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The need to tailor competency models – with a use case from Rolls-Royce

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1. Definitions of competency and why it is important to Systems Engineering community
2. Detailed case study of work performed adapting / defining Systems Engineering competency model for Rolls-Royce
3. What next for INCOSE and competency - recommendations

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What is competency?

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- UK Engineering Council Standard for Professional Engineering Competence defines professional competency as

  "integrating knowledge, understanding, skills and engineering"

- It goes further..

  "professional competency goes beyond the ability to perform specific tasks"

- So demonstration of competency requires demonstration of skill, not just completion of tasks

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Why do you need to define competency?

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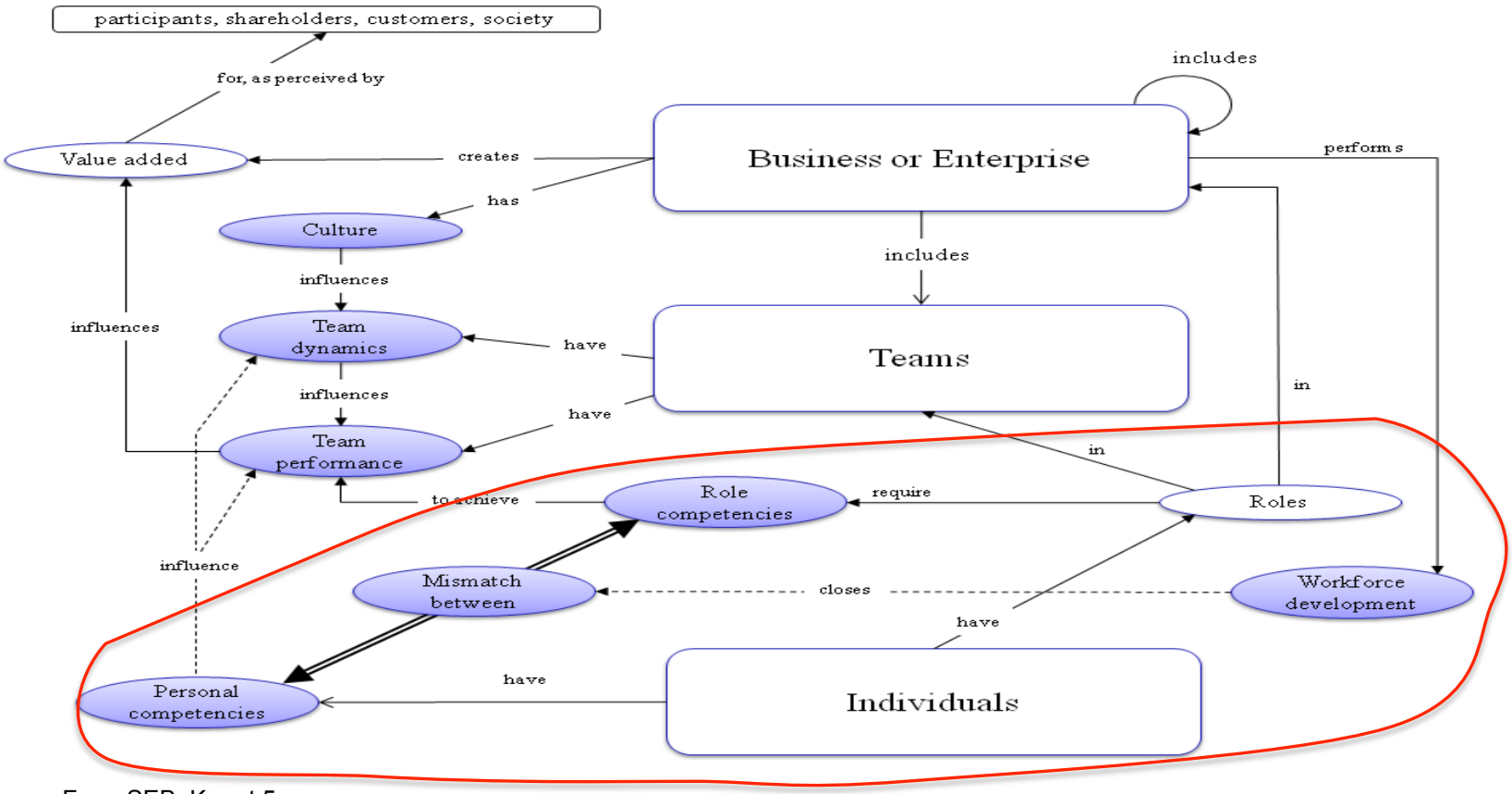
- **People produce the output of organisations:**
  - Performing required activities
    - Carrying out / following relevant processes
    - Using appropriate tools / methods
- Definition of relevant competencies for people, to fit into the roles needed by the organisation, is essential
- Successful organisations need to develop "towering technical competency in all engineers" (ref Morgan & Liker, Toyota Product Development system, 2006)

Competency as part of organisation



From SEBoK part 5 -
http://www.sebokwiki.org/1.1/index.php?title=Determining_Needed_Systems_Engineering_Capabilities_in_Businesses_and_Enterprises

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Systems engineering and competency

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- Systems Engineering gives significant return (see Eric Honour work)
- Challenges of making Systems Engineering a profession much discussed
  - Issue around creating a new discipline from an “interdisciplinary approach” and the jurisdiction issues involved (see Dixit and Valerdi, 2007)
  - Difference between Systems Engineering “*the activities*” and Systems Engineering “*the roles*” (see Kasser and Hitchins, 2012)
- **Individuals need to know what competencies needed in their role, and can develop the competencies, to perform the relevant Systems Engineering activities**
- To achieve purpose, organisations need to define
  - Complete set of roles to perform full range of engineering activities, including Systems Engineering
  - Level of Systems Engineering needed in the roles, to achieve organisation purpose

2. Tailoring competency model – Rolls-Royce case study

Current state of competency framework in RR

- Rolls-Royce has strong commitment to developing Engineering expertise
- Engineering divided into sub-skills (Systems Engineering now one), each with a company skill owner
- All engineers to be in a generic role, defined by accountability and competencies
- Skill owner defines competency framework, roles, levels of competency required in role, and training / other interventions needed to help achieve competency levels required
- Individuals self-assess against competency profile for role to define development needs (not for performance assessment)
    - So follow Kolb learning cycle (Kolb, DA 1984 Experiential learning)

Introducing Systems Engineering to Rolls-Royce – a timeline

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Engineering skill defined

Sub-skills defined

SE not included

RR Learning Management System (LMS) launched

SE framework live in LMS

SE added to skills

SE roles defined and populated

Consolidate – and include qualification

1st one week SE training in UK defence

One week SE training spread across rest of UK, Germany, US, Canada

>1000 individuals through 1 week course

2000 2003 2005 2008 2012

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Starting points for SE competency in RR

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- Systems Engineering wasn't originally included
  - "what every engineer should be doing"
  - so was "implicit" in a lot of roles
- Recognised wanted to make more explicit, so created SE as an additional skill
- Started looking at 3 sources
  - SE Handbook
  - (UK) INCOSE competency framework – especially appendix on evaluating competency
  - 12 Systems Engineering roles (Sheard 1996)

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Direction taken

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- Wanted to focus on competencies rather than activities to perform
- INCOSE framework appeared best fit
  - Lots of competencies - so merged / summarised)
  - Cover ALL engineering – so mapped against full engineering organisation
- Mapped existing training against competencies, and filled gaps
- Defined explicit Systems Engineering roles, as well as definition of what SE needed in all roles

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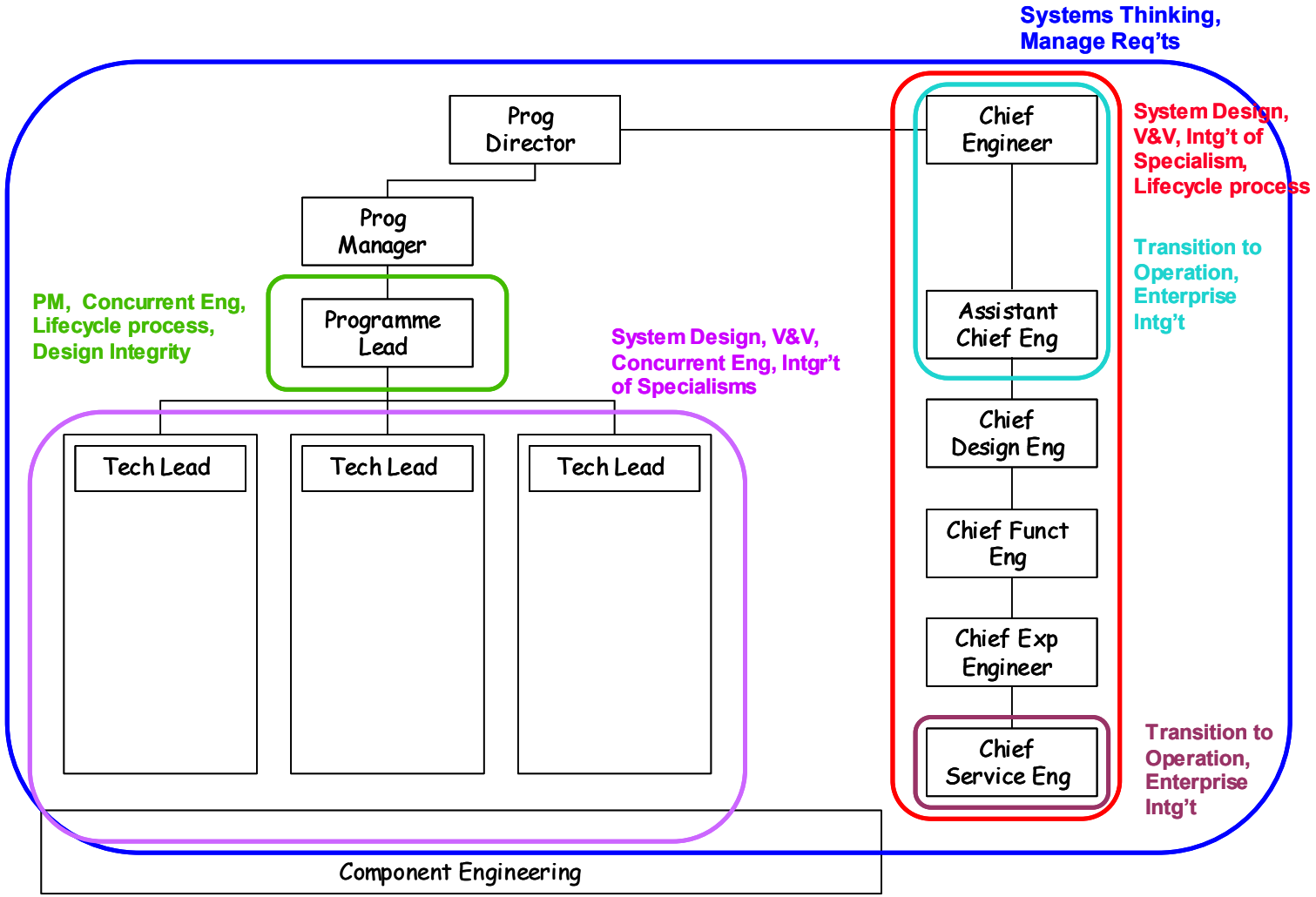
Project organisation – with SE skills

Project Matrix with System Engineering Competencies



Systems Engineering skills in Rolls-Royce organisation

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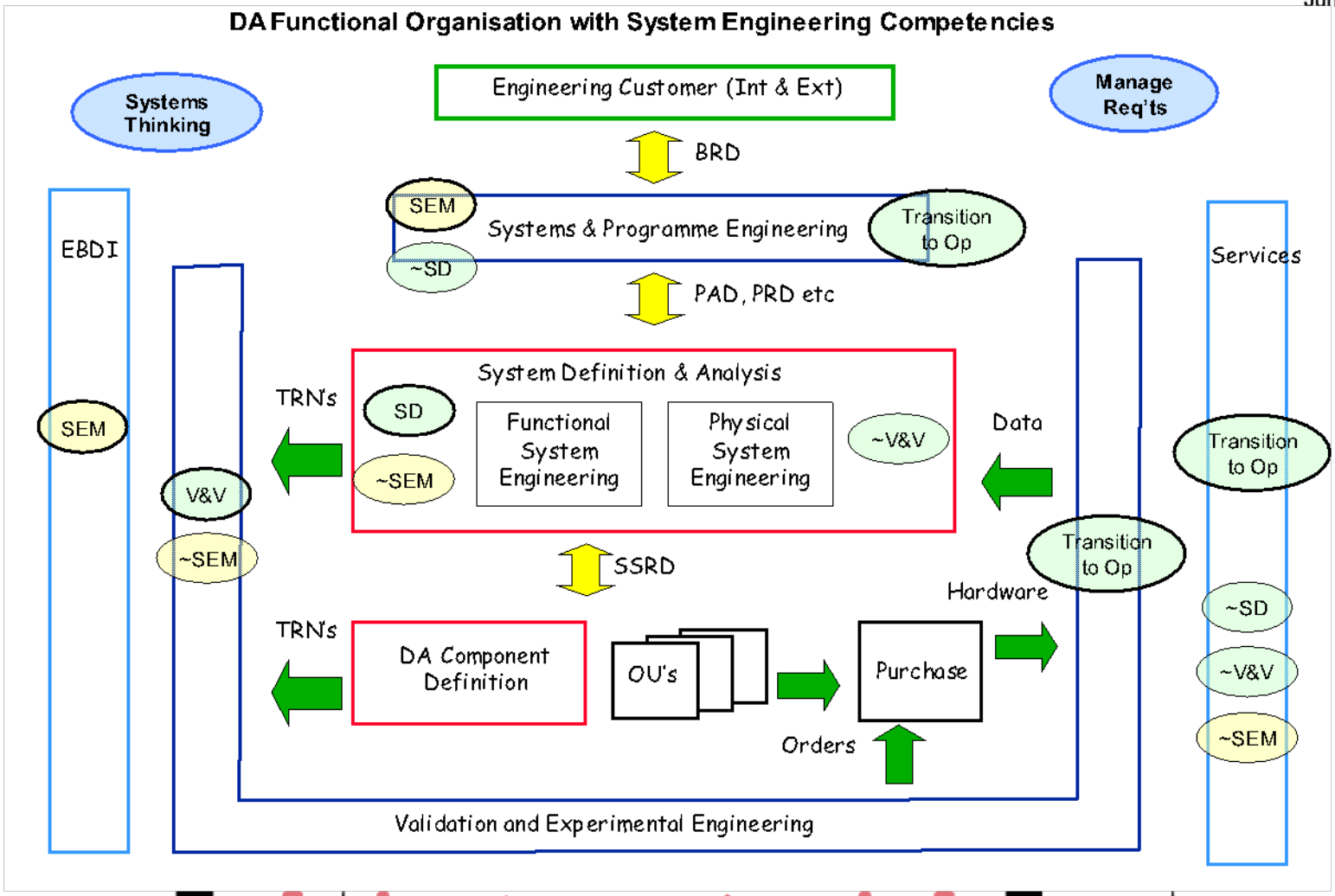

Merged competencies defined

Summarised into 11 competencies (from INCOSE 21 in 3 groups)

1. Systems Thinking
2. Determine and Manage Requirements
3. Systems Architecture
4. Programme leadership of Technical Programmes
5. System Operation and Customer Understanding
6. Transition to Operation
7. System Definition and Robustness*
8. Interface Management
9. Attribute Analysis*
10. Management of Emergent Properties
11. Verification*

* *Denotes competency to be borrowed from another skill*

Behavioural competencies form Rolls-Royce-wide standard list

"Measles chart" – Systems Engineering in every role!

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	Chief Project Engineer	FOST	Systems Engineer	Engineering PL	Chief Functional Engineer	Performance / Fluids/ aero	Chief Design Engineer	System Designer	Chief Dev Engineer	Dev Eng (compliance /PSIP)	Chief Service Engineer	Service Engineer
Systems Thinking	3	4	4	3	3	3	3	3	3	3	3	2
System Operation / Customer Understanding	4	4	4	3	4	2	3	2	2	2	4	3
Determine & Manage Requirements	2	1	4	3	3	2	3	3	3	3	3	2
Programme Leadership of Technical Progs	2	1	3	4	2	2	3	2	3	3	2	2
Systems Architecture	2	2	3	1	4	3	4	3	2	1	3	2
Function / attribute analysis and modelling	2	1	2	2	4	3	3	2	1	1	3	2
.Management of Emergent Properties	3	1	3	3	4	2	4	3	2	2	4	
System Definition and robustness	2	2	2	1	4	3	4	3	2	1	3	2
Interface Management	3	1	3	3	4	3	4	3	3	2	3	3
Verification / Proof	2	2	2	2	3	3	3	2	4	4	2	2
Transition and Support to Operation	3	3	3	2	3	2	2	2	3	3	4	3

1	Awareness
2	Supervised
3	Practioner
4	Expert

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Systems Engineering roles

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- Systems Engineering is to be “the way Rolls-Royce does Engineering”
- On journey defined different SE roles to be the focus for Systems Engineering knowledge

Project Systems Engineer

- Provide expertise and lead the project / programme team on a Systems Engineering approach, facilitating appropriate tools

Systems Engineer Specialist

- Expert in an aspect of Systems Engineering (Systems Thinking, MBSE, architecture, Customer Operation, or Requirements management)

Work Package Owner (PM in Engineering role)

- Planning, monitoring, controlling technical programmes (strong link with Programme Management competencies)

Next steps in Rolls-Royce

- Refine / update competency framework – build on learning
- Get Systems Engineering explicitly into **all** roles
- Get Systems Engineering roles on career paths
  - our “How to be a Chief Engineer” guide gives Chief Engineer responsibility to ensure that Systems Thinking drives project
- Get away from self assessment to having clear “qualifications” in proven ability to do (aspects of Systems Engineering), and add assessment of knowledge and experience
- Competencies defined for “in role” – need to identify “potential” for developing Systems Engineering
- Develop more “interventions” to develop competency past “supervised practioner” to “practioner” and “expert” faster

Summary of RR competency case study

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Purposes of Systems Engineering competency framework in RR are

1) Understand what Systems Engineering is in terms of competencies people need
2) Develop explicit Systems Engineering roles and develop people in these roles
3) Develop guidance for professional development, including on-the-job
4) Develop qualification (not self-assessment) to know health of Systems engineering in organisation

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3. INCOSE and competency – recommendations

Competency and INCOSE

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INCOSE should

- Compile range of competency framework use cases, from as wide a range of organisations (different points on Jack Ring's value cycle)
- Understand full range of possible uses for a framework (e.g. this case study doesn't include recruitment)
- Provide definitive guide to tailoring competency framework and defining SE into organisation roles

INCOSE should <u>not</u> attempt to define

- total jurisdiction over who does Systems Engineering
- rigid / definitive competency framework or role definitions

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Conclusions

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- To carry out Systems Engineering activities then people require
  - Correct competencies to perform activities professionally
- Organisations need to define complete, integrated roles
- This requires development of an organisation specific competency framework
- Development of this has to understand purpose for which organisation required framework
- INCOSE should provide guidance on how to tailor competency frameworks to given situations
  - Types of organisations, purposes of organisations, maturity of Systems engineering within organisation etc.

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QUESTIONS?

Reliability, integrity, innovation