INCOSE UK GUIDE

Annex A - Guide to Competency Evaluation



INCOSE UK
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Acknowledgements

The 'Systems Engineering Competencies Framework' (Phase 1 Working Group) and 'Guide to Competency Evaluation' (Phase 2 Working Group) have been produced from the output of a number of INCOSE UK workshops. Phase 3 of the Working Group updated both documents using feedback from implementation. The Working Groups were attended by the following people:

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Contents

Introduction

Objectives

This Guide to Competency Evaluation is designed as a companion to the Systems Engineering Competencies Framework Document. It gives guidance on how to evaluate people against the competency framework.

The following objectives were set at the inaugural Working Group meeting:

1. Using Systems Engineering Competencies Framework Document, define objective methods of measurement for (in order of approach):
- Each competency
- Selected Supporting Techniques and Basic Skills and Behaviour

2. Agree 'other parameters' that need to be considered, together with a definition:
- E.g. size of previous project, complexity of previous project, quality of previous work, years of experience.

Guide Development

The Working Group brainstormed the possible contributory types of evidence that may be used for evaluating competency. The different types of possible evidence were then allocated to the four defined competency levels as follows:
When evaluating individuals against the competency framework, the following points should be considered:

Competency Level	Possible Contributory Types of Evidence
Awareness	Learning and Development Tell me about it (overview)
Supervised Practitioner	Certified Education Tell me about it (can explain and understands why) Experience of doing (on a training course or as part of a team)
Practitioner	Experience of doing - Relevant and Recent (last 5 years) Objective Evidence
Expert	Experience of doing - Relevant and Recent (last 5 years) Objective Evidence Peer References/Assessment

- Measures of competency should be de-coupled from roles in an organisation.
- Experience in the competency should be relevant and recent - an individual can drop through the levels for a particular competency if experience is not relevant or recent.
- Any combination of types of evidence may be acceptable (this will be decided by each organisation implementing the Framework and Evaluation Guide).

Competency Evaluation Tables

Each competency evaluation table provides:

- A description of the competency and why it matters
- The possible contributory types of evidence for each competency level

Any combination of the types of evidence may be acceptable depending on how the Systems Engineering Competencies Framework and Guide to Competency Evaluation is tailored and used by organisations.

Competency Evaluation Tables

COMPETENCY AREA - Systems Thinking: System Concepts

Description:
The application of the fundamental concepts of systems thinking to systems engineering. These include understanding what a system is, its context within its environment, its boundaries and interfaces and that it has a lifecycle.

Why it matters:
Systems thinking is a way of dealing with increasing complexity. The fundamental concepts of systems thinking involves understanding how actions and decisions in one area affect another, and that the optimisation of a system within its environment does not necessarily come from optimising the individual system components.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS – SYSTEM CONCEPTS

	Tell me About it (Overview) - Listen for...
Is aware of the need for systems concepts	■ Understands that systems are more than interfaced collections of parts ■ Appreciates both static and dynamic properties of systems ■ Understands viewpoints – different perspectives on systems
Aware of the importance of system lifecycle	■ Aware that a system has a lifecycle from concept to retirement (ISO 15288) ■ Knows a number of key life cycle stages ■ Appreciates relationship between the stages/phases and the possibility of interaction, e.g. basic trade-offs, such as first cost versus operating costs
Aware of the importance of hierarchy of systems	■ Knows that this includes but also means more than decomposition ■ Understands something about levels of detail ■ Can relate this issue to those of context, super system, system of interest, sub systems and beyond
Aware of the importance of system context	■ Appreciates the hierarchical view ■ Understands that context is important when considering systems

Competency Evaluation Tables

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS – SYSTEM CONCEPTS

	Tell me About it (Overview) - Listen for...
Aware of the importance of interfaces	■ Understands a system has a boundary ■ Understands the system interacts across its boundary ■ Aware that interfaces may be external or internal to the system
Aware of the importance of interactions amongst systems and their elements	■ Aware of the concepts of abstraction, interaction and emergence

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- Systems Thinking Course
- Chapter 1 of *Systems Engineering coping with complexity*, Stevens et al., 1998
- Chapter 1 of *Putting Systems to Work*, Hitchins, 1992.
- Chapters 1 and 2 of *Systems Engineering,* Sage, 1992.
- Chapter 1 of *System Engineering Management,* Blanchard, 1991.
- Chapter 2 of *Systems Engineering Guidebook*, Martin, 1996.
- Chapter 4 of *Systems Thinking, Systems Practice,* Checkland, 1984.
- ISO/IEC 15288, 2008, section 5.1
- INCOSE handbook v3.1, chapter 2
- EIA 632 section 6

Competency Evaluation Tables

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER – SYSTEM CONCEPTS

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Understands systems concepts	■ Can explain; lifecycle, context, hierarchy, sum of parts, purpose, boundary, interaction	■ Has used a basic concept map or other model of a system at some stage of its development ■ Has seen and appreciated the utility of system concept(s) prepared by others
Understands the system lifecycle in which they are working	■ Can explain the system lifecycle in which they are working ■ Can explain the model for handling lifecycle realisation and maintenance processes ■ Can explain the limitations (if any) of the approach used	■ Has participated in the lifecycle aspects of a current or recently completed project/programme
Understands system hierarchy and the principles of system partitioning in order to deal with complexity	■ System partitioning may be carried out by analysis of scenarios, functional decomposition, physical decomposition, interface reduction, heritage etc. ■ System partitioning deals with complexity by breaking down the system into realisable system elements each of which will be less complex than the whole ■ Can explain the relative merits of different system partitioning approaches ■ Understands that hierarchy and partitions are constructs	■ Has performed some form of decomposition - functional analysis or other modelling
Understands the concept of emergent properties	■ Can explain that emergent properties of the system are those that appear as a result of the interaction between systems elements which are not evident in individual systems elements ■ Can explain that emergent properties may be desirable or undesirable	■ Can provide examples of emergent properties in his/her own or associated work.
Can identify system boundaries and understands the need to define and manage the interfaces	■ Can explain how system boundaries are identified ■ Can explain the need to define and manage the interfaces (see interface management)	■ Has carried out or been involved in partitioning or interface work
Understands how humans and systems interact and how humans can be elements of systems	■ Can explain the difference between humans in the loop and human activity systems ■ Can explain the importance of human factors	■ Has contributed to analysis of human factors

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Systems Thinking or Introduction to Systems.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER – SYSTEM CONCEPTS

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify and manage complexity with appropriate techniques in order to reduce risk	■ Has carried out system partitioning on projects/programmes and can explain the choices made ■ Has used different simplification techniques and can discuss relative merits ■ Through use of simplification techniques appreciates that there are complexity overheads to partitioning and other forms of "simplifying" complexity	■ System studies tackling the issues of complexity and recommending suitable approaches
Able to predict resultant system behaviour	■ Has experience of predicting resultant system behaviour through e.g. modelling	■ Requirements for system modelling and validation exercises
Able to define system boundaries and external interfaces	■ Experience of defining system boundaries ■ Experience of defining external system interfaces	■ Validated system analysis ■ System definition document ■ System block diagram
Able to assess the interaction between humans and systems, systems and systems	■ Has performed human factors modelling/task analysis, ergonomic models or other modelling techniques ■ Has performed system analysis, simulation and modelling to determine and understand interactions between systems	■ System interface control document ■ Human factors analysis reports ■ HCI models ■ System analysis reports
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ System models ■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in System Concepts ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT – SYSTEM CONCEPTS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to review and judge the suitability of systems solutions and the planned approach	■ Experience of reviewing and advising based on a deep understanding of suitability of systems solutions	■ Acted as an internal or external consultant in the relevant areas	■ Has acted as System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching System Concepts ■ Can describe how they have been involved in the preparation and delivery of training material in System Concepts ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Customer/competitor accolades ■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel System Concepts techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in System Concepts ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel System Concepts techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/ introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe novel System Concepts techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in System Concepts ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel System Concepts techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA - Systems Thinking: Super System Capability Issues

Description:
An appreciation of the role the system plays in the super system of which it is a part.

Why it matters:
A system is not successful unless it meets the needs of the super system of which it is a part. Capturing the complete set of system requirements is not possible unless the context of the super system is fully appreciated. Failure to do this can result in sub-optimisation.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - SUPER SYSTEM CAPABILITY ISSUES

	Tell me About it (Overview) - Listen for...
Understands the concept of capability	■ Capability includes people, information, organisation, strategic goals and the technical systems etc. needed to achieve the aims of the super system owner ■ Explains the concept of capability and its relationship to system requirements ■ An appreciation of the hierarchy of systems
Understands that capability requirements can be satisfied by a system of systems approach	■ Can explain the term systems of systems ■ Understands that different organisations/teams may develop the individual systems
Understands that super system capability needs impact on the system development	■ Appreciation that there is interaction as well as interface, i.e. the system will affect the super system and vice versa ■ Understands that there are constraints/impacts on the system imposed by the super system
Appreciates the difficulties of translating super system capability needs into system requirements	■ Understands basic conceptual mapping between capability and lower level requirements ■ Appreciates the need for modelling/simulation in aiding the translation

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- Chapter 2 of *Systems Engineering Guidebook*, Martin, 1996.
- ISO/IEC 15288, 2008, section 5.1 & 5.2
- INCOSE Handbook V3.1, section 2.4

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - SUPER SYSTEM CAPABILITY ISSUES

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Can describe the environment and super system into which the system under development is to be delivered	■ Has identified the context in which a system of interest will operate and seen that as a super system ■ Recognises a need to watch out for downstream emergence	■ Has worked on a project/programme where the understanding of context is important
Identifies, with guidance, the super system capability issues which will affect the design of a system	■ Can identify the interfaces and interactions with the super system ■ Can map the affects of the system on the super system and vice versa ■ Appreciates that elements of the super system may be at different stages of the lifecycle	■ Has participated in team reviews of systems context definition

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Systems Thinking or Introduction to Systems.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - SUPER SYSTEM CAPABILITY ISSUES

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify the super System Capability Issues which will affect the design of a system and translates these into system requirements	■ Has identified the context in which the system must operate to achieve a specific super system capability ■ Has identified possible changing super systems contexts and has determined the affect on the design of the system ■ Has dealt successfully with a capability change issues ■ Understanding that capabilities identified or claimed at any level can conflict ■ Has produced translated requirements set against clear statements of capability	■ System requirements document ■ Minutes of user/system requirements reviews ■ Technical reports
Able to assess extent to which the proposed system solution meets the super system capability, and provide advice on trade-offs	■ Experience of assessing the extent to which the proposed system solution meets the super system capability, and provide advice on trade-offs	■ Trade study reports ■ Review evidence ■ Technical reports
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Super System Capability Issues
		■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SUPER SYSTEM CAPABILITY ISSUES

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has reviewed and advised on the suitability of systems solutions	■ Experience of reviewing and advising based on a deep understanding of a range of techniques for flowing capabilities down to requirements ■ Experience of reviewing and advising based on possession of both direct and indirect knowledge of the application of different techniques	■ Acted as an internal or external consultant in the relevant areas	■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Super System Capability Issues ■ Can describe how they have been involved in the preparation and delivery of training material in Super System Capability Issues ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation ■ Documented examples of the introduction of novel Super System Capability Issues techniques and can provide evidence of the improvement made.	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Super System Capability Issues techniques they have introduced and the improvements achieved. ■ Can describe instances of championing the introduction of novel techniques and ideas in Super System Capability Issues ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility). ■ Published articles or books etc. ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognised, as best practice ■ Member of industry working group concerning Super System Capability Issues (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc. ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA - Systems Thinking: Enterprise and Technology Environment

Description:
The definition, development and production of systems within an enterprise and technological environment.

Why it matters:
Systems Engineering is conducted within an enterprise and technological context. These contexts impact the lifecycle of the system and place requirements and constraints on the Systems Engineering being conducted. Failing to meet such constraints can have a serious effect on the enterprise and the value of the system.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - ENTERPRISE AND TECHNOLOGY ENVIRONMENT

	Tell me About it (Overview) - Listen for...
Aware of the influence the enterprise (environment, objectives, social, political, financial, cultural, research) has on the definition and development of the system	■ An understanding that influences may affect requirements ■ Understands the need to address influences with the agreement of stakeholders
Aware of the influence technology has on the definition and development of the system	■ Understands the risk of mandating a technology ■ Understands the risk of relying on technology innovation to provide solutions ■ Technology availability and maturity affects system development
Aware of the influence the system has on the enterprise	■ The system may have an effect on the enterprise (e.g. facilities, number of staff, etc.) ■ Effects may not be apparent in the early stages of system development
Aware of the influence the system has on technology	■ Understands that new systems (projects/programmes) either reinforce or broaden an enterprise's understanding of its technology base when in-sourced or do that for someone else when outsourced. – enterprise level strategic issue

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- Various sections in *The Technology Management Handbook*, Dorf, 1998.
- *Systems Thinking, Systems Practice,* Checkland, 1984.
- *Systems Thinking, Creative Holism for Managers*, Jackson, 2005
- INCOSE Handbook V3.1, section 6.2 and 6.3
- EIA 632 section 5

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - ENTERPRISE ANDTECHNOLOGY ENVIRONMENT

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Can identify, with guidance, the various enterprise issues (markets, products, policies, finance, technologies etc.) which interact with the system to be developed	■ Has an understanding of potential influences, how they have behaved in the past and behaviour predicted ■ Has an understanding of cultural barriers and norms when dealing with soft systems ■ Has a knowledge of appropriate methods and their actual or potential application to these issues ■ Enterprise issues include markets, products, policies, finance etc	■ Has contributed to analysis of one or more such issues as part of a project/programme ■ Has used one or more methods
Can contribute, with guidance, to the technology plan	■ Technology plans typically cover what technologies are required and how they are obtained ■ Able to identify various factors from technology ■ Able to identify specific influences on technology	■ Has read and understood a plan ■ Has contributed to a plan or taken part in analysis or other work contributing to a plan
Can contribute, with guidance, to the enterprise improvement plan	■ Enterprise improvement plans typically cover processes, tools and organisational capabilities ■ Able to identify blockers in the enterprise to systems development and how they may be fixed	■ Has read and understood a plan ■ Has contributed to a plan or taken part in analysis or other work contributing to a plan

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in the Business Environment and/or Technology management.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - ENTERPRISE AND TECHNOLOGY ENVIRONMENT

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Identifies the enterprise and technology issues which will affect the design of a system and translates these into system requirements	■ Examples of enterprise and technology issues that have been translated into requirements	■ Has written or supervised the production of system requirements that take enterprise and technology considerations into account
Able to produce and implement a technology plan that includes technology innovation, risk, maturity, readiness levels and insertion points	■ Knows how the issues addressed by the plan will impact at different levels and phases throughout the life cycle	■ Technology plan
Able to contribute to delivery of enterprise improvements to enable better system development	■ Can describe how they have identified or implemented changes to organisational practices	■ Enterprise improvement plan ■ Updated practices
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Enterprise and Technology Environment ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ENTERPRISE AND TECHNOLOGY ENVIRONMENT

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Influences and maintains the technical capability and strategy of their enterprise	■ Development of enterprise technology strategy ■ Knows the strategic importance of the make or buy decision ■ Looks at the implications with a programme of work, not just for a single project/programme	■ Successful projects/programmes with technology advances either in depth and/or broader application	■ Recognised as an Enterprise Asset by senior management in a large organisation
Recognised as an authority in technology planning and management	■ Knows in detail what the enterprise technical capabilities are and those of its competitors and collaborators ■ Give examples of successful strategies and enterprise growth	■ Successful projects/programmes with technology advances either in depth and/or broader application	■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Enterprise and Technology Environment ■ Can describe how they have been involved in the preparation and delivery of training material in Enterprise and Technology Environment ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ENTERPRISE AND TECHNOLOGY ENVIRONMENT

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Enterprise and Technology Environment techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Enterprise and Technology Environment ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Enterprise and Technology Environment techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc. ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognised, as best practice ■ Member of industry working group concerning Enterprise and Technology Environment (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc. ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Holistic Lifecycle View: Determining and Managing Stakeholder Requirements

Description:
To analyse the stakeholder needs and expectations to establish and manage the requirements for a system.

Why it matters:
The requirements of a system describe the problem to be solved (its purpose, how it performs, how it is to be used, maintained and disposed of and what the expectations of the stakeholders are). Managing the requirements throughout the lifecycle is critical for implementing a successful system.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Tell me About it (Overview) - Listen for...
Understands that there are different types of requirements e.g. functional, non functional, business etc.	■ The different types of requirements and an explanation of the needs for each type
Understands the need for good quality requirements	■ To understand what the customer wants ■ Reduces risk/uncertainty ■ Bad requirements make the job more difficult ■ Reduces ambiguity ■ So they can be tested
Able to identify major stakeholders	■ Customer ■ User ■ Legislation ■ Provider ■ Standards ■ Business ■ Sub-contractor supplier ■ Manufacturing ■ Employees ■ Local Community ■ Political/social ■ Etc.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Tell me About it (Overview) - Listen for...
Understands the importance of managing requirements throughout the lifecycle	■ Management of change/impact of change ■ Delivery against the agreed set of requirements ■ Maintain integrity ■ Reduce risk
Understands the need to manage all types of requirements	■ Understanding not just function and performance but also cost, schedule, quality, delivery, standards, packaging quantities, statement of work, documentation, etc.

Learning and Development

NB: Course in the process not driving a tool

- Typically part of an introduction to Systems Engineering Course or short Requirements Management Course
- *Systems Engineering, Coping with Complexity*, Stevens et al
- INCOSE Handbook, V3.1, section 4.2 and 4.3
- *Requirements Engineering: Process and Techniques* (Wiley Worldwide Series in Computer Science) by Gerald Kotonya
- *Mastering the Requirements Process* by Suzanne Robertson and James Robertson.
- EIA 632 section 4.3.1
- ISO 15288, 2008, section 6.4.1 and 6.4.2

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to identify all the stakeholders and their sphere of influence	■ Conduct stakeholder analysis ■ Identify indirect stakeholders (e.g. stakeholders in the product and process) ■ Social, political, Government, environmental, standards etc	■ Example of stakeholder identification e.g. Stakeholder map, matrix
Can support the elicitation of requirements from stakeholders	■ Use cases, scenarios, simulation etc. ■ QFD, questionnaires, workshops, etc.	■ Support of meetings, use of cases, scenarios, development of questionnaires ■ Identification of gaps, questions, traceability, coverage, constraints
Understands the characteristics of good quality requirements	■ Understands the need to manage transition to good quality requirements ■ Verifiable, unambiguous, complete, concise, consistent, etc	■ Examples of requirements documents
Understands methods used in requirements gathering	■ Elicitation methods, interviews, workshops, brainstorm, seminar, prototyping, demonstrations, standards ■ Understanding of bias and sampling ■ Check for completeness and follow up on an incomplete set of requirements	
Understands the need for traceability in the requirements process	■ Impact analysis ■ Ensures control of the system development ■ Ensure what is designed meets the requirements ■ Accountability and allocation of requirements ■ Provides consistency ■ Base lining of requirements	■ Examples of traceability matrix
Understands the relationship between requirements and acceptance	■ Payment, testable, Contract fulfilled ■ Fulfilment of user needs	■ Has produced a requirements acceptance matrix
Able to establish acceptance criteria for simple requirements	■ Acceptance criteria – test, analysis, similarity, demonstration	■ Has produced a requirements acceptance matrix
Understands the relationship between design and requirements	■ Requirements specify what is required ■ Design defines how the set of requirements may be implemented	

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Requirements Engineering

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Has successfully elicited and validated stakeholder requirements	■ Maintain a tolerance for ambiguity during stakeholder elicitation before selection of preferred solution ■ Resolution of conflict between different stakeholders for preferred solution ■ Experience of requirements validation	■ Stakeholder map ■ Independently assessed requirements specification ■ Requirements validation analysis
Has written good quality, consistent requirements	■ Can explain how to write good quality requirements	■ Independently assessed requirements specification
Able to derive requirements from analysis of the super system design	■ Describes the super system and interaction with the system of interest ■ Transition from user requirements to system requirements	■ Architectural models
Able to establish acceptance criteria for requirements for the system of interest	■ Experience of establishing acceptance criteria for interconnected requirements	■ Acceptance criteria
Able to resolve and negotiate requirement conflicts in order to establish a complete and consistent requirement set for the system of interest	■ Can describe experiences in resolving and negotiating requirement conflicts in order to establish a complete and consistent requirement set	■ Requirements trade study ■ Minutes of meetings e.g. design review
Identifies areas of uncertainty and risk when determining requirements	■ Management of risks and uncertainties pertaining to requirements	■ Risk register ■ Assumption analysis ■ Dependencies
Able to challenge appropriateness of requirements in a rational way	■ Experience of creating a constructive argument	■ Minutes of meeting
Able to define and document an approach for requirements elicitation and management	■ Effective, cost efficient, minimal set, elegant ■ The lifecycle of a requirements management spec – e.g. definition, baselines, handling changes	■ Requirements Management plan
Can assess the impact of changes to requirements on the solution and programme	■ Impact/traceability analysis ■ Identify the impact of change on requirements and the system	■ Impact/traceability analysis ■ Change requests
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Determining and Managing Stakeholder Requirements ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Acknowledged as an authority in the elicitation and management of requirements	■ Asked to: help with bids, review papers for conferences	■ Facilitation of requirements elicitation workshops	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Reviews and judges the suitability of the approach to requirements elicitation and management	■ Has reviewed requirements management plans ■ Can describe occasions where they have provided advice on requirements management strategies that has led to changes being implemented	■ Approved requirements management plan ■ Review comments	■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews and judges the suitability and completeness of the requirements set	■ Has reviewed requirements ■ Can describe occasions where they have provided advice on requirements suitability that has led to changes being implemented	■ Review comments ■ Requirements analysis	■ Recognised as an Enterprise Asset by senior management in a large organisation
Advises on the sensitive requirements negotiations on major programmes	■ Balanced, rational arguments on way forward ■ Holistic approach	■ Minutes of meetings ■ Establish and participate in communities of interest ■ Stakeholder approval of requirements	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - DETERMINING AND MANAGING STAKEHOLDER REQUIREMENTS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Determining and Managing Stakeholder Requirements ■ Can describe how they have been involved in the preparation and delivery of training material in Determining and Managing Stakeholder Requirements ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Determining and Managing Stakeholder Requirements techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Determining and Managing Stakeholder Requirements ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Determining and Managing Stakeholder Requirements techniques and can provide evidence of the improvement made. ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Architectural Design

Description:
The definition of the system architecture and derived requirements to produce a solution that can be implemented to enable a balanced and optimum result that considers all stakeholder requirements (business, technical….).

Why it matters:
Effective architectural design enables systems to be partitioned into realisable system elements which can be brought together to meet the requirements.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - ARCHITECTURAL DESIGN

	Tell me About it (Overview) - Listen for…
Understands the principles of architectural design and its role within the lifecycle	■ Defines the boundary of a system, identifies major interfaces to the system and allows functional analysis ■ Can associate the role of architectural design within the overall system lifecycle ■ Can describe the importance of architectural design (e.g. common vehicle for communication between stakeholders, allows quality attributes such as performance to be modelled, etc.) and understands the criteria for good design. ■ Can describe architecture in terms of a decomposition of a system into its components, their interrelationships and the constraints that apply
Aware of the different types of architecture	■ Recognises there is not a 'one size fits all' approach to architectural design ■ Can abstract a system into a structured representation (e.g. a complex weapon system, an IT system, etc.) ■ Types of architecture may include physical, logical, operational etc.
Aware that architectural decisions can constrain and limit future use and evolution	■ Limitations and constraints

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- *Systems Architecting*, Rechtin, 1991
- *The Art of Systems Architecting*, Maier & Rechtin, 2000
- INCOSE Handbook, V3.1, section 8.2
- ISO15288, 2008, section 6.4.3
- EIA 632 section 4.3.2

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - ARCHITECTURAL DESIGN

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to use techniques to support architectural design process	■ Can describe a traceable approach to architectural design. ■ Dealing with abstraction and the benefits of controlling complexity ■ Can distinguish between types of architectures ■ Can describe a set of architectural design principles ■ Can describe the advantages of a formal approach	■ Has contributed to developing architectures as part of the system engineering lifecycle ■ Has experience of using a set of architectural design principles
Able to support the architectural design trade-offs	■ Can describe architecture trade-offs in terms of finding an acceptable balance between constraints such as performance, cost and time parameters	■ Has participated in an architecture design review that has considered design trade-offs
Able to contribute to alternative architectural designs that are traceable to the requirements	■ Can describe the derivation of alternative architectural designs from a set of requirements ■ Appreciates the differences in architectural design considerations when following different approaches ■ Has an appreciation of the differences in approach and can describe the application of one of them	■ Can provide examples of an architectural design (conceptual, functional, logical and physical) to which they have contributed and can discuss the merits of the design chosen
Able to interpret an architectural design	■ Can describe the design and explain key features	■ Has contributed to a review of an architectural design

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Systems Engineering and Systems Design

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - ARCHITECTURAL DESIGN

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to generate alternative architectural designs that are traceable to the requirements	■ Can describe the derivation of alternative architectural designs from a set of requirements ■ Can explain the differences in architectural design considerations when following different approaches ■ Can describe the differences in approach and the application of them	■ Can provide examples of an architectural design (conceptual, functional, logical and physical) which they have produced and can discuss the merits of the design chosen
Able to assess a range of architectural designs and justify the selection of the optimum solution	■ Can perform architecture trade-offs in terms of finding an acceptable balance between constraints such as performance, cost and time parameters	■ Trade study showing alternatives and the solution selected ■ Architectural design document.
Able to define a process and appropriate tools and techniques for architectural design	■ Describes a process for architectural design ■ Can describe the use of architectural frameworks in assisting consistency and re-usability of architectural design ■ Can describe the use of an architectural design tool, methodology or modelling language ■ Can describe the advantages and limitations of the use of architectural design tools in relation to at least one tool	■ Authored architectural process definition and tool selection in a document such as SEMP, other project/programme plan or organisational process
Able to choose appropriate analysis and selection techniques	■ Has used techniques for analysing the effectiveness of a particular architectural solution and selecting the most appropriate solution ■ Can provide examples of using techniques such as: > Cost-benefit analysis > User panels > Multi-criteria decision analysis > Convergence criteria	■ Documented examples of using techniques such as: > Cost-benefit analysis > User panels > Multi-criteria decision analysis > Convergence criteria ■ Minutes of meetings, reports, design documents
Able to partition between discipline technologies and derive discipline specific requirements	■ Can provide examples of partitioning discipline technologies specific to their domain such as software, hardware, human factors, packaging, safety, etc.	■ Documented examples of partitioning
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Architectural Design ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ARCHITECTURAL DESIGN

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Can demonstrate a full understanding of architectural design techniques and their appropriateness, given the levels of complexity of the system of interest	■ Can describe a full range of architectural design techniques for a range of systems	■ Documented use of architectural design techniques such as: > Solution abstraction; > Clustering; > Interface minimisation; > Layering	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews and judges the suitability of architecture designs	■ Has reviewed architectural designs ■ Can describe occasions where they have provided advice on an architectural design that has led to changes being implemented ■ Can describe an architectural design approvals process	■ Can provide records of a review process in which they have been involved ■ Can provide evidence of an architectural design on which they have provided advice, can summarise the advice given and the resulting changes made ■ Can provide evidence of architectural design approvals in which they have been involved	■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Architectural Design ■ Can describe how they have been involved in the preparation and delivery of training material in Architectural Design ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ARCHITECTURAL DESIGN

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Architectural Design techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Architectural Design ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Architectural Design techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/ company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice. ■ Member of industry working group concerning Architectural Design (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Concept Generation

Description:
The generation of potential system concepts that meet a set of needs and demonstration that one or more credible, feasible options exist.

Why it matters:
Failure to explore alternative options may result in a non-optimal system. There may be no viable option (e.g. technology not available).

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - CONCEPT GENERATION

	Tell me About it (Overview) - Listen for...
Understands the need to explore alternative and innovative ways of satisfying the need	■ First idea isn't always the best ■ Alternatives for different needs ■ An 80% solution might be sufficient if the extra 20% costs the majority of the customer budget ■ Don't rely on adaptation of existing solutions ■ Words like; select, trade, solution space ■ Need to avoid cognitive bias or decision traps ■ Use of creative thinking techniques or formal design methodologies that aid in exploring solution space
Understands that alternative discipline technologies can be used to satisfy the same requirement	■ Different technologies might do the same thing but in a different way ■ Use of different technologies as an example – e.g. software vs. hardware,

Learning and Development

- Typically part of an introduction to Systems Engineering Course, could be a specific 'Creativity Techniques' course, possibly TRIZ or other technique
- INCOSE Handbook, V3.1, section 4.4
- EIA 632 section 4.3.2
- ISO 15288, 2008, Section 6.4.2

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - CONCEPT GENERATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Can contribute candidate concepts (no matter how radical)	■ Creativity techniques may include; brainstorming, lateral thinking, TRIZ ■ Research, data collection and analysis ■ Weird, radical ideas ■ Discover, invent	■ Evidence of using creativity techniques to generate concepts
Can support assessment of the feasibility of concepts	■ Assessment of concepts against requirement (selection criteria) ■ Feasibility of possible solutions ■ Concepts can address or create uncertainty	■ Participated in feasibility studies, trade studies, QFD

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Concept Generation

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - CONCEPT GENERATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Understands the strengths and weaknesses of relevant technologies in the context of the requirement	■ Trade studies, feasibility analysis, QFD & creativity techniques ■ Identify strengths and weaknesses of the concept against the requirements ■ Familiar with a number of different technologies	■ Written reports/papers drawing conclusions of trade studies, feasibility analysis, QFD & creativity techniques
Able to create and be open to a range of alternative and innovative interdisciplinary concepts	■ Creating alternative options against requirements ■ Doesn't immediately dismiss new ideas ■ Identifies new technologies ■ Listen for: Horizon scanning and technology watching	■ Reports/minutes of brainstorming sessions ■ Identified new technologies
Able to down select to a number of possible alternative options and demonstrate that credible, feasible options exist	■ Assess potential options against selection criteria ■ Down selection to a number of credible solutions ■ Justify selection in qualitative and quantitative terms ■ Trade-off studies, feasibility, risk, cost, schedule, technology requirements, human factors, -ilities etc. ■ QFD ■ Cost-benefit/effectiveness analysis	■ Trade study reports/conclusions ■ QFD analysis ■ Cost-benefit/effectiveness analysis
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Concept Generation ■ Evidence of assignment as a Mentor

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - CONCEPT GENERATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to guide and advise practitioners in techniques for Concept Generation	■ Defines the use of concept generation techniques ■ Guides and advises practitioners	■ Concept document	■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews down selected concepts for credibility, feasibility, etc.	■ Evaluated against the business and customer needs in order to weed out the non-starters and identify the best overall solution	■ Review comments	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Concept Generation ■ Can describe how they have been involved in the preparation and delivery of training material in Concept Generation ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Concept Generation techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Concept Generation ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Concept Generation techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - CONCEPT GENERATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Concept Generation (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc. ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Design for….

Description:
Ensuring that the requirements of all lifecycle stages are addressed at the correct point in the system design. During the design process consideration should be given to the design attributes such as manufacturability, testability, reliability, maintainability, safety, security, flexibility, interoperability, capability growth, disposal ,cost, natural variations etc.

Why it matters:
Failure to design for these attributes at the correct point in the development lifecycle may result in the attributes never being achieved or achieved at escalated cost.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - DESIGN FOR….

	Tell me About it (Overview) - Listen for…
Understands the need to design for the requirements of all lifecycle stages	■ Identify 'Design for…' attributes of a system within their domain. ■ Identify from later parts of the lifecycle those activities for which 'Design for…' expertise would be beneficial during the design phase ■ Can talk about the advantages of the left-shifted approach of considering such design attributes early on to mitigate against increased costs further downstream to account for the requirements associated with these attributes ■ Understands the importance of the whole lifecycle cost. ■ Understands the need for design trade-offs

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- INCOSE Handbook, V3.1, Section 4.11, 4.12 and 9
- EIA 632 section 4.3
- ISO 15288, 2008, section 6.4.10
- *Systems Engineering and Analysis*, Blanchard and Fabrycky

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - DESIGN FOR.....

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Can describe the design attributes and how they influence the design	■ Identification of generic 'design for…' attributes and those specific to their domain ■ Identifies which attributes are applicable	■ Participated in workshops for developing 'design for…' design attributes within a system development
Supports the identification and balancing of these design attributes throughout the design process	■ Understands the need of multidisciplinary system design team and can identify 'design for…' practitioners both generically and with reference to their own domain ■ Shows appreciation of the need to tailor such a team for different systems ■ Identifies which attributes are applicable	■ Been involved in a design when these attributes have been taken into account ■ Involvement in peer review of designs

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Design, Requirements capture, Lifecycle or Systems Engineering Management.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - DESIGN FOR....

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify and balance these design attributes throughout the design process	■ Identifying of 'design for...' design attributes within a system development ■ Interrelationship between attributes and how they affect each other ■ Balancing attributes to create an optimum design ■ Listen for: dependencies	■ Relevant section of Systems Engineering Management Plan or Systems Requirement Document ■ Relevant section of Systems Engineering Management Plan or other project/programme plans ■ Design notes and reports ■ Design decision logs
Able to work with appropriate specialists to ensure that the design effectively addresses these attributes at the correct time	■ Defining the members of a system design team at the appropriate phase in the lifecycle ■ Effectively communicating needs of the system to the specialists to enable the requirements of the 'design for...' attributes to be addressed ■ Effectively translating specialists requirements into system requirements ■ How the design has changed by considering design for attributes	■ Document or model showing abstraction of system in terms needed by specialists ■ Requirements document showing appropriate translation of specialists requirements into system requirements
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner'. ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Design For.... ■ Evidence of assignment as a mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - DESIGN FOR.....

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to review and judge the suitability of plans for the incorporation of all lifecycle design attributes at the correct point within the design process	■ Sitting on an oversight committee or similar body that deals with approval of such plans ■ Reviews and approves plans	■ Terms of Reference for and evidence of membership of an oversight committee	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Able to advise on complex issues and resolve conflicting design requirements	■ Formal decision making or trade-off studies with respect to design requirements	■ Authored report (or equivalent) of such a formal study	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Design For... ■ Can describe how they have been involved in the preparation and delivery of training material in Design For... ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Design For... techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Design For... ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Design For... techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc. ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - DESIGN FOR.....

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognised, as best practice ■ Member of industry working group concerning Design For... (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Functional Analysis

Description:
Analysis is used to determine which functions are required by the system to meet the requirements. It consists of the decomposition of higher-level functions to lower-levels and the traceable allocation of requirements to those functions.

Why it matters:
Functional Analysis is a way of understanding what the system has to do. Failure to carry out this activity may result in a solution that fails to meet its key requirements.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - FUNCTIONAL ANALYSIS

	Tell me About it (Overview) - Listen for...
Understands what Functional Analysis is	■ What the system has to do ■ Functional vs. non functional
Understands the need for Functional Models	■ Understands need to develop Functional Architecture ■ Understands the need to establish the system boundary ■ Understands that functional models take many forms – e.g.: Behaviour Diagrams, Context Diagrams, Control Flow Diagrams, Data Flow Diagrams, Data Dictionaries
Understands the relevance of the outputs from Functional Analysis and how these relate to the overall system design	■ Aware of Functional Analysis outputs; context diagrams, detailed specs, functional hierarchy, diagram functional matrix (N^2 diagram), functional flow block diagram etc. ■ An understanding that Functional Analysis identifies missing functional requirements and develops derived requirements ■ Realises that Functional Analysis helps identify poorly written/unrealistic requirements

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- Appendix A, *Systems Engineering and Analysis*, Blanchard and Fabrycky, 1990
- INCOSE Handbook, V3.1, section 4.3
- EIA 632 Requirement 17 (Logical Solution Representations)
- ISO 15288, 2008, section 6.4.2

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - FUNCTIONAL ANALYSIS

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to use appropriate tools and techniques to conduct Functional Analysis	■ Functional Architecture – hierarchy of decomposed functions ■ Decomposition to basic sub-functions ■ Development of definition of interfaces	■ Using appropriate tools and techniques e.g.: RDD 100; Rationale Rose, timeline analysis, N^2 , etc.
Has contributed to Functional Analysis activities	■ Can explain the elements of functional models ■ Can explain at least one functional model type and its application e.g.: behaviour diagrams, context diagrams, control flow diagrams, data flow diagrams, data dictionaries ■ Can describe Functional Analysis Outputs: context diagrams, detailed specs, functional hierarchy diagram, functional matrix (N^2 diagram), functional flow block diagram etc.	■ Examples of Functional Analysis models and diagrams

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Functional Analysis

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - FUNCTIONAL ANALYSIS

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to define the strategy and approach to be adopted for the Functional Analysis of the system	■ Has defined strategy and approach to Functional Analysis on specific projects/programmes ■ Describe the rationale for the choice (alternatives, criteria etc.)	■ Authored project/programme plan
Has performed Functional Analysis.	■ Can lead Functional Analysis activity on a project/programme ■ Has modelled system behaviour to derive requirements ■ Has generated low level functional requirements that remain solution free ■ Has maintained traceability between decomposed functionality and system requirements ■ Has experience of allocating functions to components in system architecture ■ Appropriate reuse of existing Functional Analysis models	■ Functional model elements
Able to define a process and select appropriate tools and techniques for Functional Analysis	■ Able to define a process that enables complete functional coverage ■ Can identify appropriate tools and techniques for each aspect of the required Functional Analysis	■ List of approved tools ■ Authored documents defining process
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Functional Analysis ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - FUNCTIONAL ANALYSIS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Can demonstrate a full understanding of the techniques and their appropriateness, given the levels of complexity of the system of interest	■ Can explain when and why to use behaviour diagrams, context diagrams, flow diagrams. transition diagrams, functional block diagrams etc	■ Authored project/programme plan or document	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews and judges the suitability of functional analyses	■ Sets local (company) policy for review process	■ Minutes of reviews ■ Policy documents developed	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Functional Analysis ■ Can describe how they have been involved in the preparation and delivery of training material in Functional Analysis ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Functional Analysis techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Functional Analysis ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Functional Analysis techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - FUNCTIONAL ANALYSIS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognised, as best practice ■ Member of industry working group concerning Functional Analysis (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Interface Management

Description:
Interfaces occur where system elements interact, for example human, mechanical, electrical, thermal, data, etc. Interface Management comprises the identification, definition and control of interactions across system or system element boundaries.

Why it matters:
Poor Interface Management can result in incompatible system elements (either internal to the system or between the system and its environment) which may ultimately result in system failure or project/programme overrun.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - INTERFACE MANAGEMENT

	Tell me About it (Overview) - Listen for...
Understands the need for Interface Management and its impact on the integrity of the system solution	■ Can describe what an interface is ■ Can describe interface stakeholders ■ Can describe the reason why management of interfaces is necessary ■ Can describe the importance of interface ownership ■ Can describe the potential impact on the system of failure to manage interfaces ■ Can describe the importance of configuration management when managing interfaces
Understands the possible sources of complexity in Interface Management, e.g. multinational programmes, multiple suppliers, different domains, novel technology, etc.	■ Can describe different types of interfaces across different domains (messages, electrical connections, mechanical, environmental etc.) ■ Can describe possible sources of complexity.

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- INCOSE Handbook, V3.1, section 4.3 and 4.4
- EIA 632 Requirement 12 (Control Process – Outcomes Management)
- ISO 15288, 2008, section 6.4.3

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - INTERFACE MANAGEMENT

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to follow interface management procedures	■ Can describe an interface management procedure / interface management plan ■ Contents of an interface management procedure may include: identification of interfaces, clear ownership, interface control document/specification, change and configuration management, coherence across system modelling	■ Has experience of using and following interface management procedures
Able to identify and define simple interfaces	■ Can identify interfaces for a simple system ■ Can describe simple interfaces ■ Definition of a simple interface may include; physical, electrical, thermal, data, environmental, noise, HCI etc. ■ Realisation of multiple aspects to even simple interfaces	■ Has participated in the identification and definition of simple interfaces

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Interface Management

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - INTERFACE MANAGEMENT

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to define a process and appropriate techniques to be adopted for the interface management of system elements	■ Can describe the steps necessary to define a process and appropriate techniques to be adopted for the interface management of system elements ■ Steps may include: establish context, identification of interfaces, identify stakeholders, establish ownership, define interface control document/specification, define change management ■ As above for models pertaining to the system development	■ Can provide examples of process and appropriate techniques adopted for the interface management of system elements
Able to identify, define and control system element interfaces	■ Has identified, defined and controlled system element interfaces e.g. identification of interfaces, identify stakeholders, establish ownership, define interface control document/specification, define change management	■ Can provide examples of identification, definition and control of system element interfaces
Able to describe the sources of complexity for the interface management of the system, e.g. multinational programmes, multiple suppliers, different domains, novel technology, etc.	■ Can describe the sources of complexity for the interface management of systems he has worked on possible examples include: > Multinational programmes – time zones, culture, language, perspectives, legislation > Multiple suppliers – communication, different contract types, interpretation of standards > Different domains – standards, culture, security, environment > Novel technology – not proven	■ Can provide examples of identification of the sources of complexity for the interface management of the system, e.g. multinational programmes, multiple suppliers, different domains, novel technology, etc.
Able to liaise and arbitrate where there are conflicts in the definition of interfaces	■ Able to describe conflicts in the definition of interfaces ■ Able to describe techniques used in liaison and arbitration	■ Can provide evidence of liaison and arbitration where there have been conflicts in the definition of interfaces
Able to identify consequences of changes to interfaces on the system elements, system and/or system of systems e.g. a change to a mechanical interface may impact thermal performance	■ Can describe how a change at one end of the interface can impact the other end ■ System performance may be affected by a change to an interface	■ Change notes to interface descriptions
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner'. ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Interface Management ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - INTERFACE MANAGEMENT

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has demonstrated expertise in Interface Management	■ Can describe a full range of Interface Management techniques for a range of systems ■ Can describe how management approach has varied for interfaces at different levels of the system, interface stakeholder communities and the nature of the system	■ Documented use of Interface Management techniques such as: > Service Level Agreements > Interface Control Documents System Level/Configuration Item Level > Interface Development Plans > Information Repositories > Interface Control drawings/models > Interface Emulators > Approval/Revision/Archiving > ICD Plan	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades ■ Has acted as a System Design Authority or System Technical Authority
Reviews and judges the suitability of Interface Management strategies	■ Has reviewed Interface Management strategies ■ Can describe occasions where they have provided advice on Interface Management strategies that has led to changes being implemented	■ Can provide records of a review process in which they have been involved ■ Can provide evidence of an Interface Management strategy on which they have provided advice, can summarise the advice given and the resulting changes made.	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to negotiate on the issues of interface complexity	■ Can describe negotiation on the issues of Interface Management complexity ■ Can describe negotiation on the issues of complex interfaces ■ Show how complexity was reduced through negotiation	■ Can provide records of a negotiation process in which they have been involved	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Interface Management ■ Can describe how they have been involved in the preparation and delivery of training material in Interface Management ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - INTERFACE MANAGEMENT

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Interface Management techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Interface Management ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Interface Management techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice.	■ Can describe activities that have been adopted by others, or recognised, as best practice. ■ Member of industry working group concerning Interface Management (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design - Maintain Design Integrity

Description:
Ensuring that the overall coherence and cohesion of the "evolving" design of a system is maintained, in a verifiable manner, throughout the lifecycle, and retains the original intent.

Why it matters:
Failure to maintain design integrity throughout the lifecycle can result in a system that fails to meet its stakeholder requirements, contains unnecessary design features or exhibits unexpected behaviours.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - MAINTAIN DESIGN INTEGRITY

	Tell me About it (Overview) - Listen for...
Understands the need to maintain the integrity of the design	■ Assists robustness ■ Reduces risk/uncertainty at acceptance ■ Reduces ambiguity ■ Can reduce unexpected behaviours ■ Can reduce unexpected design features ■ Can give early indication of future development problems ■ Can identify variance/inconsistency early ■ Can describe margins

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- INCOSE Handbook, V3.1, section 4.3 and 5.7
- EIA 632 Requirement 10 (Progress against Requirements)
- ISO 15288, 2008, section 6.3.5

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - MAINTAIN DESIGN INTEGRITY

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Ability to track specific aspects of the design to the original intent	■ Bi-directional traceability of requirements to design ■ Examples of tracking criteria include parameter budgets, measures of performance, measures of effectiveness etc. ■ Understands the need for baselines, design reviews etc.	■ Traceability matrix
Supports remedial actions and change control	■ Can explain monitoring and measuring techniques ■ Change management and non conformance control	■ Can provide examples on a recent project/programme or activity
Understands the process of change control and configuration management	■ Aspects of configuration management are management planning, configuration item identification, change control, status accounting and auditing	■ Can provide examples on a recent project/programme or activity

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Design

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - MAINTAIN DESIGN INTEGRITY

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify parameters to track critical aspects of the design	■ Produce or approve and maintain; internal ICD, performance models for key user requirements, behaviour model for system and subsystems, parameter budgets, HCI and ergonomic models, WLC model, safety case etc	■ Periodic project/programme reviews with parameter tracking ■ SEMP outlining metrics to be tracked
Relates the current design to the original intent throughout the supply chain	■ Bi-directional traceability ■ Flow down of requirements as parameter budgets through the physical architecture and the reconciliation with actuals as the design evolves ■ Monitor and review progress against allocated budgets ■ Perform and document design reviews ■ Monitors stability of system assumptions ■ Analyse limiting and out of spec scenarios as well as nominal ones to assure system robustness, dependability, graceful degradation ■ Maintenance of appropriate margins	■ Review minutes ■ Budget allocation tables with margin
Takes remedial actions in the presence of inconsistencies	■ Take or propose appropriate corrective or contingent action ■ Review and update the plan and process ■ Management of margins	■ Updated plans, budgets
Able to establish a system which allows the tracking of specific aspects of the design	■ Can develop a process for maintaining integrity, e.g. information management process	■ Information management process
Able to manage and trade technical margins both horizontally and vertically through the hierarchy	■ Establish and maintain parameter budgets ■ Collaborative relationships with suppliers to control and manage subsystem margin ■ Establish and maintain performance budgets	■ Collaborative agreements ■ Budget allocation tables with margin
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Maintaining Design Integrity ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - MAINTAIN DESIGN INTEGRITY

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Reviews and judges the suitability of the complete set of critical parameters that allows the tracking of the system design	■ Has established policy for this activity ■ Identify critical parameters, identify measurement method, establish control values, determine process for managing inconsistencies	■ Policies ■ Set of measures	■ Has acted as a System Design Authority or System Technical Authority ■ Recognised as an Enterprise Asset by senior management in a large organisation
Influences system trade-offs	■ Advises projects/programmes on making good decisions to re-balance requirement allocation if any development activity is unable to meet its requirements ■ Can describe occasions where they have provided advice on system trade-offs that has led to design changes being implemented whilst maintaining original intent	■ System trade studies ■ Minutes of meetings ■ Reviews ■ Design documentation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise on the allocation of technical margins	■ Experience of setting appropriate technical margin levels over several projects/programmes	■ SEMPs ■ Minutes of meetings ■ Technical reports ■ Budget history	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Maintaining Design Integrity ■ Can describe how they have been involved in the preparation and delivery of training material in Maintaining Design Integrity ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - MAINTAIN DESIGN INTEGRITY

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Maintaining Design Integrity techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Maintaining Design Integrity ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Maintaining Design Integrity techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc. ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognised, as best practice ■ Member of industry working group concerning Maintaining Design Integrity (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Modelling and Simulation

Description:
Modelling is a physical, mathematical, or logical representation of a system entity, phenomenon, or process.
Simulation is the implementation of a model over time. A simulation brings a model to life and shows how a particular object or phenomenon will behave.

Why it matters:
Modelling and Simulation provides an early indication of function and performance to enable risk mitigation as well as supporting the verification and validation of a solution. Modelling and Simulation also allows the exploration of scenarios outside the normal operating parameters of the system.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - MODELLING AND SIMULATION

	Tell me About it (Overview) - Listen for...
Understands the need for system representations	■ Allows early understanding of the system ■ Complexity and cost of implementation. ■ The need to perform trials and "what ifs" ■ Virtual systems and demonstrators ■ Interactions, interfaces, boundaries and flow diagrams
Understands the scope and limitations of models and simulations, including definition, implementation and analysis	■ There are different types of models ■ They are abstractions ■ Models and simulations contain assumptions and approximations (garbage in, garbage out) ■ Real-time and iterative simulations ■ Models can be hierarchical ■ Models and simulations need to be validated to an appropriate level ■ All models are wrong, some models are useful
Understands the different types of modelling and simulation	■ Can name different types of modelling and simulation e.g. live, virtual, constructive.

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- INCOSE Handbook, V3.1, section 9.4 & Appendix L2
- EIA 632 Requirement 23 (Systems Analysis Process – Trade-off Analysis)
- ISO 15288, 2008, section 4.3

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - MODELLING AND SIMULATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to use modelling and simulation tools and techniques to represent a system or system element	■ Right choice of model and/or simulation tool, e.g. exploratory/fitted, specific/general, numerical/analytical, deterministic/stochastic, discrete/continuous, quantitative/qualitative ■ Right choice of model – cost vs. value ■ Importance of the integrity of the model interface to the system ■ Criticality of the sub system being modelled or simulated ■ Criticality of the results of the sub system being modelled or simulated	■ Operating a model and/or a simulation
Understands the risks of using models and simulations which are outside the validated limits	■ Validity of the result is in question ■ Awareness of the number of iterations required ■ Assumptions and approximations made	■ Has identified the risks associated with the validity of the results ■ Presented the results in the context of the system

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Modelling and Simulation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - MODELLING AND SIMULATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to define an appropriate representation of a system or system element	■ Identifying the systems' constituents ■ Identifying the appropriate models and simulation tools, e.g. exploratory/fitted, specific/general, numerical/analytical, deterministic/stochastic, discrete/continuous, quantitative/qualitative ■ Re-use of existing models and simulations when appropriate ■ Define the interfaces and translate the interface data appropriately ■ Right choice of model – cost vs. value ■ Criticality of the sub system being modelled or simulated ■ Criticality of the results of the sub system being modelled or simulated	■ Rationale for model selection
Has used appropriate representations of a system or system element in order to derive knowledge about the real system	■ Experience of modelling systems or system elements ■ Ability to link multi-functional / multi-level models of (sub)systems ■ Ability to integrate models within "real" systems	■ Validation of model results against actual performance ■ Use of appropriate validated model
Able to implement the strategy and approach to be adopted for the modelling and simulation of a system or system element	■ Optimum choice of model(s) ■ Exploit/manipulate the flexibility of available models ■ Manage the limitations of models and simulations	■ Project/programme documentation, modelling reports, reviews
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Modelling and Simulation. ■ Evidence of assignment as a Mentor

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - MODELLING AND SIMULATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Demonstrates a full understanding of complex simulations for a system or system element	■ Ability to propose/envisage scenarios for validation of simulation	■ Technical document detailing consistent, validated performance	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise on the suitability and limitations of models and simulations	■ Identifying the risks and limitations of models and simulations	■ Documented advice of adoption / rejection of models and simulations	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to define the strategy and approach to be adopted for the modelling and simulation of a system or system element	■ Experience in defining the strategy and approach to be adopted for the modelling and simulation of a system or system element i.e. > How the model will be used > What will be modelled > How will the results influence the design ■ Experience in selecting type of model ■ Ability to reuse and manipulate models effectively and confidently	■ SEMP or modelling plans ■ Published work	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Modelling and Simulation ■ Can describe how they have been involved in the preparation and delivery of training material in Modelling and Simulation ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - MODELLING AND SIMULATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Modelling and Simulation techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Modelling and Simulation ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Modelling and Simulation techniques and can provide evidence of the improvement made. ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility). ■ Published articles or books etc. ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Modelling and Simulation (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc. ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Design – Select Preferred Solution

Description:
A preferred solution will exist at every level within the system and is selected by a formal decision making process.

Why it matters:
At some point in the development lifecycle a single solution must be identified in order to engineer it. Determination of a "preferred" solution which best matches the diverse requirements is critical to achieving stakeholder satisfaction.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - SELECT PREFERRED SOLUTION

	Tell me About it (Overview) - Listen for...
Understands the need to select a preferred solution	■ Baseline solution needs to be selected and communicated to the development team to allow continuation to the next systems engineering process
Understands the relevance of comparative techniques (e.g. trade studies, make/buy, etc.) to assist decision processes	■ Formal processes used to enable the decision making process and aid in arriving at a preferred solution. ■ Should talk about trade studies, make/buy, cost/benefit analysis, Quality Function Deployment (QFD) or other formal decision making processes ■ Understands the difference between 'musts' and 'wants'

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- Chapter 12 of *Successful Systems Engineering*, Reilly
- Chapter 3 of *The New Rational Manager*, Kepner and Tregoe.
- INCOSE Handbook, V3.1, section 5.5
- ISO/IEC 15288, 2008, section 6.3.3
- EIA 632 Requirement 18 (Solution Definition Process – Physical Solution Representations)

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - SELECT PREFERRED SOLUTION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to participate in the selection of preferred solutions	■ Formal Design trade-off/decision-making methods ■ Criteria selection, weighting and scoring ■ Difference between must and wants ■ Risk analysis of candidate solutions ■ Cost analysis of candidate solutions	■ Contributing to a formal decision making process where a preferred solution was selected ■ Contributing to the definition of selection criteria as part of a decision making process ■ Carrying out cost analysis as part of a decision making process ■ Carrying out risk analysis as part of a decision making process

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Selecting Preferred Solutions

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - SELECT PREFERRED SOLUTION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to define selection criteria, weightings of the criteria and assess potential solutions against selection criteria	■ Carrying out a formal decision making process where a preferred solution was selected ■ Defining selection criteria as part of a decision making process, e.g. technology requirements, off-the-shelf availability, competitive considerations, performance assessment, maintainability, capacity to evolve, standardisation considerations, integration concerns, cost, schedule, etc ■ Weighting of selection criteria ■ Carrying out cost analysis as part of a decision making process ■ Carrying out risk analysis as part of a decision making process	■ Authored output from the decision making process
Able to choose the appropriate tools and techniques for selecting the preferred solution, e.g. trade analysis, make/buy analysis	■ Choosing an appropriate tool/technique for selecting a preferred solution e.g. trade studies, make/buy, cost/benefit analysis, Quality Function Deployment (QFD) or other formal decision making processes	■ SEMP
Able to perform trade analysis and justify the result chosen in terms that can be quantified and qualified	■ Producing business case or report based on outputs of trade analysis	■ Authored output from trade analysis
Able to negotiate trades	■ Presenting trade alternatives to relevant stakeholders and reaching a consensus agreement on the preferred solution	■ Minutes of meeting describing decision made
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Select Preferred Solution ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SELECT PREFERRED SOLUTION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to guide and advise practitioners in techniques for selection of preferred solutions	■ Has experience in guiding and advising practitioners in techniques for selection of preferred solutions	■ Documented evidence in guiding and advising practitioners in techniques for selection of preferred solutions	■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews selected solutions and the criteria for selecting the solution .	■ Critical analysis of third party decisions and their selection method	■ Authored report outlining such a review	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Able to act as an arbitrator in marginal cases	■ Has arbitrated on marginal decisions	■ Meeting minutes or report outlining role as arbitrator	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to carry out sensitivity analysis on selection criteria	■ Sensitivity analysis on selection criteria and producing a report on this analysis	■ Authored report of sensitivity analysis	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to negotiate complex trades	■ Presenting complex trade alternatives to relevant stakeholders and reaching a consensus agreement on the preferred solution	■ Authored report of complex trade analysis	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Select Preferred Solution ■ Can describe how they have been involved in the preparation and delivery of training material in Select Preferred Solution ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SELECT PREFERRED SOLUTION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Select Preferred Solution techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Select Preferred Solution ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Select Preferred Solution techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Select Preferred Solution (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: System Design: System Robustness

Description:
A robust system is tolerant of misuse, out of spec scenarios, component failure, environmental stress and evolving needs.

Why it matters:
A robust system gives greater availability in practice.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - SYSTEM ROBUSTNESS

	Tell me About it (Overview) - Listen for...
Understands how the design, throughout the lifecycle, affects the robustness of the solution	■ Understands relationship between design and lifecycle ■ Robustness has to be designed in ■ Understands that robustness affects reliability ■ Understands that human factors are likely to play a part in the ultimate robustness of a system (both explicitly in a system containing humans and through human involvement in the systems engineering process)
Aware of analytical techniques and the importance of design integrity, legislation, whole life costs and customer satisfaction	■ Appreciates that there are many drivers in determining the necessary level of robustness for a system ■ Aware of a number of techniques for analysing system robustness Reliability Block Diagrams, Fault Trees, Reliability Models, FMECA, FMEA, Problem/failure reports, etc.

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- INCOSE Handbook, V3.1, section 4.11 and 8.3
- EIA 632 section – Requirement 14 (Requirements Definition Process – Acquirer Requirements)

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - SYSTEM ROBUSTNESS

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to use tools and techniques to ensure delivery of robust designs	■ Understands a number of techniques for analysing system robustness Reliability Block Diagrams, Fault Trees, Reliability Models, FMECA, FMEA, Problem/failure reports, etc.	■ Use of techniques for analysing system robustness
Able to support robustness trade-offs	■ Robustness Trade-Offs may be required to address inconsistencies between cost, schedule, performance, safety, through life costs	■ Supports trade-off activities that affect robustness ■ Documents agreed trade-offs in project/programme documentation
Understands the relationship between reliability, availability, maintainability and safety	■ Reliability and maintainability affect availability, ■ Reliability affects safety	■ Availability, reliability, maintainability and safety calculations

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in System Robustness

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - SYSTEM ROBUSTNESS

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to define the strategy and approach to be adopted for ensuring system robustness	■ Has defined strategy and approach on specific projects/programmes	■ Independently assessed documentation defining the strategy and approach to be adopted for ensuring system robustness
Able to select the appropriate techniques for ensuring system robustness	■ Has selected appropriate techniques for ensuring system robustness ■ Explains why a particular technique is appropriate	■ Independently assessed documentation selecting the appropriate techniques for ensuring system robustness
Understands the operational environment and underlying domain specific issues related to robustness	■ Can describe the operational environment and underlying domain specific issues related to robustness.	■ Independently assessed documentation describing the operational environment and underlying domain specific issues related to robustness
Able to perform robustness trade-offs	■ Has performed ARMS analysis ■ Has performed robustness trade-offs ■ Has participated in analysis where robustness trade-offs have occurred	■ Independently assessed robustness trade-off report
Able to use scenarios to determine robustness.	■ Has used scenarios and can explain how they have contributed to the determination of robustness	■ Independently assessed scenarios for determination of robustness
Able to specify procurement of system elements in terms of reliability, availability, maintainability and safety	■ Has identified ARMS requirements for system elements based on system analysis ■ Has specified procurement of system elements in terms of reliability, availability, maintainability and safety	■ Independently assessed procurement specifications of system elements in terms of reliability, availability, maintainability and safety ■ ARMS system analysis reports
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner'. ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development.	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in System Robustness. ■ Evidence of assignment as a Mentor

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SYSTEM ROBUSTNESS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to predict evolving needs and their impact on the system	■ Understands how evolving needs may impact on the system ■ Experience of implementing robustness to meet a predicted evolving need	■ Documentation of complete prediction of evolving needs and their impact on the system ■ Review comments ■ Documented advice	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Reviews and advises on trade-offs between non-functional requirements, cost and schedule	■ Has a deep understanding of a range of techniques for performing trade-offs ■ Possesses both direct and indirect knowledge of the application of different techniques	■ Acted as an internal or external consultant in the relevant areas	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Able to define scenarios to determine robustness	■ Has a deep understanding of a range of techniques for selecting and defining scenarios for determining robustness ■ Possesses both direct and indirect knowledge of the application of different techniques for selecting and defining scenarios for determining robustness	■ Acted as an internal or external consultant in the relevant areas	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching System Robustness ■ Can describe how they have been involved in the preparation and delivery of training material in System Robustness ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SYSTEM ROBUSTNESS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel System Robustness techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in System Robustness ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel System Robustness techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning System Robustness (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Holistic Lifecycle View: Systems Integration and Verification

Description:
Systems Integration is a logical process for assembling the system. Systems Verification is the checking of a system against its design – "did we build the system right?" Systems integration and verification includes testing of all interfaces, data flows, control mechanisms, performance and behaviour of the system against the system requirements; and qualification against the super system environment (e.g. Electro Magnetic Compatibility, thermal, vibration, humidity, fungus growth, etc).

Why it matters:
Systems Integration has to be planned so that system elements are brought together in a logical sequence in order to avoid wasted effort.
Systematic and incremental integration and verification makes it easier to find, isolate, diagnose and correct problems. A system or system element that has not been verified cannot be relied on to meet its requirements. Systems Verification is an essential prerequisite to customer acceptance and certification.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - SYSTEMS INTEGRATION AND VERIFICATION

	Tell me About it (Overview) - Listen for...
Understands the importance of verification against the system requirements	■ The system should be verified against the requirements (system not customer requirements) in order to ensure that the specified design requirements are fulfilled by the system
Understands the need to integrate the system in a logical sequence	■ Integration is conducted using a progressive, logical process of assembling system elements, evaluating them then assembling the next level (system build) ■ Alternative integration sequences may be assessed in order to define the most appropriate sequence in terms of overall cost and risk (this means that the integration sequence should not necessarily be based on a success assumed process) ■ If integration is performed in the wrong sequence re-work and extra cost may be incurred (dependency on suppliers, development, new technology, obsolescence, etc.)
Aware of the need to plan for Systems Integration and verification	■ Planning for integration and verification should occur at the beginning of the project/programme ■ Failure to plan could result in a delay to integration and verification; procedures may not be written, the sequences may not have been defined and the environment may not be available ■ The integration sequence should be documented ■ To identify the resources, equipment and develop test requirements (influence the design)
Aware of the relationship between verification and acceptance	■ A system may be verified against the requirements but may not be accepted by the customer as fit for purpose ■ Verification evidence may support acceptance ■ May have built the system right but it may not be the right system

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- *System Validation and Verification* (J. O. Grady)
- INCOSE Handbook, V3.1, section 4.5, 4.6, 4.7 and 8.10
- ISO 15288, 2008, section 6.4.5 and 6.4.6
- EIA 632 Requirements 30 – 32 (System Verification Process)

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - SYSTEMS INTEGRATION AND VERIFICATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to conduct system integration and test according to the plan	■ Can confirm readiness for integration (elements have passed their tests, certificate of conformity received for COTS products etc.) ■ Can confirm readiness of integration and test environment (test equipment, tools, procedures, sequence etc.) ■ Can follow an integration or test procedure and identify non conformances against the plan	■ Has run system integration and verification tests
Able to write an integration and verification plan for a small non-complex system	■ Planning should cover establishing the integration sequence, the environment and approach.	■ Has written or contributed to an integration and/or verification plan
Able to diagnose simple faults, document, communicate and follow up corrective actions	■ Can identify where results differ from those expected ■ Can record faults appropriately (process, tools used, method) ■ Can investigate simple faults in a logical manner and initiate the corrective action process ■ Can record the corrective action taken and close the outstanding fault log	■ Has diagnosed simple faults ■ Has used the appropriate process, tool etc. to record faults

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in System Integration and Verification.

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - SYSTEMS INTEGRATION AND VERIFICATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to trace verification requirements back to system requirements and vice versa	■ Can describe the approach used for tracing verification requirements to system requirements	■ Traceability matrix
Able to write an Integration and Verification plan for a complex system, including identification of method and timing for each activity	■ Can explain the different verification methods and how/when/why to select the most appropriate method (test, analysis, inspection, similarity, comparison etc.) ■ Can define detailed integration sequences and the readiness criteria for each system element ■ Can produce an integration and test schedule showing dependencies of each activity (critical path analysis) ■ Can define the integration and test environment required, including outsourcing of qualification tests as required.	■ Verification matrix ■ Integration plan/schedule ■ Verification plan/schedule
Can demonstrate effective management of systems integration and verification activities	■ Can explain the management of integration and verification activities, including appropriate reviews e.g. test readiness review ■ Can describe any problems and how they were overcome (problems with schedule, lateness of equipment etc.)	■ Integration and verification measures showing actual performance against plan ■ Minutes of test readiness review including relevant action log
Able to write detailed integration and verification procedures	■ Can write integration and verification procedures that relate directly to the requirements (design and system) ■ Writes clear, concise instructions for the activities to be performed, pre-requisites, the expected outcome and action in case of a failure	■ Approved integration procedures ■ Approved verification procedures ■ Verification matrix
Able to diagnose complex faults, document, communicate and follow up corrective actions	■ Can identify where results differ from those expected ■ Can record faults appropriately (process, tools used, method) ■ Can investigate complex faults in a logical manner and contributes to corrective actions ■ Can record the corrective action taken and close the outstanding fault log ■ Can handle consequences of corrective action (re-planning, re-test etc.)	■ Fault logs ■ Corrective actions ■ Minutes of fault analysis meetings

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - SYSTEMS INTEGRATION AND VERIFICATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to plan and prepare evidence for customer acceptance and certification	■ Can identify what evidence is required for customer acceptance and certification and ensure production of evidence is in integration and verification plans	■ Traceability matrices ■ Compliance/verification matrices ■ Test reports ■ Certification data package ■ Acceptance data package
Able to identify the integration and verification environment	■ Can identify the facilities to be used. Consideration should be given to the size of the area, furniture required, power requirements, the IT requirements and the security of the facility ■ Can identify external test facilities that may be used ■ Can identify any bespoke tools and equipment that are required for integration, e.g. simulators, emulators etc. ■ Can identify resources and skills required	■ Integration and Verification plans ■ Procurement of equipment
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Integration and Verification ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SYSTEMS INTEGRATION AND VERIFICATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Acts as an authority in the development of systems integration and verification strategies.	■ Can describe the attributes of a successful integration and verification strategy in the context of the project/programme /domain/business ■ Can describe typical risks and mitigation techniques	■ Integration and verification strategies that proved successful	■ Has acted as a System Design Authority or System Technical Authority ■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews and judges the suitability of systems integration and verification plans	■ Asked to review project/programme integration and verification plans from across the organisation	■ Review comments	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to lead complex systems integration and verification activities	■ Can describe typical approaches to complex integration and verification activities and give examples of own experience	■ Integration and verification measures showing actual performance against plan	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Integration & Verification ■ Can describe how they have been involved in the preparation and delivery of training material in Integration and Verification ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - SYSTEMS INTEGRATION AND VERIFICATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Integration and Verification techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Integration and Verification ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Integration and Verification techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Integration and Verification (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Holistic Lifecycle View – Validation

Description:
Validation checks that the operational capability of the system meets the needs of the customer/end user – "Did we build the right system?"

Why it matters:
Validation is used to check the system meets the needs of the customer/end user.
Failure to satisfy the customer will impact on future business. Validation provides some important inputs to future system development.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - VALIDATION

	Tell me About it (Overview) - Listen for...
Understands the purpose of validation	■ Understands that validation comprises 'product' validation i.e. the product satisfies user needs in operation and 'requirements' validation i.e. set of system requirements meets the user needs ■ Understands the role of validation is to reduce the risk of system failure to an acceptable level. ■ Can distinguish between verification activities, which address whether a system has been built correctly in accordance with the system requirements, and validation, which addresses whether the correct system has been built against the user needs ■ Understands that validation activities should be undertaken by someone different from the people who designed and built the system
Aware of the need for early planning for validation	■ Can explain the need for early planning ■ Can describe the system engineering activities associated with validation in relation to a chosen lifecycle model ■ Can describe the reasons why every user need should have an associated validation activity ■ Understands the need to plan for the validation of the system in the correct operational environment wherever practicable (or through simulated environments where that is impracticable)

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- *System Validation and Verification* (J. O. Grady)
- INCOSE Handbook, V3.1, section 4.9
- ISO15288, 2008, section 6.4.8
- EIA 632 section 4.5.2 and 4.5.4

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - VALIDATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to conduct system validation activities according to the plans	■ Can describe validation activities undertaken ■ Can describe the inputs required to undertake validation activities	■ Has experience of undertaking testing, analysis, inspection, demonstration, stimulation and simulation activities, such as operational/user trials and testing ■ Has experience of using design documentation, prototypes, final products and systems documentation for validation activities
Able to collate validation results	■ Can describe the process of collation and presentation of validation data ■ Can describe how to handle exceptional and unexpected data ■ Can describe methods of monitoring system performance	■ Has experience of collating and presenting validation data ■ Can describe methods for handling exceptional and unexpected data

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Systems Validation.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - VALIDATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to focus on customer needs and able to communicate in the terminology of the customer/user	■ Has captured customer needs and produced the associated validation test requirements ■ Has used methods for translating validation plans into test scripts that the customer understands	■ Can present validation plans and discuss how they were carried out ■ Validation requirements ■ Test scripts ■ Validation test reports ■ Validation cross reference matrix
Able to trace validation requirements back to user needs and vice versa	■ Has maintained forward- and backward-traceability between customer requirements and validation test requirements ensuring integrity has been maintained	■ Validation cross reference matrix
Able to write validation plans for a complex system, including identification of method and timing for each activity	■ Has written a validation plan and can describe the rationale behind its detail ■ Has considered the depth of testing required for validation and has planned accordingly ■ Can discuss the content of a validation test plan they have written including, for example: objectives, conditions, priorities, schedules and responsibilities, tools, facilities, procedures and standards to be applied, and the success criteria to be applied, etc. ■ Can discuss the need to plan to capture the appropriate degree of evidence (for example, safety critical software requires a greater degree of validation than non-safety critical)	■ Validation plan

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - VALIDATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to write detailed validation procedures	■ Has developed (or used) scenarios for a basis of planning validation activities and has agreed the use of these scenarios with the users ■ Has developed a process for requirements validation to provide early assurance that requirements will meet customer, end user and stakeholder requirements ■ Has identified pass/fail criteria for validation tests, maintaining the link to the appropriate user requirement (while understanding that the two need to be developed together) ■ Has identified validation strategies and test cases ■ Can discuss techniques for requirements validation, for example: requirements analysis, exploration of requirements adequacy and completion, assessment of prototypes, stimulations, simulations, models, scenarios and mock-ups ■ Can discuss the construction of validation test cases, covering, for example: doing things wrong, using the system in the wrong way, doing nothing, doing too little, doing too much, etc. ■ Can discuss the implementation of test strategies such as, for example: top-down, bottom-up, thread testing, stress testing, etc.	■ Validation scenarios ■ Validation procedures ■ Validation test documentation
Has demonstrated effective management of system validation activities	■ Has monitored and controlled a successful system validation programme ■ Has established a validation test organisation ■ Has identified passed and failed items and taken corrective action to make the failed items conform to requirements ■ Has implemented a procedure for identifying unambiguously the inspection and test status of system components being validated including provision for quarantine status ■ Has identified and used validation test tools	■ Organisational structures ■ Management documentation e.g. metrics etc.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - VALIDATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to assess validation results	■ Has specified the validation records that need to be created and kept ■ Has used statistical techniques to demonstrate sufficient and necessary validation activities have taken place ■ Has related validation results back to the user needs ■ Can provide evidence of validation records and can explain the rationale behind the data collection, for example: they provide evidence that a test has been conducted and the data can be used for trend analysis, etc.	■ Validation records
Able to plan and prepare evidence for customer acceptance	■ Has planned and prepared evidence for customer acceptance ■ Has developed a systematic method for classifying the results of validation test reports ■ Can provide evidence of customer acceptance reviews and associated planning activities ■ Can provide evidence of devising and using a validation test results classification method, for example: pass, mild deficiency, annoyance, catastrophic, etc.	■ Minutes of customer acceptance reviews
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Validation ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - VALIDATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Acts as an authority in the development of validation strategies	■ Has advised others on their validation strategies ■ Others seek their advice on validation strategies	■ Documented advice on validation strategies to others that has been implemented	■ Has acted as a System Design Authority or System Technical Authority ■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to write validation plans for a highly complex system	■ Has written validation plans for highly complex systems	■ Validation plans that they have authored and have been successfully implemented	■ Recognised as an Enterprise Asset by senior management in a large organisation
Reviews and judges the suitability of validation plans	■ Has reviewed and approved validation plans for highly complex systems	■ Evidence of review and approval of validation plans	■ Has acted as a System Design Authority or System Technical Authority ■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to lead the validation activity	■ Has led a validation activity for a highly complex system	■ Evidence of leading validation activities, for example job specifications, minutes of meetings, etc.	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise the customer on validation issues	■ Has advised customers on their validation requirements and issues	■ Evidence of advice to customers on validation issues, for examples letters, e-mails etc.	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Conducts the sensitive negotiations in the terminology of the customer/end user	■ Has successfully conducted sensitive negotiations on a highly complex system making limited use of specialised, technical terminology	■ Evidence of sensitive negotiations taking account of customer's background and knowledge, for example in minutes of meetings, position papers, e-mails, etc.	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - VALIDATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Validation ■ Can describe how they have been involved in the preparation and delivery of training material in Validation ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Validation techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Validation ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Validation techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility). ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Validation (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA - Holistic Lifecycle View: Transition To Operation

Description:
Transition to Operation is the integration of the system into its super system. This includes provision of support activities for example, site preparation, training, logistics, etc.

Why it matters:
Incorrectly transitioning the system into operation can lead to misuse, failure to perform, and customer/user dissatisfaction. Failure to plan for transition to operation may result in a system that is delayed into service/market with a consequent impact to the customer. Failure to satisfy the customer will impact on future business.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - TRANSITION TO OPERATION

	Tell me About it (Overview) - Listen for...
Aware of the need to carry out 'Transition to Operation'	■ Achieve user satisfaction in operation ■ Sustained use of the system ■ There is a transition phase between completion of development/production and readiness for use ■ Transition into service
Aware of the type of activities required for transition to operation	■ The system is ready for installation, delivery and use ■ The system has to be supported in operation ■ The people are trained ■ Provision of guides, manuals, demonstrations, instructions etc. ■ Consideration for packaging, storage, export controls etc.

Learning and Development
- Typically part of an introduction to Systems Engineering Course
- *Integrated Logistics Support handbook* – James V. Jones
- EIA 632 section 4.4.2
- ISO 15288, 2008, section 6.4.7
- INCOSE Handbook, V3.1, section 4.8 and 4.10

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - TRANSITION TO OPERATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to plan simple transition to operation activities	■ Enabling products ■ Shipping and storage ■ Preparation of sites where end products will be stored, installed, used, maintained or serviced ■ Delivering the system at the correct location and time ■ System commissioning ■ Service level agreement ■ Training ■ In use support and maintenance	■ Has experience of transition planning
Able to conduct 'transition to operation' activities according to a plan	■ Can describe transition to operation for a simple system according to the plan (as described above)	■ Has participated in the transition to operation of a system
Aware of the system's contribution to the super system	■ Knows what to supply for the transition of the system into the next level up	■ Has participated in transitioning a system into operation within a super system

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Transitioning Systems into Operation.

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - TRANSITION TO OPERATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to communicate in the terminology of the user	■ Can describe why using the terminology of the user is important ■ Can describe how the system is used by the operator	■ Manuals, guides etc. written in the vocabulary of the user
Understands the system's contribution to the super system	■ Has identified the context in which a system of interest will operate and seen that as a super system ■ Can identify the interfaces and interactions with the super system ■ Can map the effects of the system on the super system and vice versa	■ Transition plan ■ Operations plan
Able to plan and oversee a transition to operation activity	■ Gives examples of project/programme activities and their contribution to the success of the transition ■ Describes the steps in transitioning to operation of a successful past project/programme ■ Has planned and overseen a transition to operation activity ■ Has produced a transition to operation plan	■ Project/programme Transition to Operation authored plans and reviews
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development.	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/programme showing responsibility for managing those involved in Transition to Operation ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - TRANSITION TO OPERATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to plan and oversee highly complex transition to operation activities	■ Describes experience in transition to operation for highly complex systems, e.g. adverse conditions, highly political, multi national, very large scale, replacing legacy systems, technically complex	■ Transition Plan or other project/programme engineering plans ■ Transition Completion Reports	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has successfully transitioned a system to operation	■ Responsible for System Transitions to Operation	■ System being used successfully for the required period of time	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Transition to Operation ■ Can describe how they have been involved in the preparation and delivery of training material in Transition to Operation ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process. ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Transition to Operation techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Transition to Operation ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Transition to Operation techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - TRANSITION TO OPERATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Transition to Operation (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Systems Engineering Management: Concurrent Engineering

Description:
Managing concurrent lifecycle activities and the parallel development of system elements.

Why it matters:
Systems engineering lifecycles involve multiple, concurrent processes which must be coordinated to mitigate risk and prevent nugatory work, paralysis and a lack of convergence to an effective solution. Concurrency may be the only approach to meeting customer schedule or gaining a competitive advantage. Performance can be constrained unnecessarily by allowing individual system elements to progress too quickly.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - CONCURRENT ENGINEERING

	Tell me About it (Overview) - Listen for...
Aware that lifecycle activities and the development of systems elements can occur concurrently	■ Different aspects developed concurrently ■ Multidisciplinary team ■ Development moves forward over diverse range of disciplines ■ Development moves forward over diverse range of teams ■ For concurrent design the focus is on the design part of the lifecycle ■ Overlap between SE processes ■ Practical implementation of the concept of left shift with regard to resources
Aware of the advantages and disadvantages of concurrency	■ Reduced development time in an attempt to reduce cost ■ Reduced development time and hence 'time to market' ■ Optimised solution through increased communication ■ Compromise design through lack of in depth analysis time ■ Increased Risk ■ Need for increased management vigilance ■ Need for efficient information control infrastructure

Learning and Development

- Typically part of a Systems Engineering Management Course.
- Chapter 7 of *Successful Systems Engineering*, Reilly, 1992.
- Chapter 8 of *Systems Engineering*, Stevens et al., 1998.
- INCOSE Handbook, V3.1, section 5.2 and 6.4
- ISO 15288, 2008, section 5.2
- EIA 632 6.1.2.3, 6.3 and Annex B

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - CONCURRENT ENGINEERING

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Able to describe the systems engineering lifecycle processes that are in place on their programme	■ Task interdependencies ■ Configuration control ■ Interface definition ■ Communication across multidisciplinary design team	■ Identify concurrent engineering tasks ■ Identifying base-lining milestones and describing the significance to associated tasks ■ Identifying task interdependencies
Able to support co-ordination of concurrent engineering activities	■ Control of schedule ■ Interdependencies between tasks ■ Effective flow of information across team	■ Scheduling multiple concurrent tasks

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in concurrent Engineering or Engineering Management.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - CONCURRENT ENGINEERING

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify which system elements can be developed concurrently	■ Scheduling engineering tasks concurrently ■ Identifying task dependencies and relationships ■ Can define inputs and outputs of system development tasks	■ Project/programme schedules showing concurrent engineering tasks
Able to manage the interactions within a systems engineering lifecycle	■ Configuration management ■ Interface management ■ Dealing with change requests that effect interfaces or system performance ■ Task tracking and progress monitoring ■ Design review strategy (when to hold reviews and maturity of artefacts)	■ Configuration control plan ■ Interface Control Document ■ Schedule for base-lining or interface definition milestones in a project/programme schedule ■ Evidence of identifying task performance or schedule variance and appropriate intervention
Has co-ordinated concurrent activities and dealt with emerging issues	■ Interface control ■ Dealing with change requests that effect interfaces or system performance ■ Resource budget ■ Performance budget	■ Resource budget and evidence of the management of this ■ Performance budget and evidence of the management of this
Able to contribute to the Systems Engineering Management Plan	■ Engineering processes ■ Lifecycle identification and tailoring ■ Interface definition ■ System budgets (resource and performance) ■ Concurrent design	■ Example of authored SEMP with identification of section relating to dealing with concurrent engineering
Able to advise on concurrency issues and risks	■ Maintenance of design integrity ■ Change control ■ Configuration management ■ Interface management ■ Technical performance measures ■ System resource budgets	■ Technical notes, reports, e-mail highlighting individual issues or the generic issues and risks ■ Periodic project/programme reports showing awareness of and highlighting these issues and risks
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Concurrent Engineering ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - CONCURRENT ENGINEERING

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Known as an authority in systems engineering management	■ Authority in Concurrent Design / Engineering ■ Authority in Concurrent Design Facilities	■ Published papers in refereed journals ■ New facility supporting concurrent engineering	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to develop new strategies for concurrent engineering	■ Develop new strategies in concurrent engineering ■ Develop new facilities/infrastructure	■ Published papers in refereed journals ■ New facility supporting concurrent engineering	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Able to advise customers and senior programme managers on concurrency issues and risks.	■ Advise customers and senior programme managers on concurrency issues and risks	■ Meeting minutes or report showing authored advice	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Reviews and judges the suitability of Systems Engineering Management Plans	■ Advises on suitability of SEMP or sections of SEMP relevant to Concurrent Engineering	■ Sign-off on multiple SEMPs	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - CONCURRENT ENGINEERING

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Able to influence the implementation of concurrent engineering within the enterprise	■ Recommends use of Concurrent Engineering to senior programme managers ■ Recommends use of specialised facility to aid Concurrent Design	■ Meeting minutes or report showing authored recommendation	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Concurrent Engineering ■ Can describe how they have been involved in the preparation and delivery of training material in Concurrent Engineering ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Concurrent Engineering techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Concurrent Engineering ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Concurrent Engineering techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Concurrent Engineering (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Systems Engineering Management: Enterprise Integration

Description:
Enterprises can be viewed as systems in their own right in which systems engineering is only one element. System Engineering is only one of many activities that must occur in order to bring about a successful system development that meets the needs of its stakeholders. Systems engineering management must support other functions such as Quality Assurance, Marketing, Sales, and Configuration Management, and manage the interfaces with them.

Why it matters:
As enterprises become larger, more complex and the functions within the enterprise more insular, the interdependencies between the functions should be engineered using a systems approach at an enterprise level to meet the demands of increased business efficiency.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - ENTERPRISE INTEGRATION

	Tell me About it (Overview) - Listen for...
Is aware that an enterprise is a system in its own right	■ Analogies between systems and the business infrastructure ■ The importance / relevance of interfaces, processes and methodologies governing operations ■ Influences and interactions ■ Organisational culture
Is aware that other functions of the enterprise have inputs to and outputs from the systems engineering process	■ Relationships and interfaces. ■ Outputs and dependencies from systems engineering process to other functions ■ Inputs and dependencies to systems engineering process from other functions ■ Models and frameworks ■ Allocation of functions and responsibilities ■ Gate review processes and peer assessment

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- *Project Management: A systems approach to planning, scheduling and controlling* – Harold Kerzner, 2006
- *Systems Thinking, Systems Practice*, Checkland
- *Systems Thinking, Creative Holism for Managers*, Jackson
- INCOSE Handbook, V3.1, section 5.8, 6.2, 6.3 and 6.5
- EIA 632 section 5 and Annex B

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - ENTERPRISE INTEGRATION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Understands the other functions (e.g. Quality Assurance, Marketing, Sales, Strategic Management, Configuration Management, Research, Human Resources) and relationships that make up an enterprise	■ Enterprise models, architectures and frameworks in the context of processes and functional entities ■ The business/enterprise infrastructure and how information is disseminated and co-ordinated ■ Management of interactions between functions	■ Engagement and team building ■ Planning and task allocation
Able to manage the creation of systems engineering products required by other functions	■ Reporting formats and processes ■ Information exchange and dissemination ■ Shared working environments and tools	■ Has had responsibility for managing the creation of systems engineering products required by other functions

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Knowledge Management Techniques, Project/Programme Management, Reporting Processes and Information Delivery.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - ENTERPRISE INTEGRATION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to manage the relationship between the systems engineering function and other elements of the enterprise	■ Brokerage across the functions of the enterprise ■ Management of information and/or knowledge	■ Resolution of conflict ■ Allocation of tasks ■ Information on time and to the right place.
Able to identify systems engineering products required by other functions and vice versa	■ Identifying the role of each function ■ Clarifying the interfaces between the functions ■ Determining the products required	■ Task / resource maps ■ Plan of information flow to/from other functions
Able to use systems engineering techniques to contribute to the definition of the enterprise	■ Use of systems concepts and system design techniques ■ Integrating functions across the enterprise	■ Enterprise models / architectures and frameworks
Able to identify the constraints placed on the systems engineering process by the enterprise	■ Clarifying the boundaries within the enterprise and the resultant framework of operation	■ List of constraints (non-functional requirements on a system)
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/programme showing responsibility for managing those involved in Enterprise Integration ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ENTERPRISE INTEGRATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Acts as a consultant on business organisations	■ Carried out business organisation analysis ■ Has created a system model of the enterprise	■ Enterprise model ■ Minutes of meetings creating the model	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise on the effectiveness of the enterprise as a system	■ Efficiency programmes and enterprise related process improvements	■ Process improvement plans and quantitative results	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to review the impact of systems engineering capability within a business context	■ Business function agility and responsiveness ■ Definition and evaluation of Metrics	■ Metrics trends and evidence of review ■ Take-up ■ Continuity	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to review the impact of inputs from other functions on the systems engineering process	■ Analysis of impact and appropriate response ■ Enhanced and more efficient interactions and integration of the “separate” functions	■ Impact analysis ■ Report showing uptake of recommendations of analysis ■ Time saving and/or quality of the delivery	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Enterprise Integration ■ Can describe how they have been involved in the preparation and delivery of training material in Enterprise Integration ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - ENTERPRISE INTEGRATION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Enterprise Integration techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Enterprise Integration ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Enterprise Integration techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Enterprise Integration (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Systems Engineering Management: Integration of Specialisms

Description:
Coherent integration of Specialisms into the project/programme at the right time. Specialisms include Reliability, Maintainability, Testability, Integrated Logistics Support, Producability, Electro Magnetic Compatibility, Human Factors and Safety.

Why it matters:
Specialsms support the systems engineering process by applying specific knowledge and analytical methods from a wide variety of disciplines to ensure the resulting system is able to meet its stakeholder needs. The technical effort of Specialisms must be integrated in terms of time and content to ensure project/programme goals are met and the outputs generated add value commensurate with their costs.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - INTEGRATION OF SPECIALISMS

	Tell me About it (Overview) - Listen for...
Aware of the different specialisms	■ Can define a specialism ■ Can give examples of specialisms
Aware of the importance of integrating specialisms into the project/programme and that this is a potential source of conflict.	■ Can explain what is meant by integration of specialisms ■ Can explain the types of conflict that may occur ■ Identifies the practical implementation of the concept of left shift with regard to resources
Understands that the specialisms can affect the cost of ownership	■ Can explain that different implementation levels of some specialisms (such as availability, reliability, etc.) may affect the cost of ownership (total costs of delivered solution)

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- *Designing Team-Based Organisations* – Albers Mohmann et al, 1995
- INCOSE Handbook, V3.1, section 5.2, 6.5 and 6.6
- EIA 632 section 4.4.3 and requirement 10

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - INTEGRATION OF SPECIALISMS

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Understands the role and purpose of the specialisms	■ Understands that there are areas of expertise that need greater depth of knowledge than in the core team ■ Advances in specialisms may give market advantage ■ Early involvement of specialisms may reduce cost and timescales by avoiding later problems ■ Some specialisms may be key design drivers, such as safety	■ Has worked in an interdisciplinary team including specialisms
Able to work with appropriate specialists to support trade-offs	■ Understands the motivation of specialists (empathises with the viewpoint of the specialist) ■ Has sufficient knowledge to appreciate what specialists are saying. ■ Is able to explain to specialists the need for compromise	■ Has worked in an interdisciplinary team including specialisms

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Systems Management and an Overview of some Specialisms (as listed in Description).

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - INTEGRATION OF SPECIALISMS

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to manage the integration of specialisms within a project/programme	■ Has integrated specialisms into the team ■ Has managed interfaces between specialist and the rest of the team	■ SEMP, WBS, task/resource map ■ Project/programme example
Able to conduct trade-offs involving conflicting demands from the specialisms	■ Can implement a trade-off study ■ Can demonstrate the implications of conflicting demands to meeting requirements	■ Demonstrate use of trade-off tools ■ Issue resolution ■ Trade study
Understands how the specialisms affect the cost of ownership	■ Can explain that different implementation levels of some specialisms (such as availability, reliability, etc.) may affect the cost of ownership (total costs of delivered solution)	■ Whole life cost model
Able to identify the constraints placed on the system development by the needs of the specialisms	■ Can define design constraints ■ Can give examples of limits imposed on system development	■ Limits imposed on system development
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Integration of Specialisms. ■ Evidence of assignment as a Mentor

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - INTEGRATION OF SPECIALISMS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Understands primary tasks of each specialism	■ Can explain primary tasks of reliability, maintainability etc. ■ Can demonstrate advances in a specialist area and how this feeds through to system advancement	■ Project plans for specialist area	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Has successfully applied integration principles across a number of specialisms	■ Has shown integration across a large number of specialisms, particularly where some of these are outside the expert's background knowledge	■ Project documentation in the specialist area	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to resolve conflicts involving specialisms	■ Can demonstrate resolution of conflict	■ Minutes of meetings	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to estimate the combined effect of the specialisms on the cost of ownership and the system development	■ Examples of the estimating combined effect of the specialisms on the cost of ownership and the system development ■ Can explain that different implementation levels of some specialisms (such as availability, reliability, etc.) may affect the cost of ownership (total costs of delivered solution)	■ Whole life cost models	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Able to advise on the organisation of specialist functions	■ Shown leadership in decisions on investment in specialist areas, particularly when this affects competing specialisms ■ Ensure that specialisms are integrated into the system development in a coherent and timely way and that they address the relevant issues	■ Correspondence containing advice	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - INTEGRATION OF SPECIALISMS

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has coached new practitioners in this field.	■ Can describe how they have been involved in coaching Integration of Specialisms ■ Can describe how they have been involved in the preparation and delivery of training material in Integration of Specialisms ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Integration of Specialisms techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Integration of Specialisms ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Integration of Specialisms techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/ introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Integration of Specialisms (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

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COMPETENCE AREA – Systems Engineering Management: Lifecycle Process Definition

Description:
Lifecycle Process Definition establishes lifecycle stages and their relationships depending on the scope of the project/programme, super system characteristics, stakeholder requirements and the level of risk. Different system elements may have different lifecycles.

Why it matters:
Lifecycle forms the basis for project/programme planning and estimating. Selection of the appropriate lifecycles and their alignment has a large impact on and may be crucial to project/programme success. Ensuring co-ordination between related lifecycles at all levels is critical to the realisation of a successful system.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - LIFECYCLE PROCESS DEFINITION

	Tell me About it (Overview) - Listen for...
Aware of the different types of systems lifecycles	■ Typical system lifecycles include: > Acquisition (Concept, assessment, demonstration, manufacture, In-service and disposal) > Product (Concept, development, production, utilisation, support, retirement)
Aware of the different types of lifecycle models	■ Lifecycle models include Waterfall, Spiral, Iterative , Incremental, Evolutionary
Understands the need to define an appropriate lifecycle process model	■ Project/programme vs. product lifecycle ■ Characteristics that affect project/programme lifecycle models include size of project/programme, experience of staff, cycle time, acceptable defect levels ■ Appropriate lifecycle processes can be defined by tailoring standard processes

Learning and Development

- Typically part of an introduction to Systems Engineering Course
- *Introduction to Systems Engineering,* by Sage and Armstrong - Chapter 2 'Methodological Frameworks and Systems Engineering Processes'
- *Advanced Systems Thinking, Engineering and Management,* by Hitchens - Chapter 6 Systems Lifecycle Theory
- INCOSE Handbook, V3.1, section 3, 6.4 and 10
- EIA 632 section 6.3 and Annex B
- ISO 15288, 2008, section 5.3 and Annex A, C and D

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - LIFECYCLE PROCESS DEFINITION

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Understands systems engineering lifecycle processes.	■ Systems engineering lifecycle processes typically include: Requirements capture, requirements analysis, design, build, integration, verification, validation, operation and disposal ■ Understands how the system engineering lifecycle process relates to the whole project/programme lifecycle	■ Has worked on projects/programmes that follow a typical systems engineering lifecycle ■ Has carried out work on some of the system engineering lifecycle processes (for example competencies within 'Holistic Lifecycle View')
Able to support lifecycle definition activities.	■ Flexibility in tailoring is required to address variables such as nature of the customer, cost, schedule, quality of trade-offs, technical difficulty, and experience of the people implementing the process ■ Understands the implications of the chosen lifecycle definition within the enterprise ■ The integrated project/programme team should be involved in tailoring the process	■ Supports facilitation of process tailoring ■ Documents agreed tailoring in project/programme plans
Able to describe the systems engineering lifecycle processes that are in place on their project/programme.	■ Systems engineering lifecycle processes for projects/programmes are typically defined in the project/programme plans (e.g. SEMP) ■ An explanation of the system lifecycle and why the processes were selected ■ An explanation of the sub processes and key review gates	■ Has carried out work on some of the system engineering lifecycle processes (for example competencies within 'Holistic Lifecycle View')

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in System Process and Programme Lifecycle Definition.

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - LIFECYCLE PROCESS DEFINITION

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to identify the project/programme, enterprise and technology needs that affect the definition of the lifecycle	■ Factors that affect definition of lifecycle include; customer programme lifecycle, complexity of the system, stability of requirements, milestone and delivery dates, technology insertion/readiness, standards, internal policy and process requirements, product lifecycle, availability of tools	■ Defines/advises on suitability of system and programme lifecycles ■ Leads/facilitates process tailoring on projects/programmes
Able to influence the lifecycle of related super system elements	■ Can describe the related super system elements and their lifecycles ■ Can describe the dependencies, constraints and risks on the target system	■ Minutes of meetings with the Customer discussing super system and system lifecycles ■ Documentation of dependencies, constraints and risks of differing lifecycles
Able to identify dependencies and align the lifecycles of different system elements	■ Identifies system elements and their lifecycles ■ Can describe the dependencies, constraints and risks on the system elements	■ Documentation of the complete system lifecycle.
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Lifecycle Process Definition ■ Evidence of assignment as a Mentor

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - LIFECYCLE PROCESS DEFINITION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Acts as an authority on lifecycle definitions and the implication of the lifecycle on the project/programme	■ Describes how system and programme lifecycles were improved as a result of input	■ Documentation of complete programme lifecycles	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Has acted as a System Design Authority or System Technical Authority
Able to resolve conflicts between lifecycles	■ Understands how separate lifecycles inter-relate ■ Describes how conflict has been resolved in past experience	■ Review comments ■ Documented advice	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Reviews and judges the suitability of the definition of multiple concurrent lifecycles	■ Asked to review programme lifecycles and process tailoring	■ Review comments	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise programme management on the implication of lifecycle issues including project/programme and commercial	■ Asked to review programme lifecycles and process tailoring ■ Written a peer-reviewed paper on…	■ Review comments ■ Documented advice	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has successfully determined and documented lifecycles matched to the needs of the project/programme	■ Defined SE lifecycles	■ Documentation of SE lifecycles on many occasions	■ Recognised as an Enterprise Asset by senior management in a large organisation

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - LIFECYCLE PROCESS DEFINITION

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Lifecycle Process Definition ■ Can describe how they have been involved in the preparation and delivery of training material in Lifecycle Process Definition ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Lifecycle Process Definition techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Lifecycle Process Definition ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Lifecycle Process Definition techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/ company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Lifecycle Process Definition (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc ■ Ideas assimilated into International standards	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Guide to Competency Evaluation

COMPETENCE AREA – Systems Engineering Management: Planning, Monitoring and Controlling

Description:
Establishes and maintains a systems engineering plan (e.g. Systems Engineering Management Plan) which incorporates tailoring of generic processes .The identification, assessment, analysis and control of systems engineering risks. Monitoring and control of progress.

Why it matters:
It is important to identify systems engineering needs and coordinate activities through planning. The alternative to planning is chaos.
Failure to plan and monitor prevents adequate visibility of progress and, in consequence, appropriate corrective actions may not be identified and/or taken when the project/programme's performance deviates from that required.

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE
Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

AWARENESS - PLANNING, MONITORING AND CONTROLLING

	Tell me About it (Overview) - Listen for...
Understands the importance of planning, monitoring and controlling systems engineering activities	■ Plans are required to define project/programme activities ■ Plans are based on project/programme requirements, statements of work and estimates of effort and cost ■ Monitoring and control is required to provide an understanding of the project/programme's progress so that appropriate corrective actions can be taken when progress deviates from the plan ■ Failure to plan, monitor and control significantly increases risk and will probably lead to schedule and cost overrun ■ Systems engineering planning is typically documented in a Systems Engineering Management Plan (SEMP) ■ The relationship between the SEMP and the project/programme management plan should be clearly understood
Understands that change is inevitable and so needs to be carefully managed	■ Describes where and when change can occur in the lifecycle ■ Describes the elements of change management

Learning and Development
- Typically part of an Project/programme Management Course
- INCOSE Handbook, V3.1, section 5.2, 5.3, 5.4, 5.4, 6.5 & 8.6
- ISO 15288, 2008, section 6.3.1, 6.3.2, 6.3.4, 6.3.7
- EIA 632 section 4.2, Annex D and Annex E

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POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

SUPERVISED PRACTITIONER - PLANNING, MONITORING AND CONTROLLING

	Tell me About it (Explain and Understand Why). Listen For...	Experience of Doing /Contributing
Understands the role of systems engineering planning as part of an overall project/programme plan	■ Can explain how the systems engineering lifecycle relates to the project/programme lifecycle (see Lifecycle Process Definition competency) ■ Can explain the relationship between the SEMP and other project/programme plans ■ Typical sections in the SEMP include; definition of SE processes, integration of the systems engineering effort, responsibilities/ organisation of the systems team, technical reviews, systems schedule, systems engineering performance measures etc.	■ Contributing towards writing a SEMP or relevant section of a project/programme management plan
Able to monitor progress against the systems engineering plan	■ Progress and performance are monitored periodically at planned intervals ■ The following aspects are monitored; project/programme performance measures (schedule, cost, quality etc.), adequacy of team responsibilities/organisation, adequacy of project/programme's supporting infrastructure, adherence to processes ■ Appropriate measures should be used to monitor progress. Understands that different measures will provide information in different areas	■ Collects and collates data on project/programme performance measures (technical & programmatic)
Able to assist in the management of systems engineering risks	■ Identifies potential sources of risk ■ Monitors risk mitigation actions to closure ■ Can explain the stages in risk management	■ Assists in running a risk management activity
Able to assist in the management of systems engineering changes	■ Documents changes accurately ■ Identifies all artefacts affected by the change	■ Configuration/change records

Education

Has undertaken relevant education and demonstrated application of knowledge, e.g. Degree, Masters, Diploma that included a module in Project/Programme Management.

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - PLANNING, MONITORING AND CONTROLLING

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to plan systems engineering activities as part of an overall project/programme plan	■ Using estimates of effort and cost, statements of work and requirements to create a systems engineering plan ■ Integrates a systems engineering plan into the overall project/programme plan and any associated issues ■ Defines the systems engineering lifecycle to be used	■ SEMP
Able to identify, assess, analyse and control systems engineering risks	■ Applying the typical steps in a risk management process; planning, risk identification, risk assessment, risk reduction strategies/fall back plan, implementation of chosen strategy (risk mitigation actions etc.), quantitative assessment, risk monitoring ■ Running a risk management activity; gives examples of typical systems engineering risks, mitigation actions and outcomes ■ Handling risks that occurred but were not identified. Understands why they were not identified	■ Systems engineering risk register ■ Risk management plan ■ Minutes of risk review meetings
Able to anticipate, identify, assess, analyse and control systems engineering changes	■ The steps for effective management of system change ■ Ensuring all artefacts affected by the change are adequately updated ■ Identifying system baselines	■ Configuration/change records
Able to influence project/programme management in order to secure the systems engineering needs of the project/programme	■ Negotiating with project/programme management; what are the issues, what was the outcome? ■ Understand the roles and responsibilities of systems engineering and project/programme management	■ Before and after project/programme plans etc. ■ Minutes of project/programme review meetings

Guide to Competency Evaluation

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

PRACTITIONER - PLANNING, MONITORING AND CONTROLLING

	Experience of doing (relevant and recent) (Tell me your experience in ...)	Objective Evidence
Able to control systems engineering activities by applying necessary corrective actions	■ Defining appropriate project/programme performance measures and sets threshold limits for expected values ■ Analysing project/programme performance measures, defining corrective actions and tracking to closure when actual values deviate from those expected ■ Using historic, quantitative data from past projects/programmes to predict current project/programme performance	■ Project/programme quantitative management plan ■ Project/programme performance measures (run charts, control charts, Pareto analysis, root cause analysis etc.) ■ Evidence of project/programme tracking, e.g. updated Gantt chart, updated plans etc.
Able to tailor systems engineering processes to meet the needs of a specific project/programme	■ See Lifecycle Process Definition competency ■ Tailoring systems engineering processes to meet the needs of your project/programme. Can explain the process and comment on successes and issues ■ Factors that affect tailoring include customer programme lifecycle, complexity of the system, stability of requirements, milestone and delivery dates, technology insertion/readiness, standards, internal policy and process requirements, product lifecycle, availability of tools	■ Tailored systems engineering processes on a specific project/programme
Able to guide supervised practitioner	■ Can describe how they have supervised or mentored a 'supervised practitioner' ■ Can describe the activities they have supervised and the impact they have had on the supervised practitioner in terms of continual professional development	■ Examples of on the job training objectives/guidance etc. ■ Organisational Breakdown Structure for System Development/Project/Programme showing responsibility for managing those involved in Planning, Monitoring and Controlling ■ Evidence of assignment as a Mentor

Competency Evaluation Tables

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - PLANNING, MONITORING AND CONTROLLING

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has successfully planned, monitored and controlled complex systems engineering activities	■ Describes the steps in planning, monitoring and controlling a successful past project/programme ■ Gives examples of project/programme performance measures used and why they were useful ■ Describes how predictive measures were used to keep the project/programme on track	■ SEMP or project/programme management plan ■ Project/programme Status Reports ■ Project/programme graphs showing performance measures e.g. defect containment by phase, Schedule performance index etc.	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades ■ Has acted as a System Design Authority or System Technical Authority
Reviews and judges the suitability of systems engineering plans	■ Asked to review project/programme SEMPs from across the organisation	■ Review comments	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to advise on systems engineering risks and their mitigation	■ Asked to review project/programme risk registers ■ Describes how suggested mitigation actions were successful	■ Update to risk register showing changes to risks and/or mitigation actions ■ Minutes of risk review meetings	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to define appropriate generic systems engineering processes for the enterprise	■ Describes how systems engineering processes were defined	■ Systems engineering processes that have been adopted by the enterprise	■ Recognised as an Enterprise Asset by senior management in a large organisation
Able to influence the relationship between systems engineering and project/programme management at the enterprise level	■ Facilitates/reviews project/programme process tailoring to ensure the systems engineering process meets the needs of the project/programme and vice versa	■ Examples of improvements to project/programme planning, monitoring and control due to intervention	■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has coached new practitioners in this field	■ Can describe how they have been involved in coaching Planning, Monitoring and Controlling ■ Can describe how they have been involved in the preparation and delivery of training material in Planning, Monitoring and Controlling ■ Can describe how they have provided workshops/seminars at conferences etc.	■ Can provide examples of the coaching activities and the outcome of the process ■ Formal training courses and authored training material supported by successful post-training evaluation data ■ Listed as an approved trainer in the organisation	■ Recognised as an Enterprise Asset by senior management in a large organisation

Competency Evaluation Tables

POSSIBLE CONTRIBUTORY TYPES OF EVIDENCE

Any combination of the types of evidence may be acceptable (depending on how the Framework is tailored and used).

EXPERT - PLANNING, MONITORING AND CONTROLLING

	Experience of doing (relevant and recent) - show how you made a difference	Objective Evidence	Peer References/Assessment
Has championed the introduction of novel techniques and ideas in this field which produced measurable improvements	■ Can describe novel Planning, Monitoring and Controlling techniques they have introduced and the improvements achieved ■ Can describe instances of championing the introduction of novel techniques and ideas in Planning, Monitoring and Controlling ■ Can demonstrate the success of the techniques across a number of projects/programmes rather than just one project/programme	■ Documented examples of the introduction of novel Planning, Monitoring and Controlling techniques and can provide evidence of the improvement made ■ Published papers in refereed journals/company literature ■ Evidence of development/introduction with novel facility supporting systems engineering technique (e.g. simulated environment, concurrent design facility) ■ Published articles or books etc ■ Authored details of improvements to process and appraisal against a recognised process improvement model	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades
Has contributed to best practice	■ Can describe activities that have been adopted by others, or recognized, as best practice ■ Member of industry working group concerning Planning, Monitoring and Controlling (either within UK or Internationally)	■ Published papers in refereed journals/company literature ■ Published articles or books etc. ■ Ideas assimilated into International standard	■ Recognised as an Enterprise Asset by the community outside employer organisation (e.g. asked to be on conference panel, government advisory board etc.) ■ Recognised as an Enterprise Asset by senior management in a large organisation ■ Customer/competitor accolades

Example List of Basic Skills and Behaviours

This list defines some of the more important skills and behaviours that are used within systems engineering, it is not an exhaustive list. It should be tailored for individual roles, remembering that different roles require different combinations and levels of these skills and behaviours.

Basic Skills and Behaviour	Specific Techniques	Listen for...	Learning and Development	Experience of doing or by observation of	Objective evidence
Abstract Thinking Ability to use concepts and to make and understand generalisations e.g. London underground map	Ability to see multiple perspectives Ability to see big picture	■ Ideas expressed from different viewpoints, focus, context, perspectives ■ Conveys meaning and expression while avoiding clutter from unwanted information ■ Levels of abstraction are not levels of elaboration ■ Viewpoints and patterns	■ Courses in reading diagrams, diagrammatic techniques	■ Thorough observation	■ Describing complex situations in a simple way e.g. through diagrams
Knowing when and how to ask Ability to know limits of own knowledge and when to seek advice from others	Asking for advice, engaging an expert, peer review, requesting training	■ Timely use of peers/experts ■ Understands the limits of knowledge ■ Self confidence	■ Judgment ■ Formal decision making process	■ Understands limits of own knowledge	■ Engagement of specialists, collaboration
Knowing when to stop Ability to recognise when additional effort may be disproportionate to added value	Pareto, 80:20 rule, decision making skills	■ Not 'gold plating', over designing ■ Meeting the requirements but no more ■ Design balance and effectiveness ■ Having an exit strategy ■ Tailoring depth of analysis for particular needs	■ Decision making tools ■ Risk analysis ■ Managing Stakeholder expectations	■ Completion of tasks with balance of time, cost, quality	■ Understandable designs/artefacts ■ Fit for purpose
Creativity Ability to generate new ideas or concepts, or new associations between existing ideas or concepts	Lateral thinking, brainstorming, TRIZ, Six thinking hats Divergent thinking	■ Understand the associated impact and risks ■ Puts forward many ideas ■ Unconstrained by convention ■ Doesn't 'solutioneer' ■ Builds on the ideas of others	■ Courses in specific techniques	■ Has contributed to a brainstorming session	■ Novel ideas ■ Creativity leading to innovation

Example List of Basic Skills and Behaviours

Basic Skills and Behaviour	Specific Techniques	Listen for...	Learning and Development	Experience of doing or by observation of	Objective evidence
Objectivity Ability to be impartial, use facts and not rely on assumptions & prejudices	Reference of policy, base lining, viewpoint analysis	■ Uses formal processes ■ Uses objective measures ■ Ensure facts are understood	■ Data analysis, statistical analysis, business case generation, operational analysis, report writing, ethics and diversity	■ Compliance matrix	■ Effective use of facts (statistics, etc.)
Problem solving Ability to analyse and understand the problem and its root causes and to create a satisfactory solution	TQM tools (Cause/effect, force field, Pareto etc.) SWOT analysis PESTEL analysis Decision Trees, convergent thinking, trade-off studies	■ Defines problem space not solution ■ Systematic analysis of problem space ■ Searches for root cause ■ Develops alternative solutions ■ Enjoys problem solving ■ Determines optimum solution	■ Problem solving techniques ■ Analytical skills	■ Has solved difficult technical problems	■ Trade study reports ■ Hobbies – crosswords etc
Developing others Ability to provide guidance and advice to others in order to grow and maintain the systems engineering capability of the organisation	Coaching, mentoring, training	■ Enthusiasm when talking about the subject ■ Willingness to pass on knowledge ■ Understands different learning styles ■ Understands levels of learning ■ Able to convey information clearly	■ Train the trainer course ■ Mentoring course	■ Has successfully run training courses ■ Has mentored/coached people	■ List of training courses taught ■ Evaluation sheets from courses
Two-way Communicating Ensuring that what you 'say' is being accurately understood and that you accurately understand what is being 'said'	Listening Skills Verbal and non-verbal communication Body language Writing skills	■ Accurate, brief, clear ■ Understands the needs for different types of communication if different situations ■ Can effectively organize information ■ Checks understanding	■ Presentations skills ■ Writing skills ■ Listening skills	■ Preparing and giving briefing ■ Presenting papers ■ Conducting training courses ■ Writing reports	■ Best paper award at conference ■ Reports ■ Media press releases ■ Resolved conflicts`

Example List of Basic Skills and Behaviours

Basic Skills and Behaviour	Specific Techniques	Listen for...	Learning and Development	Experience of doing or by observation of	Objective evidence
Negotiating Ability to produce an acceptable agreement that satisfies all stakeholders	Win-win, bartering, diplomacy, cultural awareness, stakeholder management, management of expectations	■ Planning for negotiations ■ Win-win scenarios ■ Setting goals ■ Defining trades ■ Defining expected outcomes ■ Discussions dialogue	■ Negotiating training courses	■ Leading/ participating in negotiation teams, ■ Working in committees, working groups, multi-disciplinary team	■ Negotiations with satisfied parties, system requirements partitioning and flow down, defining acceptance criteria
Team working Ability to work together cooperatively as a team in order to accomplish the same goals/objectives	Belbin Team Roles, Meyers-Briggs Type Indicator, TQM tools (Cause/effect, force field, Pareto etc.), negotiation, facilitation	■ Talks about team achievements not just own ■ Willing to share information ■ Understands own and team's strengths and weaknesses ■ Can describe what makes an effective team ■ Loyalty to team vision (selflessness)	■ Team building training ■ Leadership training	■ Has worked as part of and/or managed a team	■ Has been part of a successful project where team work was important
Decision making Ability to select the most appropriate course of action among several alternatives	Risk/benefit analysis Pareto analysis, pair-wise comparison, Decision Trees, Force field analysis, six thinking hats	■ Considers all alternatives ■ Analyses all information ■ Can define criteria for decision making ■ Prioritises information ■ Categorises information ■ Understand the importance of when to make a decision ■ Decisive behaviour ■ Stand by decisions once made	■ Courses in decision making techniques	■ Chain of events leading to a decision	■ Correspondence ■ Plans

Example List of Supporting Techniques

Listen for information on general/specific techniques and any applicable tools when assessing SE Competencies.
Many specific techniques are outlined in standards (e.g. Mil-Std, ISO standards etc.) and should be defined as required by each organisation.

This list gives examples of some supporting techniques, which each organisation should tailor as required.

Category	Possible Competency Application	General Supporting Techniques	Specific Techniques	Applicable Tools
Analysis and Design	Super System Capability Issues Determining and Managing Stakeholder Requirements Concept Generation Functional Analysis Modelling and Simulation	Operational Analysis		Tools to be filled in by each organisation
	Determining and Managing Stakeholder Requirements Concept Generation Functional Analysis Modelling and Simulation	Behavioural Analysis	Event Simulation Transaction Analysis	Tools to be filled in by each organisation
	Architectural Design Interface Management Managing Design Integrity Modelling and Simulation	Logical Analysis		Tools to be filled in by each organisation
	Interface Management Maintaining Design Integrity Modelling and Simulation System Robustness	Physical Analysis	N^2 Partitioning DSM Axiomatic Design	Tools to be filled in by each organisation
	Determining and Managing Stakeholder Requirements Architectural Design Concept Generation	Structured Methods	Yourdon Quality Function Deployment – QFD SSADM, Agile Methods OOAD	Tools to be filled in by each organisation
	Select Preferred Solution	Decision Analysis and Resolution	Trade Studies	Tools to be filled in by each organisation

Example List of Supporting Techniques

Category	Possible Competency Application	General Supporting Techniques	Specific Techniques	Applicable Tools
Analysis and Design	Maintaining design integrity Modelling and Simulation System Robustness Integration and Verification	Failure Analysis	FMECA FTA FMEA	Tools to be filled in by each organisation
	Design for…	Lean Design		Tools to be filled in by each organisation
	Maintaining Design Integrity System Robustness	Management of Margins		Tools to be filled in by each organisation
	Design for…	Six Sigma Design	Statistical Analysis	Tools to be filled in by each organisation
Systems Thinking	Systems Concepts Super System Capability Issues	System Definition	SSM Seven Samurai	Tools to be filled in by each organisation
Management	Planning, Monitoring and Controlling	Estimating	COCOMO COSYSMO	Tools to be filled in by each organisation
	Planning, Monitoring and Controlling	Budgeting	EVM	Tools to be filled in by each organisation
	Planning, Monitoring and Controlling	Scheduling	Material Requirements Planning (MRP) Manufacturing Resource Planning (MRP II)	Tools to be filled in by each organisation
	Lifecycle Process Definition Planning, Monitoring and Controlling	Planning	Network Analysis, Schedule Analysis, Critical Path Analysis	Tools to be filled in by each organisation
	Maintaining Design Integrity Planning, Monitoring and Controlling	Change Management		Tools to be filled in by each organisation
	Maintaining Design Integrity Planning, Monitoring and Controlling	Configuration Management		Tools to be filled in by each organisation
	Lifecycle Process Definition Planning, Monitoring and Controlling	Progress Monitoring	Earned Value, etc Critical Parameter Management	Tools to be filled in by each organisation
	Planning, Monitoring and Controlling	Technical Risk and Opportunity Management	PESTEL	Tools to be filled in by each organisation
	Enterprise and Technology Environment	Technology Planning	TRL, SRL, DML	Tools to be filled in by each organisation

Example List of Supporting Techniques

Category	Possible Competency Application	General Supporting Techniques	Specific Techniques	Applicable Tools
Specialist	Design for… Transition to Operation	Human Factors		Tools to be filled in by each organisation
	Design for…	Reliability	RAM Analysis	Tools to be filled in by each organisation
	Design for… Transition to Operation	Maintainability Analysis	RAM Analysis	Tools to be filled in by each organisation
	Design for… Transition to Operation	Safety Analysis	FMEA, FMECA, HAZOPS	Tools to be filled in by each organisation
	Design for… Transition to Operation	Security Analysis		Tools to be filled in by each organisation
Modelling and Simulation	Modelling and Simulation	Mathematical Modelling		Tools to be filled in by each organisation
	Modelling and Simulation	Graphical Modelling		Tools to be filled in by each organisation
	Modelling and Simulation	Physical Modelling		Tools to be filled in by each organisation
	Modelling and Simulation	Synthetic Environments		Tools to be filled in by each organisation

Consideration of 'Other Parameters' that may affect Ability

The 'other parameters' that may contribute to an individual's ability are:

- Size and Complexity of previous projects
- Quality of previous work
- Number of years of experience

The Working Group agreed that these 'other parameters' should be tailored and implemented by each organisation as they wish. However, some information on each subject is given in the following sections.

Size and Complexity of Previous Projects

The following table gives a list of some attributes/parameters that affect size and complexity, together with considerations that should be applied.

Attribute/Parameter of Complexity	Considerations/Warnings
Number of sub systems	The way sub systems are interconnected affects complexity (even a small number of sub systems may exhibit unpredictable behaviour when interconnected)
Number of requirements	Consider type and level of requirements - pure number may not be a good indicator
Number of interfaces (interactions, interdependencies, interoperations, interconnections)	Consider whether they are new or already defined, their complexity, who owns the interface definition (single or multiple organisations) – again pure number may not be a good indicator
Type of technology used	Consider whether technologies are new (not yet fully defined) or old (obsolescence may be a factor), legacy products
Costs	Non-Recurring Engineering cost vs. total project cost
Size of team	
Number of stakeholders	
Type of customer	e.g. Government, Civil, etc.
Type of contract:	e.g. Multinational, multi company, multicultural
Number of partners	
Number of suppliers	Relative position in supply chain
Socio-politico environment	e.g. Project in public eye

Quality of Previous Work

Consider quality of products, documents and general approach to work of the individual. The following may act as indicators to quality of previous work:

- Number of defects found in review of documents written/products design
- Happy customers
- Attainment of standards, accreditations, e.g. CMMI, ISO, etc.
- Reputation within the organisation
- Previous projects were delivered on time, with few problems

Number of Years Experience

The Working Group did not consider number of years experience to be a good indicator of ability when used on its own.