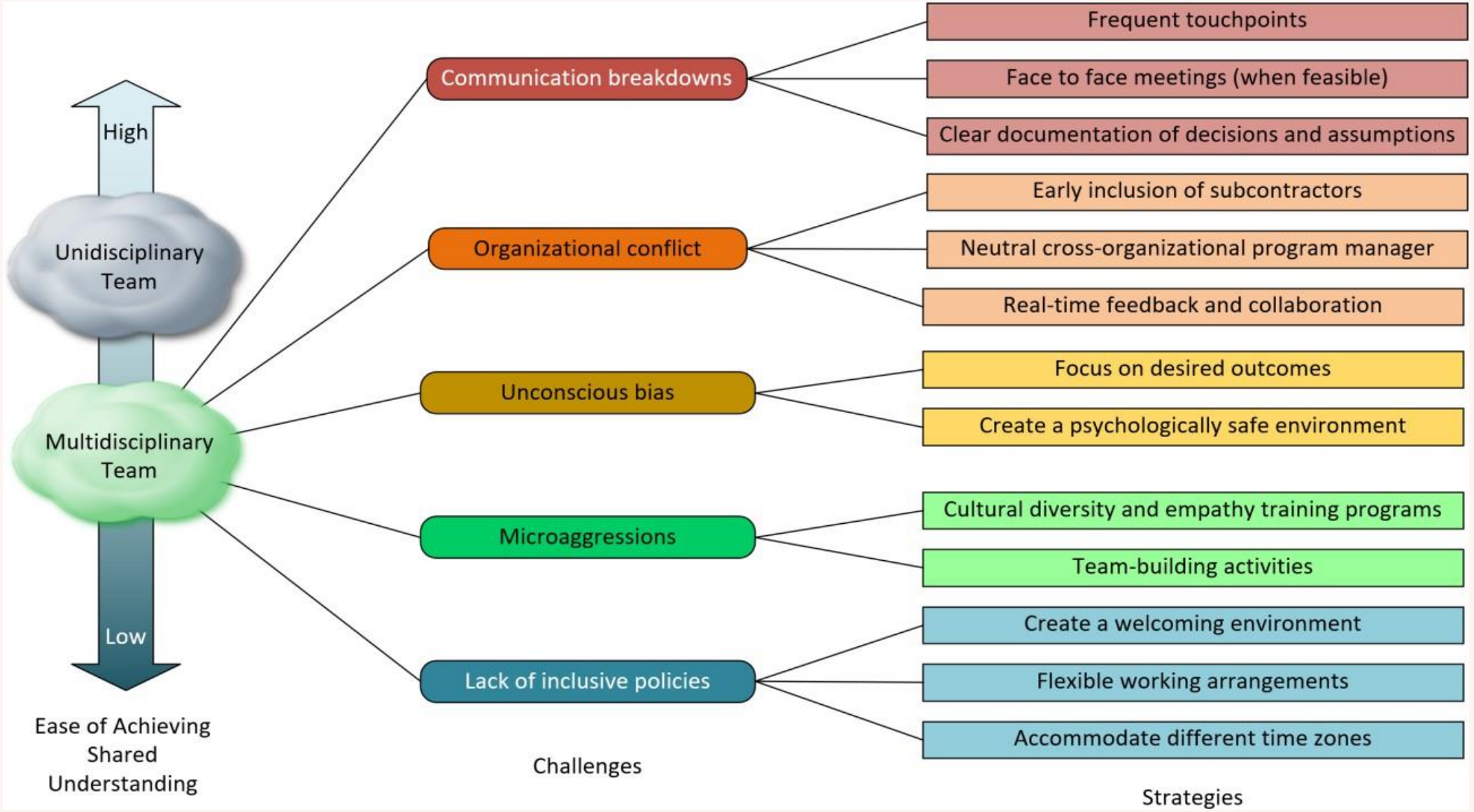


Figure 5. Strategies that help multidisciplinary teams achieve a shared understanding

Data collection focused on systems engineers as technical leaders to explore shared understanding in teams, yet the qualitative study's strategies are more applicable to technical leadership, with limited scope beyond engineering contexts.


High
Unidisciplinary Team
Multidisciplinary Team
Low
Ease of Achieving Shared Understanding
Communication breakdowns
Organizational conflict
Unconscious bias
Microaggressions
Lack of inclusive policies
Challenges
Frequent touchpoints
Face to face meetings (when feasible)
Clear documentation of decisions and assumptions
Early inclusion of subcontractors
Neutral cross-organizational program manager
Real-time feedback and collaboration
Focus on desired outcomes
Create a psychologically safe environment
Cultural diversity and empathy training programs
Team-building activities
Create a welcoming environment
Flexible working arrangements
Accommodate different time zones
Strategies

Strategies for Developing Shared Models with Multidisciplinary Teams

Communication Breakdowns

Frequent touchpoints: scheduling regular catchups and utilizing daily standups can foster alignment amongst team members.

Face-to-face meetings (when feasible): helps break down barriers, foster respect, and increase mutual understanding.

Clear documentation: helps avoid misinterpretations.

Organizational Conflict

Early inclusion: of all stakeholders affords opportunities for them to help shape the direction and for them to integrate quickly into the team.

Neutral cross-organizational program manager: helps mediate conflict between different groups, ensuring project goals remain the prime focus.

Real-time feedback and collaboration: (facilitated by cloud-based tools) helps bridge the gap between different organizations.

Strategies for Developing Shared Models with Multidisciplinary Teams

Unconscious Bias

- **Focus on desired outcomes:** through fostering collaboration and being open-minded.
- **Safe environment:** encourage diverse perspectives through open dialogue and humor.

Microaggressions

- **Training programs:** with exercises to encourage empathy and cultural diversity understanding.
- **Team-building activities:** such as social events, help humanize team members.

Lack of Inclusive Policies

- **Welcoming environment:** implementing comprehensive inclusivity training, mentorship programs, and regularly surveying employees on their experiences with inclusivity.
- **Flexible work arrangements:** foster a sense of inclusion, especially in global teams where cultural expectations may vary significantly.
- **Accommodating different time zones:** enhances inclusivity within a global workforce.

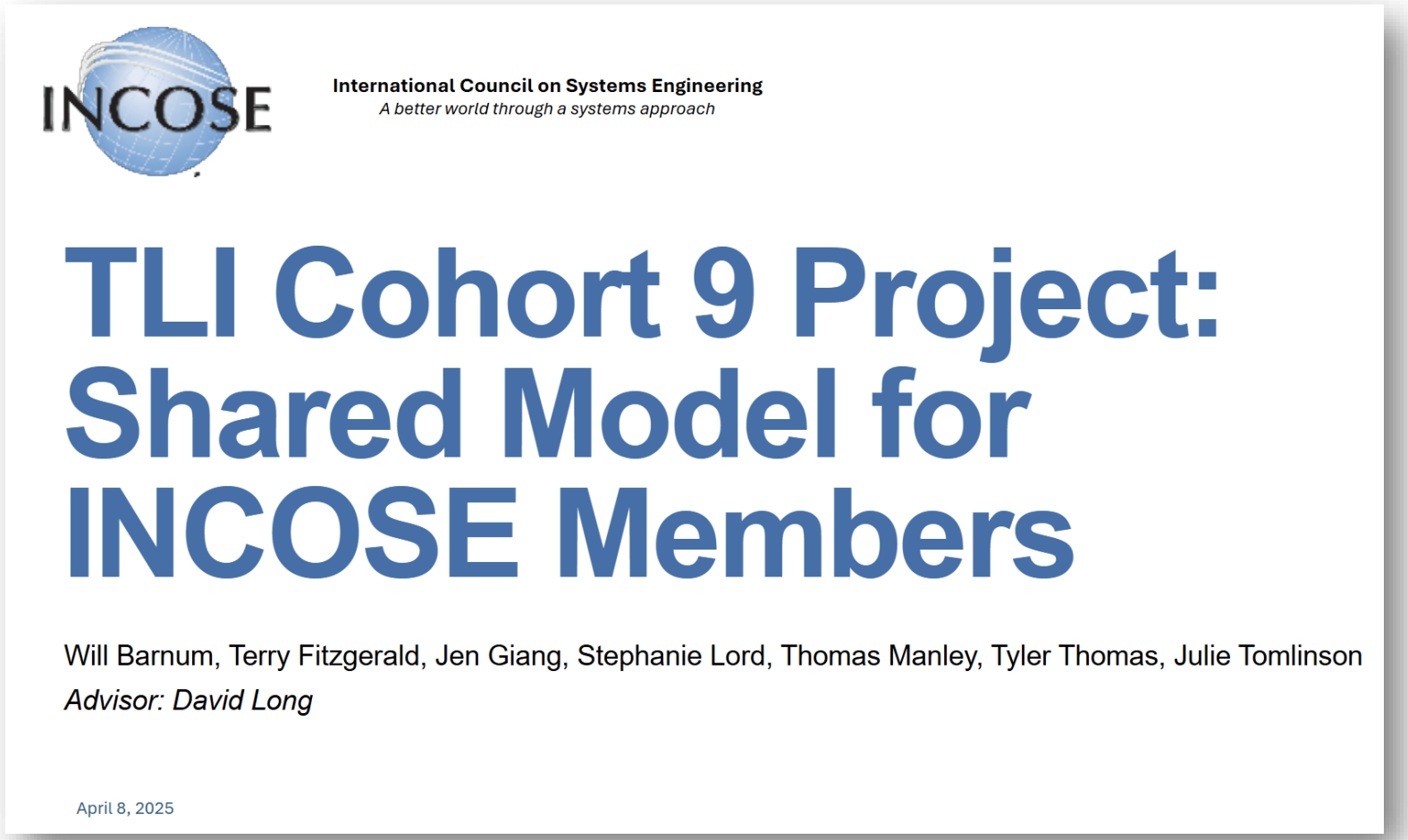
Conclusions and Future Work

This paper outlines strategies to overcome challenges in achieving shared understanding in multidisciplinary teams, emphasizing stakeholder perspectives, informed by literature review, interviews, and workshops, with suggestions for future research on communication and collaboration.

To further advance the knowledge of shared understanding in such teams, future research could explore the following areas:

Quantifying shared understanding	Identifying metrics to quantify shared understanding remains a challenge. Future research could focus on quantifying areas such as team cohesion and communication effectiveness, e.g. using network methods.
Leveraging Artificial Intelligence (AI) tools	Exploring the potential of AI-powered collaboration tools to facilitate communication and knowledge sharing.
Validating shared understanding	Developing effective validation techniques such as surveys, interviews, or brief examinations that help assess the level of shared understanding and identify any gaps.
Human Factors	Future work may focus on the development of effective conflict resolution techniques applicable to multidisciplinary teams, helping alleviate the negative impact on shared understanding and project outcomes.
Power distance	In many teams there is a structural hierarchy resulting in different levels of positional authority amongst team members e.g. Project Managers/Directors might have ultimate authority as to how the project operates. In these cases, implementing the strategies discussed in this paper may require positional authority or influence. Additionally, the existence of a power hierarchy may itself lead to a form of bias that may heed the development of a shared understanding.

Follow-on Project for TLI Cohort 9



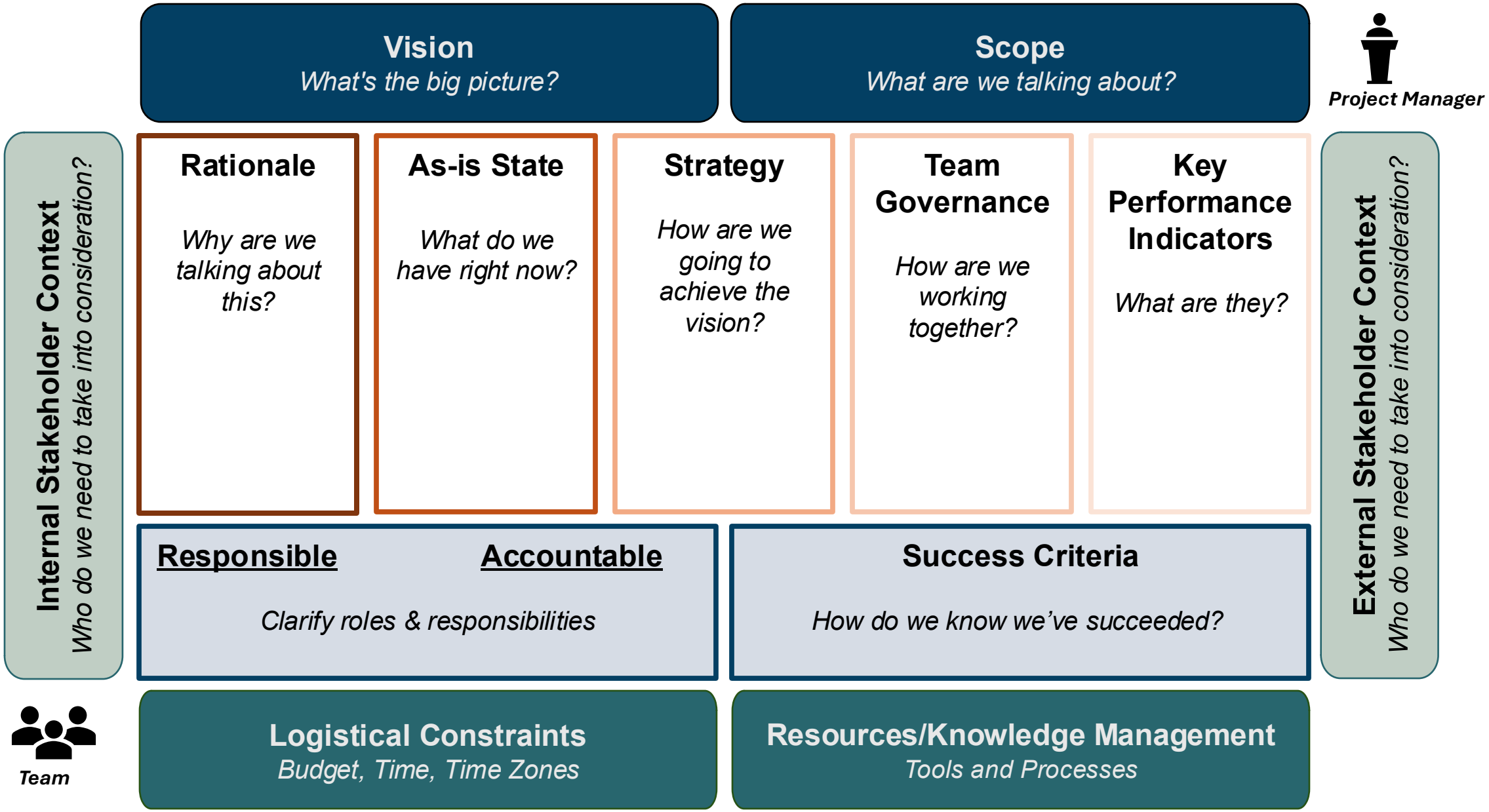
International Council on Systems Engineering
A better world through a systems approach

TLI Cohort 9 Project: Shared Model for INCOSE Members

Will Barnum, Terry Fitzgerald, Jen Giang, Stephanie Lord, Thomas Manley, Tyler Thomas, Julie Tomlinson
Advisor: David Long

April 8, 2025

Overview for Shared Model




Q&A

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Biography

Evelyn Honoré-Livermore. Evelyn Honoré-Livermore is a System Engineer at the European Space Agency, in the section for Small Satellites. Evelyn holds an MSc in Electrical Engineering, a PhD focusing on the integration of Systems Engineering and Project Management from the Norwegian University of Science and Technology (NTNU), and an MBA from Yonsei University. Evelyn has worked several years in the Norwegian space industry, as project manager for development and flight projects, both for launchers and for small satellites.

Hanish Mehta. Hanish Mehta is a Systems Engineer at Wabtec Corp. He holds a Master's degree in Systems Engineering from the University of Maryland and a Bachelor's degree in Applied Engineering from Michigan State University. He has worked on multiple transit projects in the DC-MD-VA area, with majority time spent on the Purple Line light rail project. He is an active member of the INCOSE Chesapeake Chapter and is currently serving as the chapter Treasurer. He is also a certified ASEP and a recipient of the INCOSE CC Member Scholarship.

Jennifer Giang. Jennifer Giang is a Systems Engineering Integration and Test Lead at Sierra Space with extensive experience in the space and defence industry. She holds a MS and PhD in Systems Engineering from Colorado State University, with her dissertation focused on Safeguarding Sensitive Mission Data Through Prompt Engineering. She is also the VP/President- Elect of the INCOSE Enchantment Chapter.

Julia Eng. Julia Eng is a Project Engineer at The Aerospace Corporation, specializing in MBSE, digital engineering, and enterprise architecture for space enterprise clients. She has four years of experience at Aerospace, following a rotation program at Northrop Grumman Mission Systems, where she contributed to process engineering and SEIT. Julia holds an MS in Space Systems Engineering from Johns Hopkins University (2022), and a BE in Engineering Science from Stony Brook University (2019). Additionally, Julia is a certified ASEP and SAFe Government Practitioner.

Thomas Manley. Thomas is a systems thinker with 20+ years' experience in systems engineering, enterprise architecture and network engineering. He is President of INCOSE's Australian chapter, SESA, and Co-Chair of the ICT Working Group. Thomas is a Chartered Professional Engineer, is an ESEP, and has authored articles published in INCOSE's INSIGHT Magazine (lead author) and PPI's Systems Engineering Newsjournal (SyEN).

Sharad Rayguru. Sharad is a Lead Systems Designer at Philips Healthcare India, specializing in systems engineering and model-based systems engineering. He has driven R&D initiatives, enhanced best practices, and con- ducted impactful research showcasing the value of systems engineering in medical devices R&D. Sharad holds a degree in Mechanical Engineering, a master's in Control Systems, is a member of TLI Cohort 9, and an experienced Systems Engineering practitioner.

Interview Guide

1. [Mandatory] What is your definition of a multidisciplinary team?
2. [Mandatory] Can you share your experience working on a multidisciplinary team?
    a. How large is/was your multidisciplinary team?
    b. How many disciplines are/were in that team?
3. [Mandatory] What is their perspective on shared understanding in multidisciplinary teams?
4. How can we measure if there is a shared understanding?
    a. What are the categories of symptoms to consider?
    b. How does team size affect shared understanding in a multidisciplinary work- space? Is smaller team more effective to communicate with vs a larger team?
5. How can systems engineers take the lead (initiative) to bridge the gap between team members coming from different disciplines (esp. when not empowered to do so)?
    a. As a technical leader, how do you effectively bring your insights and voice to the conversation without quieting others?
    b. As a team member, how do you effectively bring your insights and voice to the conversation without quieting others?
6. What adaptive strategies do successful multidisciplinary teams use to maintain shared understanding over the course of a project?
    a. What communication strategies can be used to reduce misunderstandings and improve collaboration among multidisciplinary team members?
7. What methods/tools to frame to assist system engineers across many disciplines their re- sponsible to understand in order to develop viable solutions in the vastly complex environment?
    a. Is there a framework that is available or can be made to facilitate shared understanding?
8. How do cognitive/personality styles, diverse backgrounds, and learning preferences im- pact the level of shared understanding?


THANK YOU!