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

Developing Competence in Competency Assessment and Development – Experiences from applying the INCOSE Systems Engineering Competency Framework from two Large Organizations

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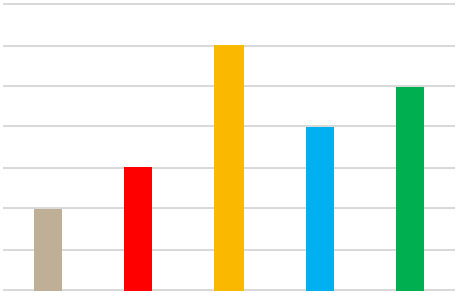
Does the value match the need?

How is that value measured?



What is the ”currency”?

How do we target investments to increase that value?

Understanding competence needs

We need more system engineers in our projects !

But

- Roles ≠ Competence

How do we clone “Anne” …. ?

But

- Individuals do not define competence

Using a systematic competence framework is a pre-requisite for strategic competence planning.

Agenda

Introduction to INCOSE SE Competency Framework (SECF)

Boeing Application of SECF

Saab Application of SECF

Discussion – Competency Management

Lessons Learned and Recommendations

Conclusions

INCOSE Systems Engineering Competency Framework (SECF)

37 Competency Areas of the INCOSE SECF Grouped in 5 Specific Competency Groups

Professional Competencies	*Behavioral competencies well-established within the Human Resources (HR) domain.*	**Communications**
		Ethics and Professionalism
		Technical Leadership
		Negotiation
		Team Dynamics
		Facilitation
		Emotional Intelligence
		Coaching and Mentoring

Technical Competencies	*The ability to perform tasks associated primarily with the suite of technical processes.*	**Requirements Definition**
		System Architecting
		Design for …
		Integration
		Interfaces
		Verification
		Validation
		Transition
		Utilization and Support
		Retirement

Core Engineering Principles	*Core engineering competencies.*	**Systems Thinking**
		Lifecycles
		General Engineering
		Capability Engineering
		Critical Thinking
		Systems Modelling and Analysis

Engineering Management Competencies	*The ability to perform tasks associated with controlling and managing engineering activities.*	**Planning**
		Monitoring and Control
		Risk and Opportunity Management
		Decision Management
		Concurrent Engineering
		Business and Enterprise Integration
		Acquisition and Supply
		Information Management
		Configuration Management

Integrating Competencies	*This competency group recognises engineering as an integrating discipline, joining activities and thinking from specialists i other disciplines to create a coherent unity.*	**Project Management**
		Finance
		Logistics
		Quality

Proficiency Levels of the INCOSE SECF

Proficiency Level	Definition
Awareness	The person displays **knowledge of key ideas** associated with the competency area and understands key issues and their implications.
Supervised Practitioner	The person displays an **understanding** of the competency area and has **some limited experience**.
Practitioner	The person displays **both knowledge and practical experience** of the competency area and **can function without supervision** on a day-to-day basis.
Lead Practitioner	The person displays extensive and substantial practical knowledge and experience of the competency area and **provides guidance to others** including practitioners encountering unusual situations.
Expert	In addition to extensive and substantial practical experience and applied knowledge of the competency area, this individual **contributes to and is recognized beyond the organizational or business boundary**.

Proficiency Levels of the INCOSE SECF

Effective Indicators of Knowledge and Experience		
Awareness	Supervised Practitioner	Practitioner
Explains why there is a need for good quality requirements. [TRDA03]	Elicits requirements from stakeholders under guidance in *order* to understand their need and ensuring requirements validity. [TRDS03]	Uses plans and processes for requirements definition, interpreting, evolving, or seeking guidance where appropriate. [TRDP03]
Identifies major stakeholders and their needs. [TRDA04]	Describes the characteristics of good quality requirements and provides examples. [TRDS04]	Elicits requirements from stakeholders ensuring their validity, to understand their need. [TRDP04]
Explains why managing requirements throughout the lifecycle is important. [TRDA03]	Describes different mechanisms used to gather requirements. [TRDS05]	Develop good quality, consistent requirements. [TRDP05]

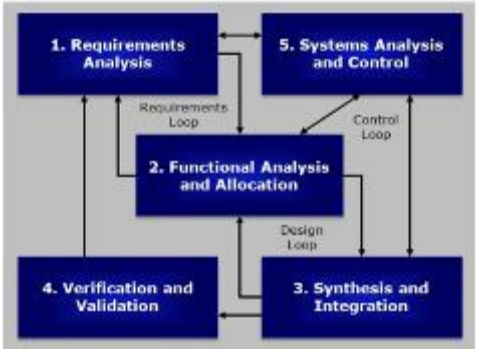
Boeing Application of Systems Engineering Competency Framework

1) Overview
2) Model Organization
3) Boeing Skill Management
4) Boeing Skills Mapped to the INCOSE SECF
5) Extending the INCOSE SECF to Include the Systems Engineering Research Center(SERC) Digital Engineering Competency Framework (DECF)

Overview

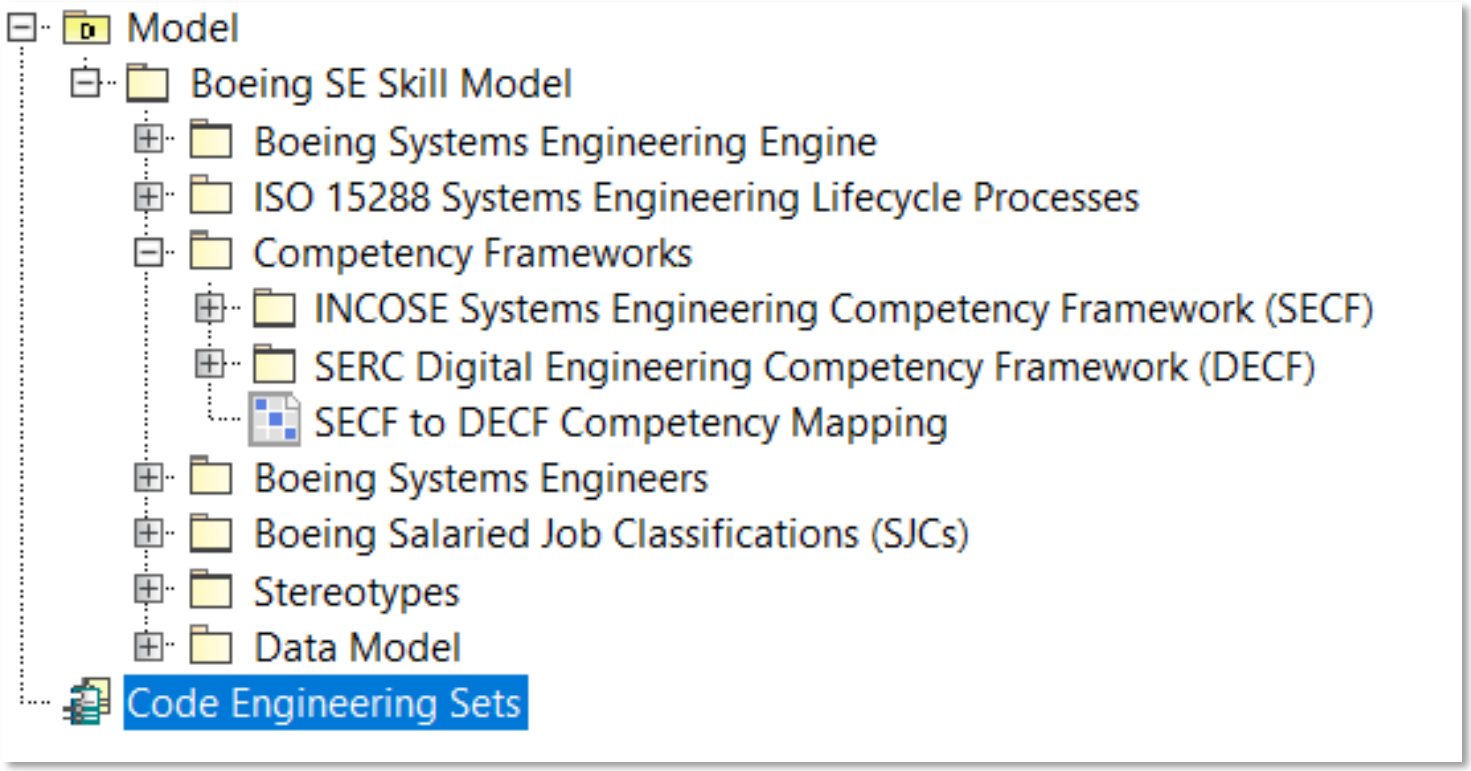
Boeing Skill Management Model leverages the INCOSE SECF for the following purposes:

- Assessing breadth and depth of skills along multiple dimensions
  - Industry Standard Systems Engineering Processes
    - Systems Engineering Engine
    - ISO 15288 – Systems and Software Engineering
      System Lifecycle Processes (ISO, 2015)
  - Industry Standard Competency Frameworks
    - International Council on Systems Engineering (INCOSE)
      Systems Engineering Competency Framework (SECF) (INCOSE, 2018)
    - Systems Engineering Research Center (SERC)
      Digital Engineering Competency Framework (DECF)
- Develop objective career guidance
  - What career paths are available
  - What knowledge, skills and abilities are needed to advance

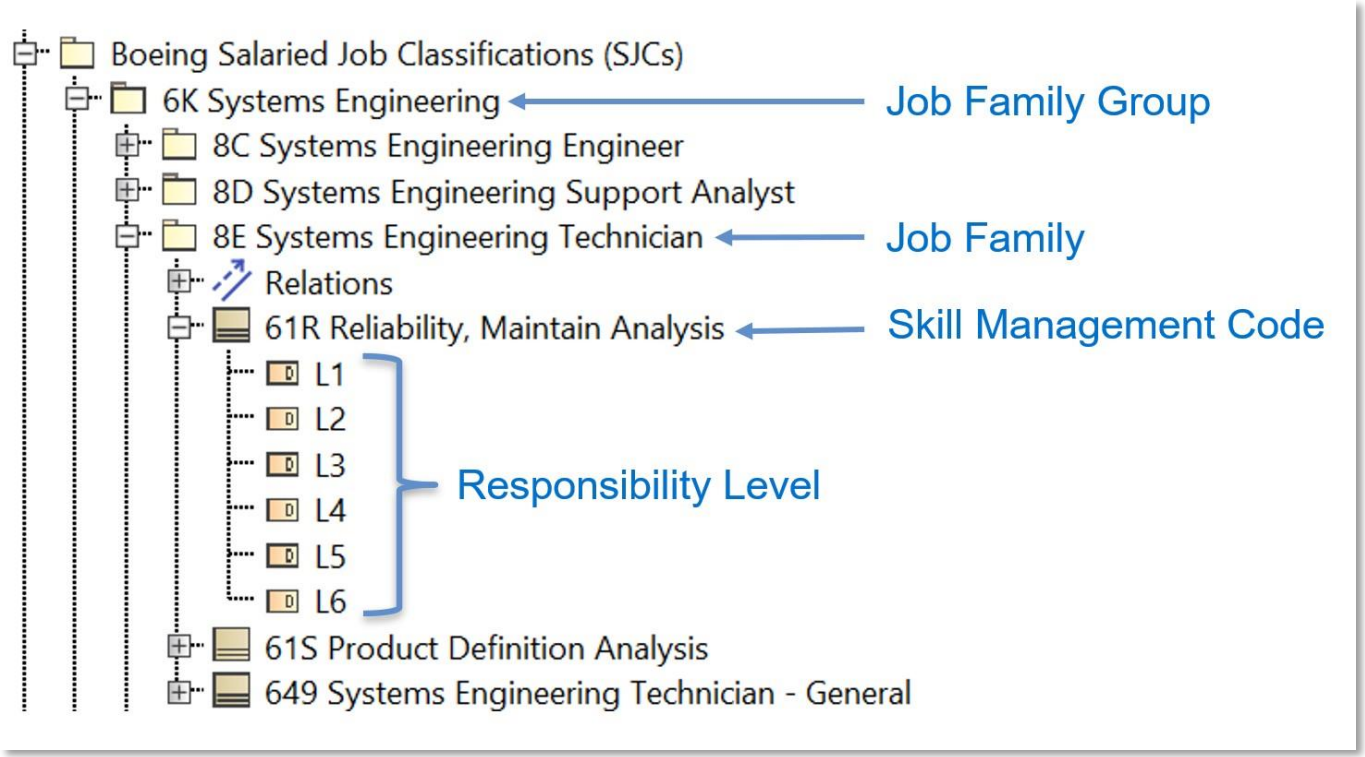


The Systems Engineering Engine

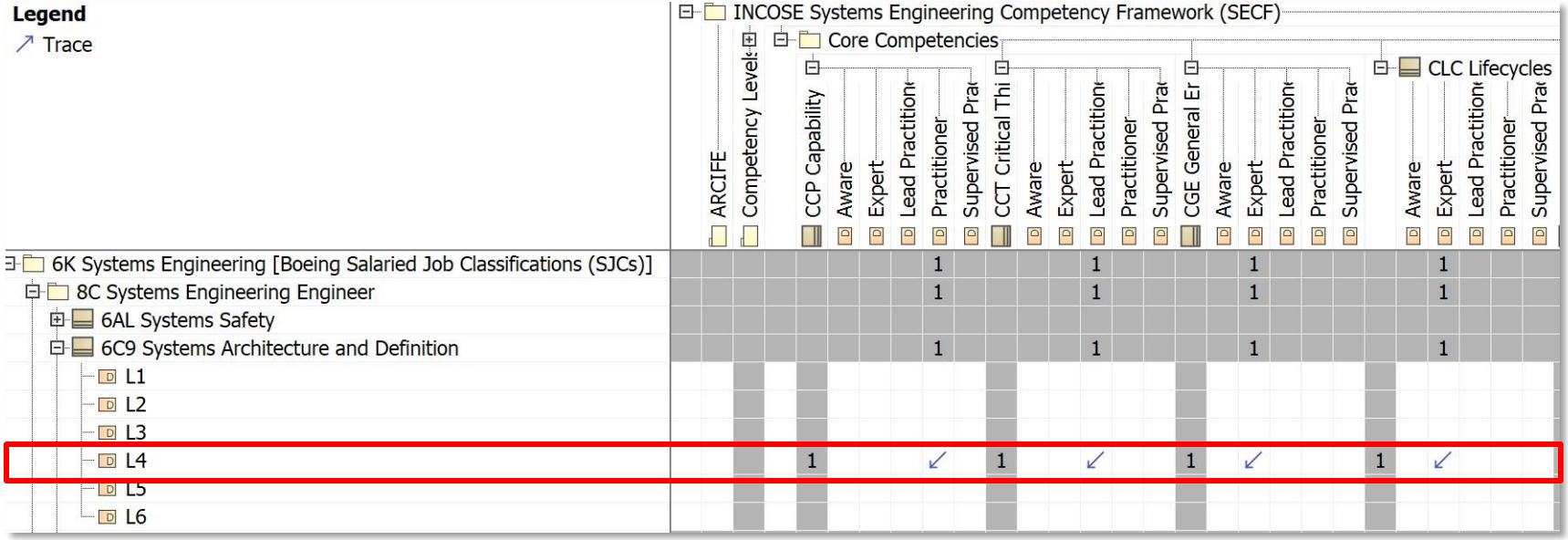
Model Organization



Boeing Skill Management

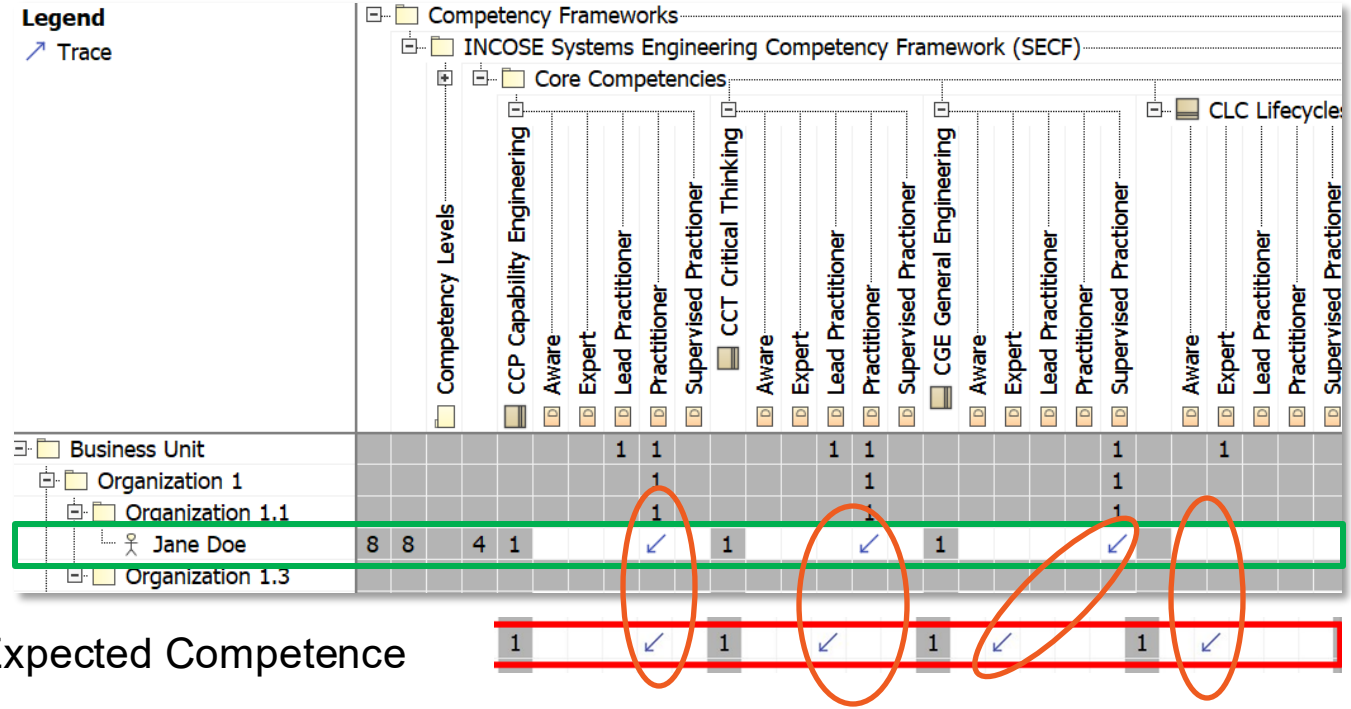


Boeing Skills Mapped to the INCOSE SECF



- Modeling Boeing Systems Engineering Skill Management Codes to the Responsibility Level and INCOSE Systems Engineering Competencies to the Competency Levels allows very detailed mapping.
- For each Responsibility Level within a Boeing Systems Engineering Skill Management Code, it can be determined what Systems Engineering Competencies need to be acquired by a Systems Engineer employed in the Skill Management Code, and at which Proficiency Level.

Boeing Skills Mapped to the INCOSE SECF



Expected Competence

Jane is a Level-4 6C9 Systems Engineer:

- Is she in the right SMC?
- What skill development she needs to undertake?

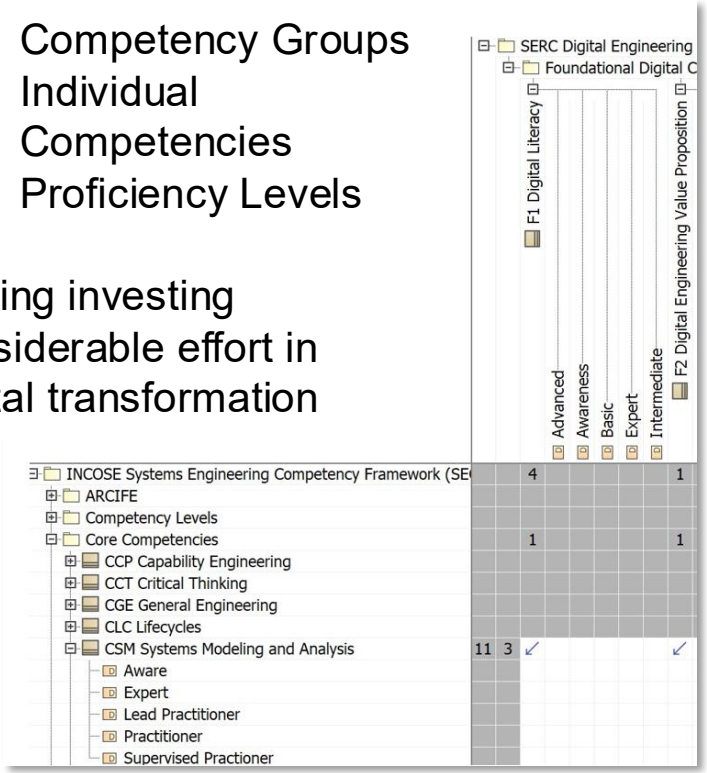
If we have ratings for the rest of her team:

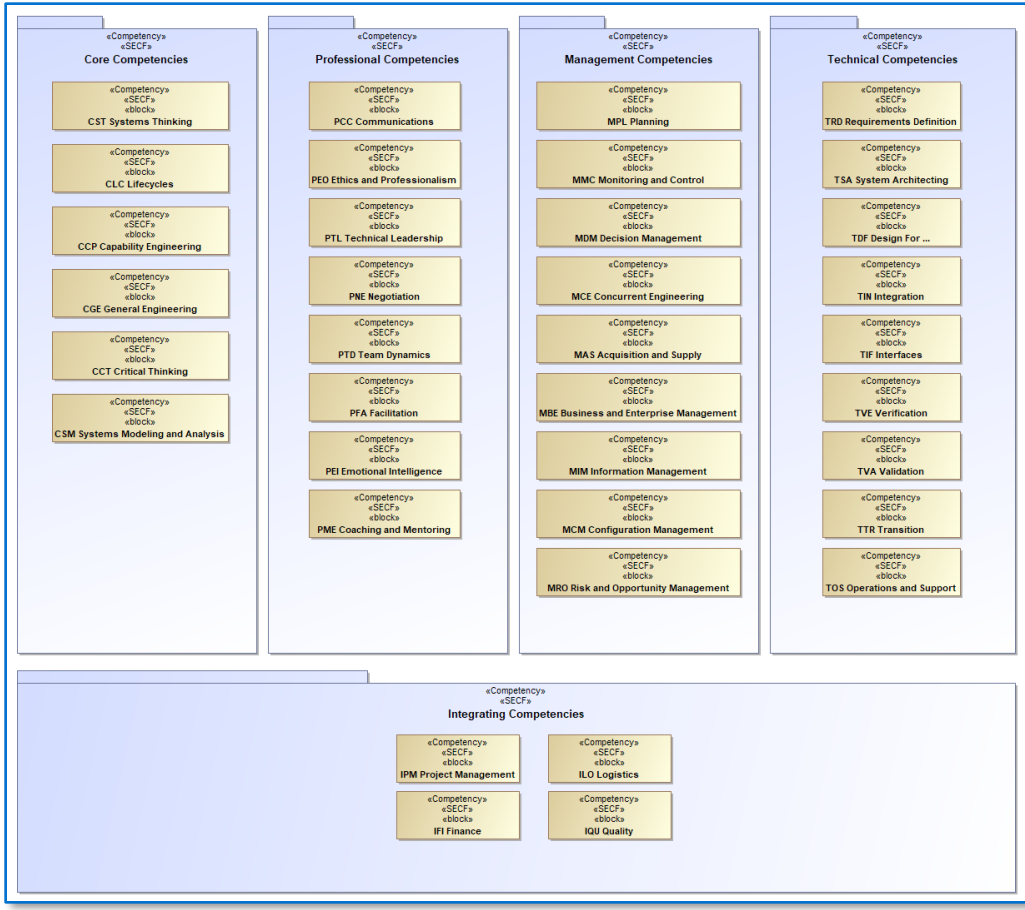
- In the context of her team, what skills are most needed?

Extending the INCOSE SECF to Include the SERC DECF

- SERC DECF is organized by
  - Competency Groups
  - Individual Competencies
  - Proficiency Levels

- Boeing investing considerable effort in digital transformation

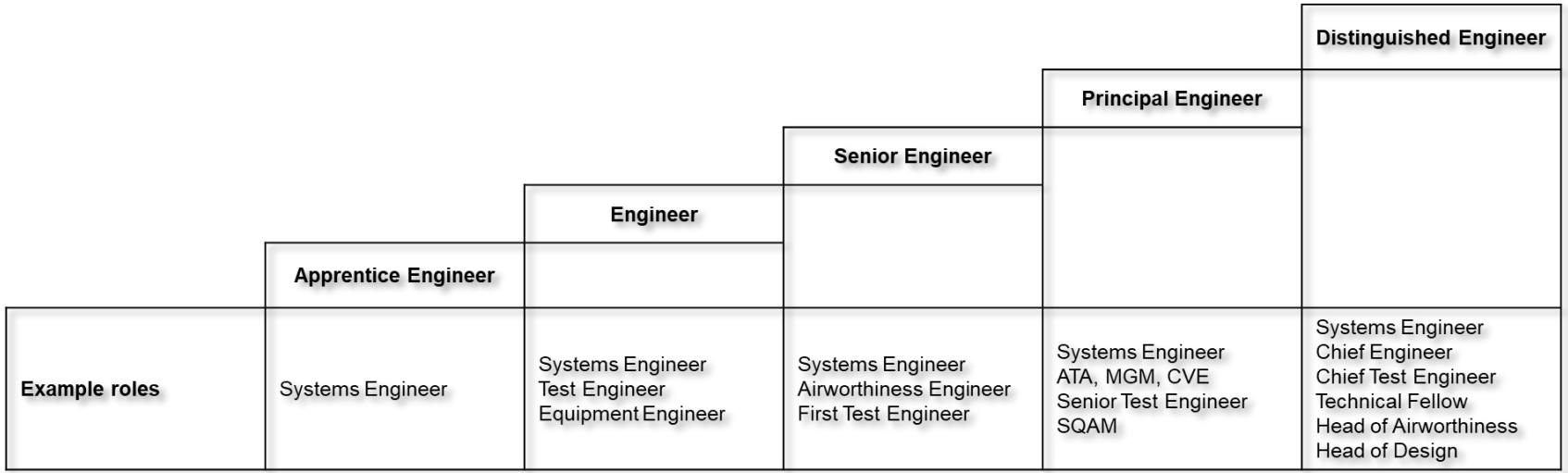




Saab Application of Systems Engineering Competency Framework

1) Background
2) Introducing and Extending the INCOSE SECF
3) Proficiency Levels and the Approach to Competency Assessment
4) From Competency Assessment to Progression in the Engineering Career Ladder
5) Summary and Evaluation

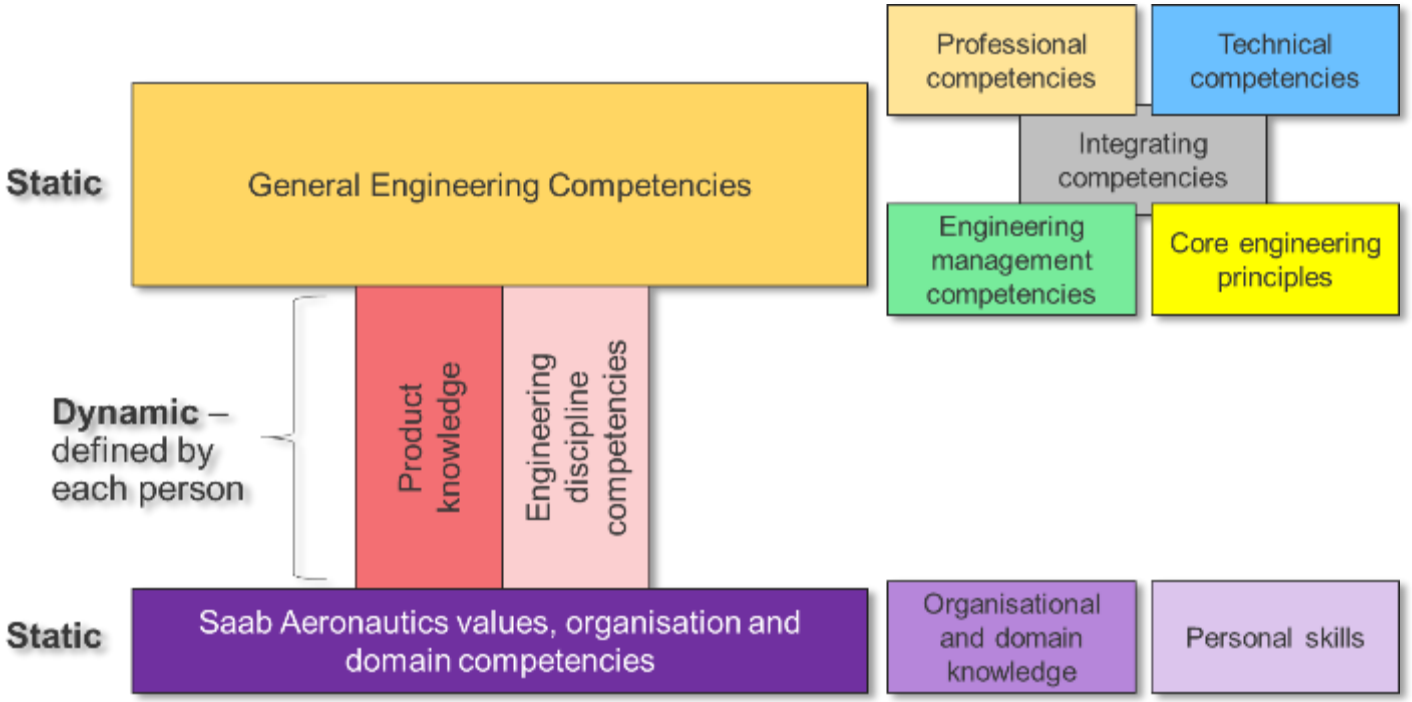
Background



	Apprentice Engineer	Engineer	Senior Engineer	Principal Engineer	Distinguished Engineer
Example roles	Systems Engineer	Systems Engineer Test Engineer Equipment Engineer	Systems Engineer Airworthiness Engineer First Test Engineer	Systems Engineer ATA, MGM, CVE Senior Test Engineer SQAM	Systems Engineer Chief Engineer Chief Test Engineer Technical Fellow Head of Airworthiness Head of Design

Engineering Career Ladder at Saab Aeronautics

Introducing and Extending the INCOSE SECF



Structure of Saab Aeronautics Competency Framework

Proficiency Levels and The Approach to Competency Assessment

Grade	Label	Simplified Interpretation	Description
0	Unaware	I don't know this subject	The person has only very limited knowledge in the competency area.
1	Awareness	I know what the competence area is theoretically, but I have no, or only very limited, working experience	The person displays knowledge of key ideas associated with the competency area and understands key issues and their implications. The person asks relevant and constructive questions on the subject. This level characterises engineers new to the competency area. The level is also applicable for non-engineers interacting within engineers – i.e., not working actively in the competency area, but is aware enough for participating in informed professional discussions in the area.
2	Supervised Practitioner	I can work independently, but need help on a regular basis	The person displays an understanding of the competency area and has some experience. The person requires regular guidance and supervision during the daily work. This level typically defines those engineers who are "in-training", are inexperienced, has not practised in the area for a long time, or has the specific competency as a complementary side area.
3	Practitioner (added)	I work independently on a daily/weekly basis but need occasional help with infrequent activities. I am providing support to supervised practitioners.	The person has sufficient knowledge and practical experience to work independently on most day-to-day tasks. The person is capable to provide advice and guidance to supervised practitioners. Being a practitioner means that the person, although being able to work independently, will need help with some more complex or infrequent topics, e.g., the definition of planning documentation based on existing processes.
4	Senior Practitioner	I work independently and provide support to supervised practitioners and practitioners	The person displays both knowledge and practical experience of the competency area and can work without any supervision. The person is also capable of providing guidance and advice to less experienced practitioners. The person is well versed in tailoring activities and other infrequent task. Being a senior practitioner within a competency area implies that a person is well versed in and up to date with best practice. This competency level is the final result for the vast majority of the employees within an organisation during a successful working life.

Proficiency Levels as Adopted by Saab Aeronautics

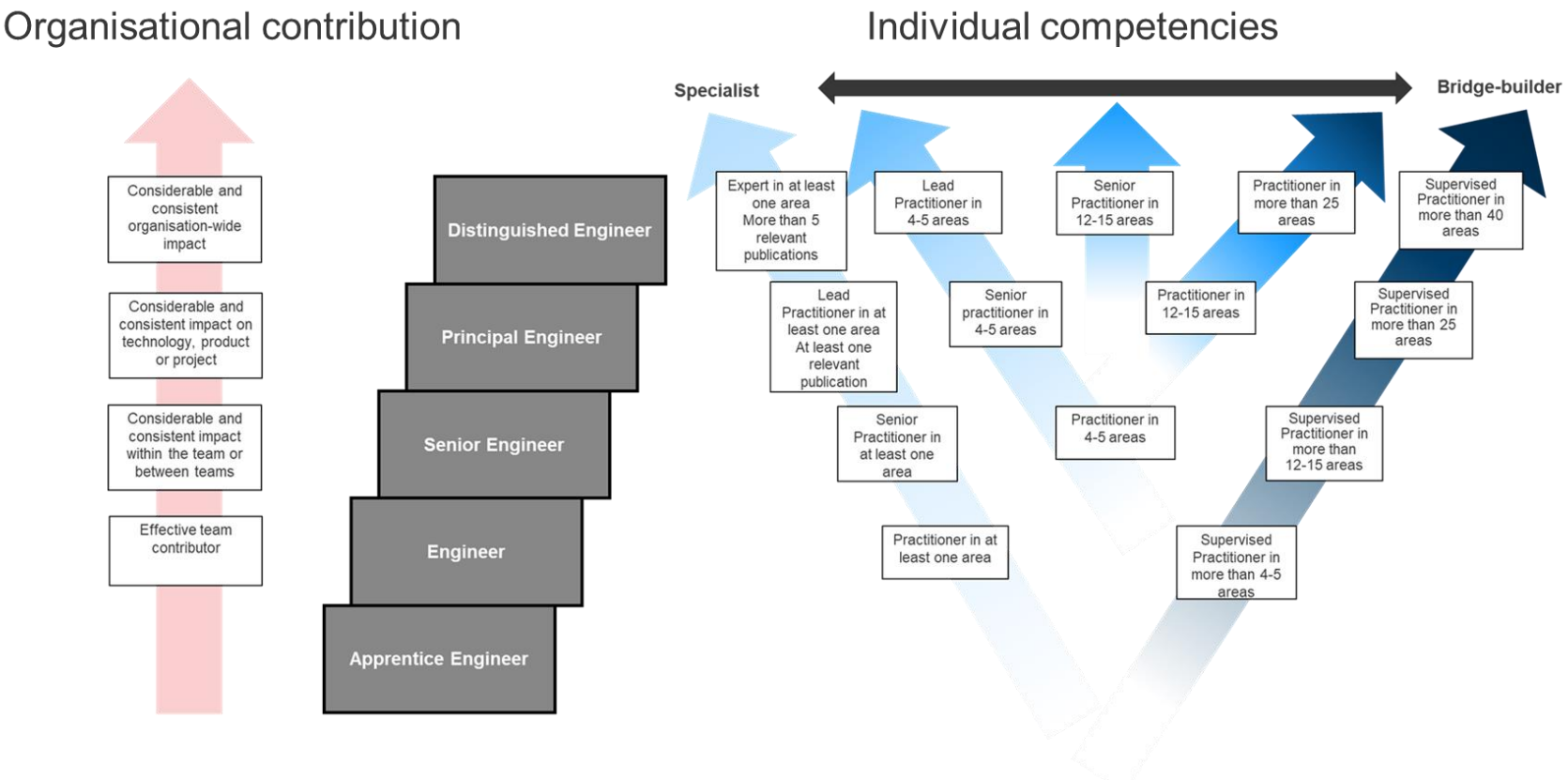
Proficiency Levels and The Approach to Competency Assessment

For Engineers with Exceptional Knowledge (Few)

Grade	Label	Simplified Interpretation	Description
5	Lead Practitioner	I am the person within the organisation that the practitioners turn to for advice	The person displays extensive and substantial practical knowledge and experience of the competency area and provides guidance to others, including practitioners encountering unusual situations. Typically, this level is associated with an individual who is the “go-to” person for advice. Moreover, the person contributes to and improves best practice within the competency area within an organisation or business unit. The number of lead practitioners in an organisation is rather small.
6	Expert	I am an authority on national or international level in the subject	In addition to extensive and substantial practical experience and applied knowledge of the competency area, this individual contributes to and is recognised beyond the organisational or business boundary. Typically, this level is associated with contribution to and definition of national or international best practices within the competency area. Experts are rare, for many competency areas there are no experts – even in a large organisation.

Proficiency Levels as Adopted by Saab Aeronautics

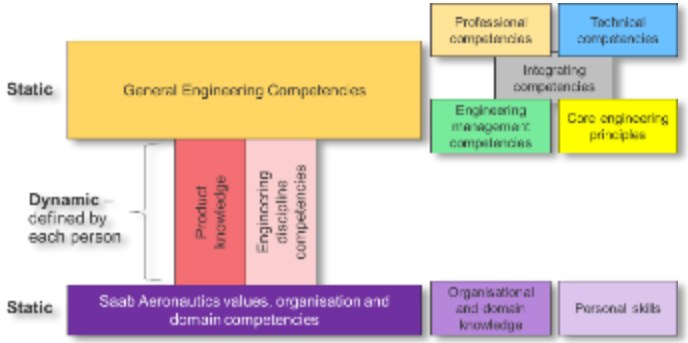
From Competency Assessment to Progression in the Engineering Career Ladder

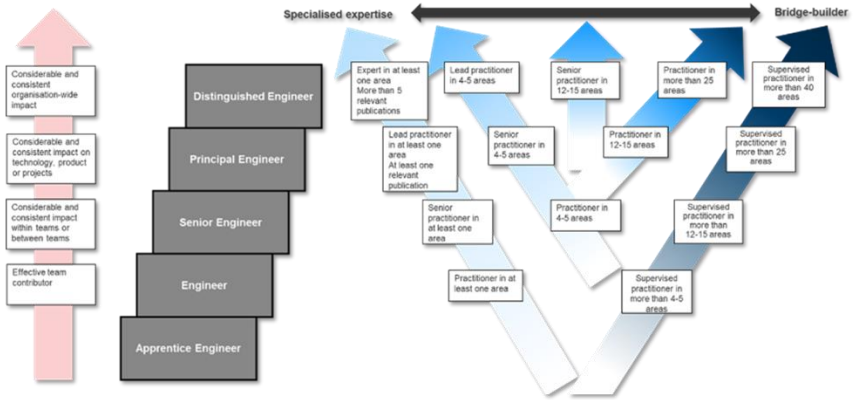


Specified Organizational Contributions and Proficiency Level for Promotion in the Engineering Career Ladder

Saab Summary and Evaluation

	Apprentice Engineer	Engineer	Senior Engineer	Principal Engineer	Distinguished Engineer
Example roles	Systems Engineer	Systems Engineer Test Engineer Equipment Engineer	Systems Engineer Airworthiness Engineer First Test Engineer	Systems Engineer ATA, MGM, CVE Senior Test Engineer SQAM	Systems Engineer Chief Engineer Chief Test Engineer Technical Fellow Head of Airworthiness Head of Design





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4	**Senior Practitioner**	I work fully independently and provide support to practitioners	The person displays both knowledge and practical experience of the competency area and can work without any supervision. The person is also capable of providing guidance and advice to less experienced practitioners. The person is well versed in tailoring activities and other infrequent task. **Being a senior practitioner within a competency area implies that a person is well versed in and up to date with best practice. This competency level is the final result for the vast majority of the employees within an organisation during a successful working life.**
		FOR ENGINEERS WITH EXCEPTIONAL KNOWLEDGE (VERY FEW)	
5	**Lead Practitioner**	I am the person within the organisation that the practitioners turn to for advice	The person displays extensive and substantial practical knowledge and experience of the competency area and provides guidance to others, including practitioners encountering unusual situations. Typically, this level is associated with an individual who is the "go-to" person for advice. Moreover, the person contributes to and improves best practice within the competency area within an organisation or business unit. **The number of lead practitioners in an organisation is rather small.**
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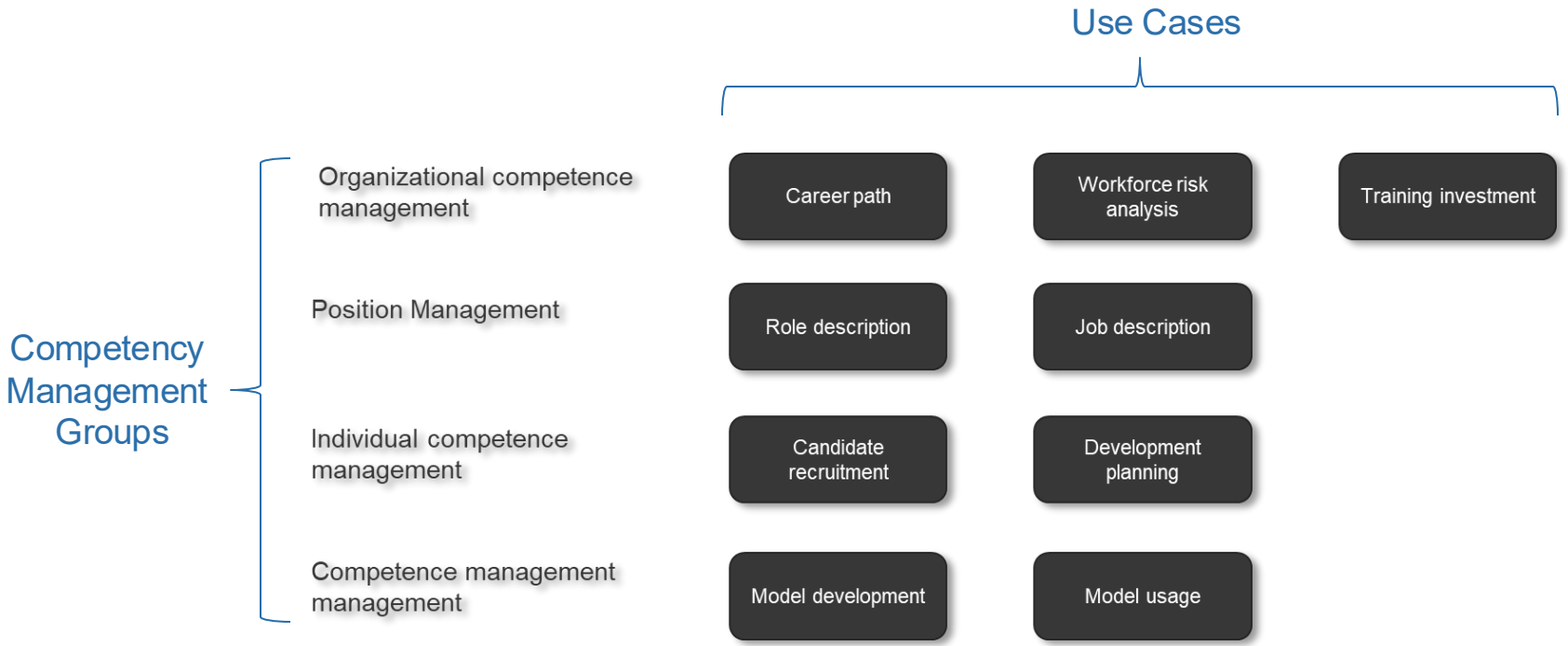
Discussion about Competency Management

INCOSE SECF Prioritized Use Cases for Boeing and Saab

Use Case	Boeing	Saab
Candidate recruitment	–	Plan
Career path	Plan	Implemented
Course curricula	–	–
Development planning	Plan	Implemented
Educational courses	–	–
Educational verification	–	–
Job description	Plan	Plan
Model development	Plan	–
Model usage	Plan	–
Performance assessment	–	–
Role description	Plan	Plan
Training investment	–	Plan
Workforce Risk Analysis	Plan	Plan

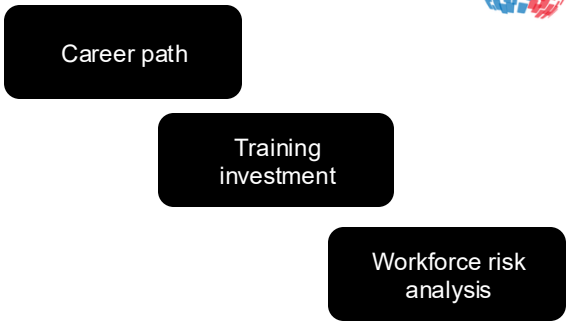
Source of Use Cases: Amenabar, J. P., & Whitcomb, C. A. (2024). INCOSE Systems Engineering Competency Assessment Guide Systems Modeling Language (SysML) Model Description. In INCOSE International Symposium (Vol. 34, No. 1, pp. 1505-1520).

Use Cases Related to Competency Management Group



Organizational Competency Management

- A uniform set of Competency Areas allows for analyses over the complete engineering population within an organization.
    - Functionality for anonymizing individual's competency is important, as the ability to aggregate information for analyses over the entire engineering population
- Enabling resource efficient competency investments in the organization, based on competency analyses
    - Can be performed both on an individual, team or organizational level.



Position Management

Job description

Role description

- Allowing for definition of competency profiles for key organizational roles
    - Important to allow for a certain amount of flexibility - the competency need for a role will depend on the complexity of the system of interest, the system's maturity, and the competency of the immediate team.
    - Appointees to a role may be allowed a time period to improve their competency to meet the expectation documented for a role.
- Allowing for clear cut definition of the requirements for a position
    - Flexibility must be allowed for, since the competency profile is not the sole indicator for suitability for a position.

Individual Competency Management

Development planning

Candidate recruitment

- Allows for a quick calibration during recruitment of the competency of a candidate with regard to the competency required for the role
- Allows engineers to see both their strengths and weaknesses – probably the strongest aspect of the INCOSE SECF!
    - A tool for planning their competency development accordingly – for a specific role or general progress

Management of Competency Management

Model usage

Model development

- Each organization needs to develop as a strategy for how it will tailor the INCOSE SECF for meeting their organizational need – two approaches demonstrated in this paper

- Over time an organization will manage and extend its incarnation of the competency framework.
    - Includes integrating new versions of the framework and implementing organization specific extensions.

Lessons Learned and Recommendations

- Start with the existing framework
- Don’t modify, but extend
- Be clear on objectives and use
- Application to individual roles
- Formality of the application
- Identify the system of interest
- Performing the assessment
- Professional competencies are personal

Lessons Learned and Recommendations

Don't modify, but extend

Application to individual roles

Start with the existing framework

Identify the system of interest

Be clear on objectives and use

Professional competencies are personal

Formality of the application

Performing the assessment

The influence of culture

Conclusions

- The Boeing Company and Saab AB applied the INCOSE SECF in their organizations
- Both The Boeing Company and Saab AB require significant utilization experience before attaining all identified SECF benefits at scale.
- INCOSE SECF is an excellent resource for identifying Systems Engineering related competencies.
- Adopting and extending SECF is a low-cost route for introducing detailed Systems Engineering competency management in an organization.
- The Boeing Company and Saab AB gratefully acknowledge the development work of the INCOSE Competency Working Group.
- Summary of application experiences:
  - At Boeing, skill modeling shows great potential in supporting multi-faceted skill assessment and career development.
  - At Saab, competency assessment has introduced more depth in competence development conversations and introduced new energy for engineers and technical leaders to engage in competency planning and development.
  - When employing INCOSE SECF avoid Competency Area modifications. Extensions to areas not covered by the standard framework is always an option. The INCOSE SECF is not only applicable to Systems Engineers. Essentially all engineering disciplines benefit from using the structure and Competency Areas defined.
  - Developing SECF models is highly labor intensive and time consuming. Recommend publishing standards and frameworks as models in industry standard formats (e.g., XMI, XML files).
  - Each organization introducing INCOSE SECF needs to consider optimal use of the framework.
- Having authors from two organizations writing about and analyzing the approaches taken to competency development is by itself an excellent approach to competence development in competency development.

35th Annual INCOSE international symposium

hybrid event

Ottawa, Canada

July 26 - 31, 2025

Questions?

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