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Implementing the Systems Engineering approach in Rolls-Royce

“Making Systems Engineering Real”

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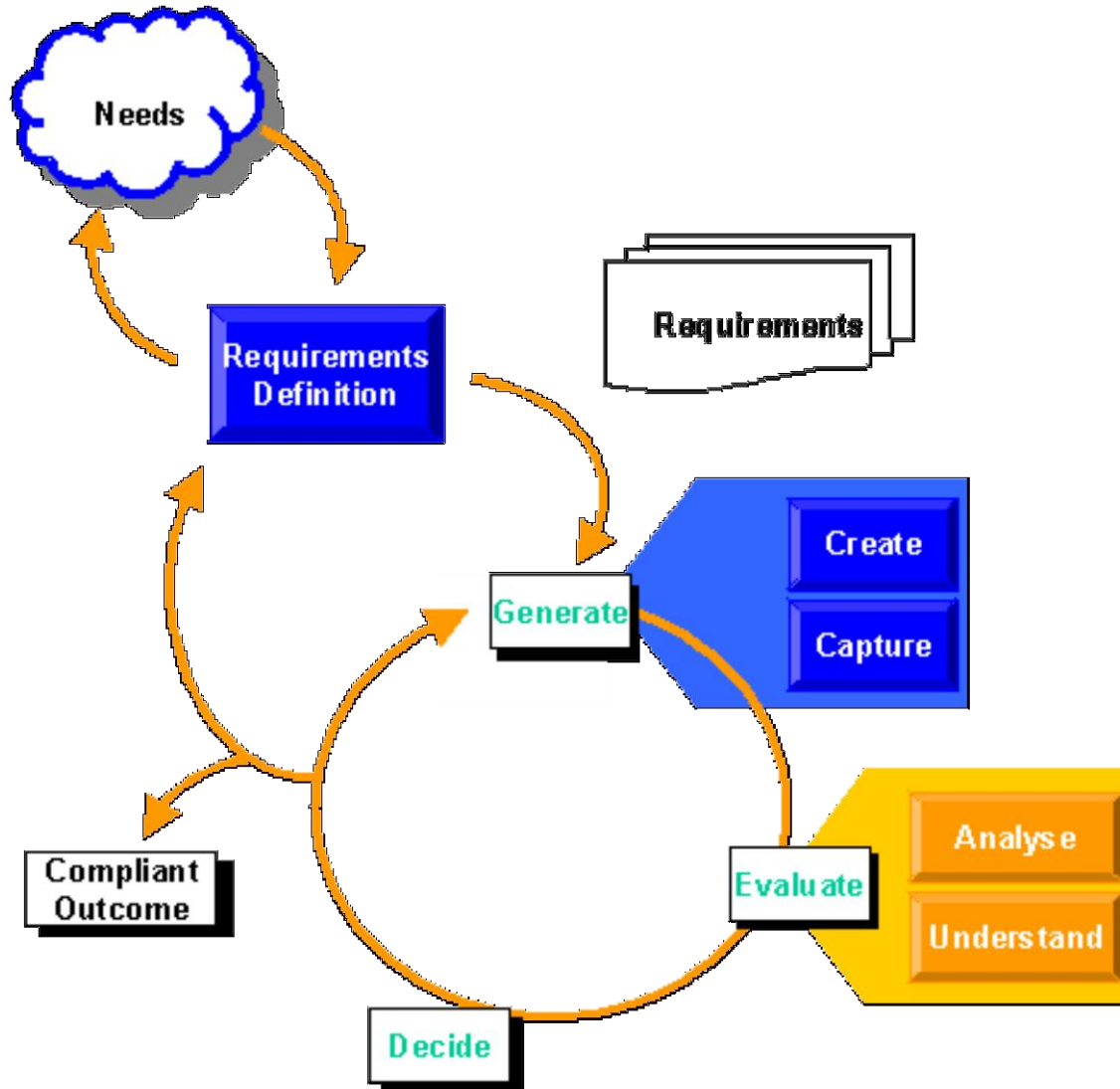
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“Systems Engineering activity feels like a quest and needs to be finally defined. Need to describe Systems Engineering as a project activity, not a skill”

i.e - **MAKE IT REAL AND MEANINGFUL**

Top level design process



Existing Skills in Rolls-Royce



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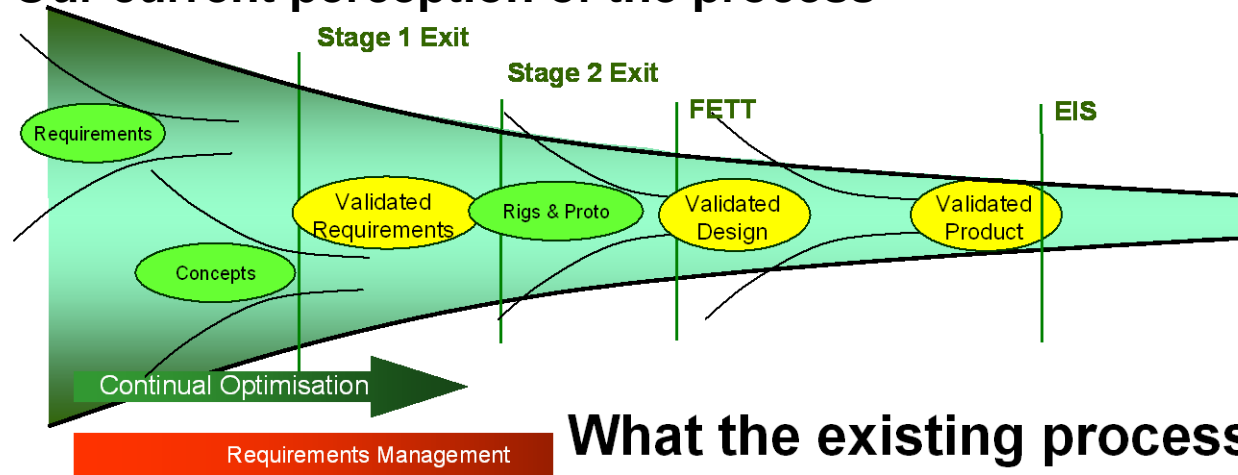
- All Rolls-Royce engineers are in a specific, primary skill group
- Systems Engineering is the newest of 22 skills
 - Aerothermal
 - Applied Science
 - Business Management
 - Control Systems
 - Design
 - Development
 - Electrical
 - Engine & Aircraft Performance
 - Hydrodynamics
 - Manufacturing Engineering
 - Materials
 - Measurement Systems
 - Mechanical
 - Nuclear
 - Product Definition
 - Project/ Function Management
 - Safety & Reliability
 - Service Engineering
 - Support Engineering
 - Systems Engineering
 - Test Engineering
 - Thermo Fluids

Why do R-R want Systems Engineering?

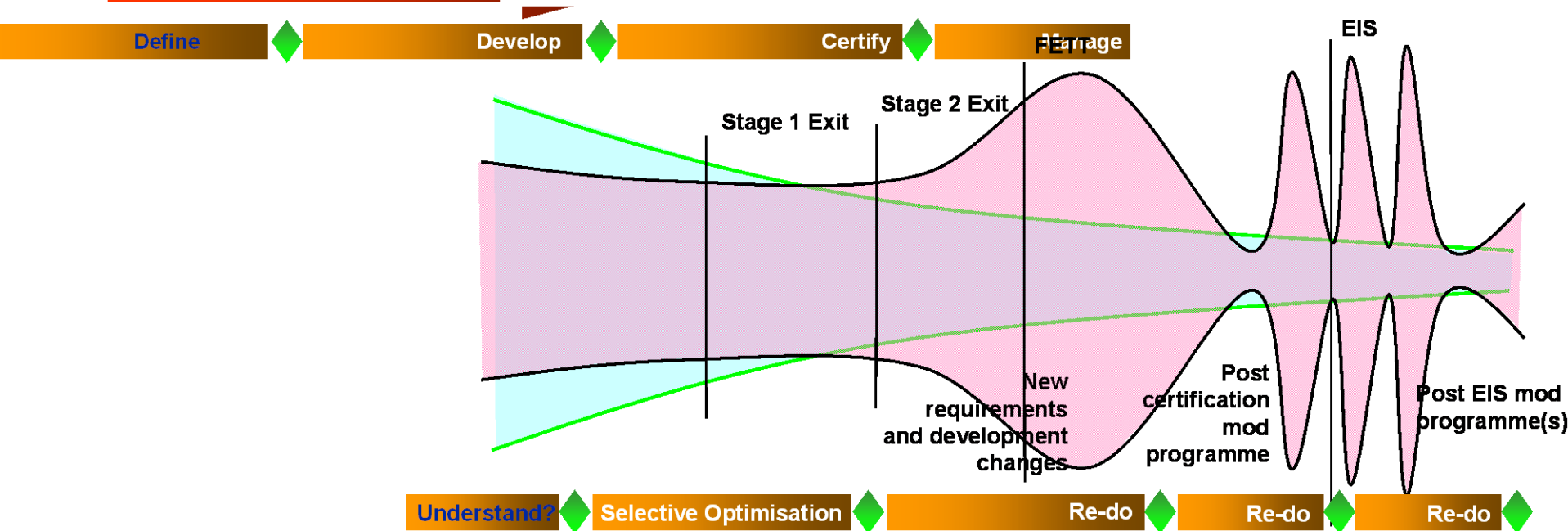


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Our current perception of the process



What the existing process really is



Systems Engineering is:



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Applying a Systems Approach to the realization of a new system or the modification of an existing one



Systems Engineering – an alternative definition

- “Basically Systems Engineering is good engineering with special areas of emphasis, ...
 1. Top-down approach
 2. Life cycle orientation
 3. Better and more complete emphasis on definition of requirements
 4. Interdisciplinary approach”

From Systems Engineering and Analysis, 4th ed, 2006, B Blanchard and W Fabrycky

- Therefore approach in RR is to approach SE as **Both** - a thinking approach required across most of Engineering (as add-on to existing primary skill)
And – a specific primary skill focusing on determining and maintaining integrated and coherent requirements (especially at system level)

Systems Engineering competency framework



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- There are 11 core competencies an organisation needs to produce / be a good at Systems

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

Organisational competencies

Systems Skill competencies

- Have developed Rolls-Royce specific competency framework to define specifically what is needed in these skills

These are derived from INCOSE core competency framework

Who does Systems Engineering?



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Systems Engineering is a cross cutting skill .There are probably three levels needed

1. Everyone needs some

- All engineers and non-engineers - include marketing, procurement, logistics and Programme Management

2. “Integrated System Designers”

- need significant Systems Engineering sub-skills – as an add on to existing primary skill (e.g CDE, System Designers etc.)

3. Systems Engineers – as primary skill

- “Develops and maintains the system (power system in its widest context) requirements”
- Reflecting and taking into account ALL stakeholders and where “system” is in life cycle
- Systems Engineering specialist being the “Voice of the System” to support those defining the system

Expectation is that you need some people to focus full-time in the requirements arena rather than the solution

Preliminary assessment of SE skills in CFBU (DA)

	Chief Engineer	Programme Manager	Chief Project Engineer	Chief Design Engineer	Chief Functional Engineer	Chief Service Engineer	Chief Dev Engineer	Dev (Vehicle owner)	Dev Eng (PSIP)	Systems Engineer	Engineering PL	FOST	Chief of Core Sys Design	Chief of mechanical design	System Designer	Chief of Functional core	Perf / Fluids/ Aero	Whole Engine analyst	Prod Structure Controller	Service Engineer
Systems Thinking	3	3	3	3	3	3	3	2	3	4	3	4	3	3	3	3	3	3	2	2
Determine & Manage Requirements	3	3	2	3	3	3	3	1	3	4	2	1	3	2	3	3	2	2	1	2
Systems Architecture	4	2	2	4	4	3	2	1	1	3	1	2	4	3	3	3	3	2	2	2
Prog Leadership of Tech Progs	3	4	2	3	2	2	3	2	3	3	4	1	2	2	2	2	2	2	2	2
System Op / Customer Understand	3	2	4	3	4	4	2	1	2	4	1	4	3	3	2	3	2	3	1	3
Transition and Support to Operation	4	2	3	2	3	4	3	1	3	3	3	3	3	4	2	3	2	3	1	3
System Definition and robustness	3	2	2	4	4	3	2	1	1	2	1	2	4	3	3	3	3	2	2	2
Interface Management	3	2	3	4	4	3	3	2	2	3	3	1	4	2	3	4	3	3	3	3
Functional System Definition	3	2	2	3	4	3	1	1	1	2	2	1	3	4	2	4	3	3	2	2
Management of Emergent Properties	4	2	3	4	4	4	2	1	2	3	2	1	4	2	3	2	2	2	2	
Verification / Proof	3	2	2	3	3	2	4	3	4	2	2	2	3	3	2	3	3	3	2	2

1	Awareness
2	Supervised
3	Practitioner
4	Expert



Problem

- **Need to introduce Systems Thinking as something everyone does**
 - But need to make clear roles that do Systems Engineering full time
- **Systems Engineering seen as another initiative**
 - e.g. Robust Design using many similar tools
- **Where we are**
 - “I do this already”
 - Short timescales drive natural “jump to solution”
 - Rework viscous circle
 - Got to use resource to “put out current fires, not work on fire prevention”

Way forward



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Promote definition of SE - “common sense” needed by all

Process

- **Define specific requirements management process**
- **Link process to roles in project teams**

Tools

- **Implement Systems Engineering capability in key engineering tools**

People

- **General training in the approach – promote “systems thinking” - to**
 - **Overall leaders**
 - **Systems engineering “doers” (engineering leadership)**
 - **Awareness for all engineers**
- **Use competency framework to assess the level of Systems Engineering skill needed in roles and define explicit SE roles**
- **Plan to assess against required competencies and fill gaps**



Summary

To get the right systems people apply **Systems Engineering to your organisation**

1. Define what you **want** from Systems Engineering (in your terms)
2. Define **what level** of Systems Engineering **skills** you want in existing roles (in terms relevant to your industry)
3. Strongly recommend (if roles don't exist) to **create explicit** Systems Engineering **roles** to focus the development of the skill
4. Ensure the whole organisation (process, other roles, tools) **supports and understands** implementation of Systems Engineering
 - So you don't just train Systems Engineers in Systems Engineering
5. Identify likely people (write holistic outlook) and put them in Systems Engineering roles
 - To learn in detail with suitable support (internal and external)



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Questions?

**Richard Beasley – System Engineering
specialist and corporate skill owner**