Comprehensive Approach to Systems Engineering Capability Development in GE Healthcare

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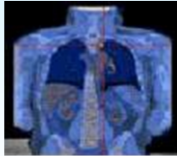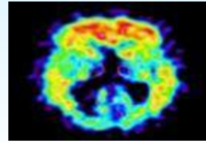# GE Healthcare

Broad Based Diagnostics

Diagnostic Imaging

- CT, PET/CT
- MR

Medical Diagnostics

- Contrast agents
- Molecular diagnostics

Clinical Systems

- Ultrasound
- Critical care systems

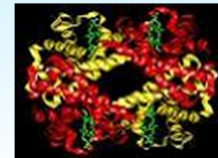**Information Technology & Services**

- Electronic medical records
- Revenue cycle

- Performance solutions
- Multi-vendor services

Life Sciences

- Discovery systems
- Protein separations

Professional Development
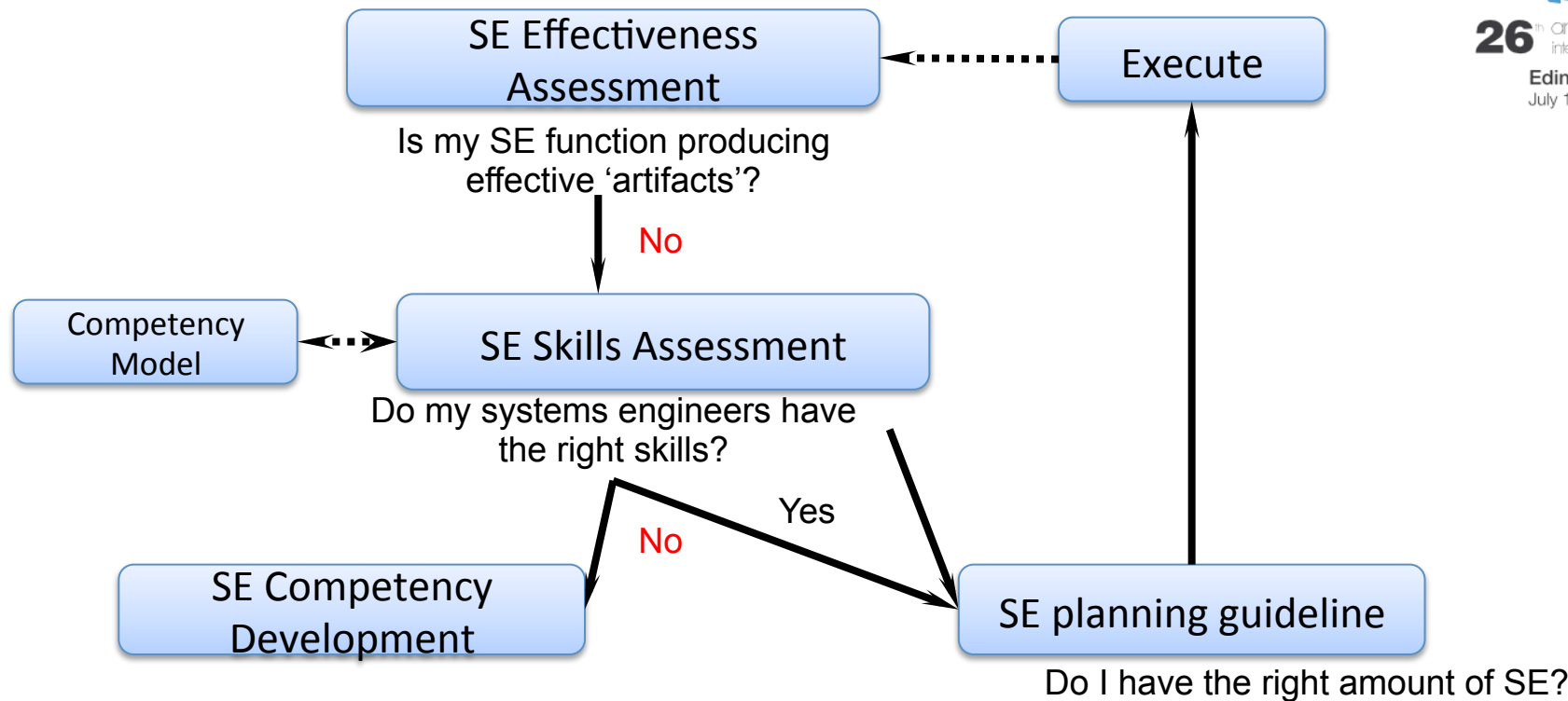# Problem Statement – GE Healthcare

- ~20 businesses

- Many countries

- Systems Engineering teams ranging in size from >100 to <10 engineers

- No consistent way to assess and develop engineers

SE Handbook – Professional Development

Figure 2.9

SE Effectiveness Assessment

Execute

Is my SE function producing effective 'artifacts'?

No

Competency Model

SE Skills Assessment

Do my systems engineers have the right skills?

Yes

No

SE Competency Development

SE planning guideline

Do I have the right amount of SE?

Professional Development Response

- SE Effectiveness Assessment
  - Short assessment of SE program implementation – based on SEI survey
- SE Skills Assessment:
  - Competency model: four levels; 9 technical excellence, 6 leadership skills.
- SE Competency Development
  - A set of development strategies were defined for each competency area
  - Mix of self-study, classroom, on-the-job, experiential, and intact team training.
- SE Estimation Guideline
  - Simple guides to estimating based on the work of Eric Honour (2013).
- Execution Monitoring
 - Reusing the criteria for SE effectiveness…with a bias toward actions

SE Effectiveness Assessment

Elm and Goldenson showed a simple assessment with four levels can differentiate performance

We combined their 83 systems capability questions into 30 questions

We included more extensive questions on topics related to "Design for …"

- Usability
- Reliability
- Six Sigma
- Manufacturability
- Serviceability
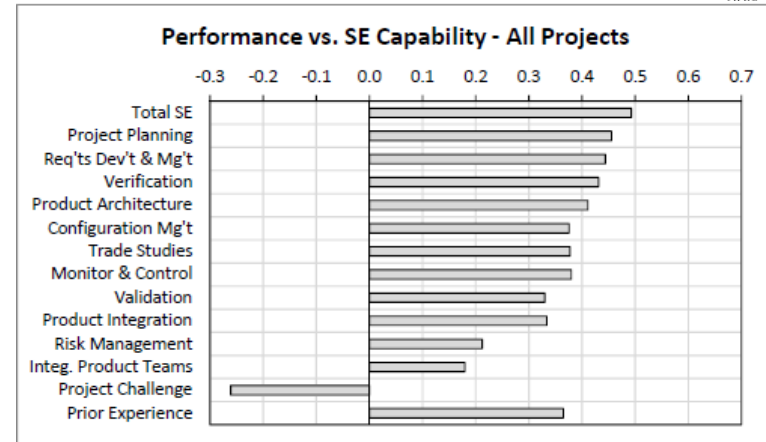
The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey Elm and Goldenson, 2012

SE Skills Assessment Competency Model

- Different locations were assessing their engineers on a 'local' scale ("the tallest skyscraper in Kansas")
  - Needed a consistent assessment scale (functional or competency maturity model)
  - Based on objective, observable behaviors
- Needed something simple (~10 criteria)
- Needed to balance technical and leadership skills
- Had to be consistent with existing leadership models (I.B.)

SE Skills Assessment Competency Model

- GE Corporate Systems Council agreed to a technical competency model based on the NASA model
  - It was simple
  - The two level hierarchy made it scalable
  - NASA was close to GE Oil and Gas headquarters, and they could 'outsource' their SE handbook development
  - It mapped well to Elm and Goldenson ("don't optimize the subsystems")
- GE Healthcare then further simplified the technical model and integrated our leadership model

SE Skills Assessment Competency Model

Technical Excellence Competencies

SE 1.0 System Design

| SE 1.1 Scope and Requirements Management |
| SE 1.2 Architecture and Design Optimization |

SE 2.0 Product Realization

| SE 2.1 Application, Product, and Technology Knowledge |
| SE 2.2 Product Integration, Verification, and Validation |
| SE 2.3 Product Lifecycle/ DFx Management |

SE 3.0 Technical Management

| SE 3.1 Systems Engineering Management |
| SE 3.1.1 Technical Design Reviews |
| SE 3.2 Technical Risk Management (and Safety) |

SE 4.0 Critical Thinking

SE 5.0 Technical Leadership Competencies

SE 5.1	Communication and Conflict Resolution
SE 5.2	Takes Risks Courageously
SE 5.3	Adapts and Leads Change

SE 6.0 Business Acumen

| SE 6.1 | Customer, Clinical and External Acumen |

SE 7.0 Personal Attributes

| SE 7.1 | Execution and Accountability |
| SE 7.2 | Teamwork and Collaboration |

Balancing simplicity with effectiveness

- ✓ 4 Technical, 3 Leadership Competency Areas
- ✓ 15 Competency sub-areas
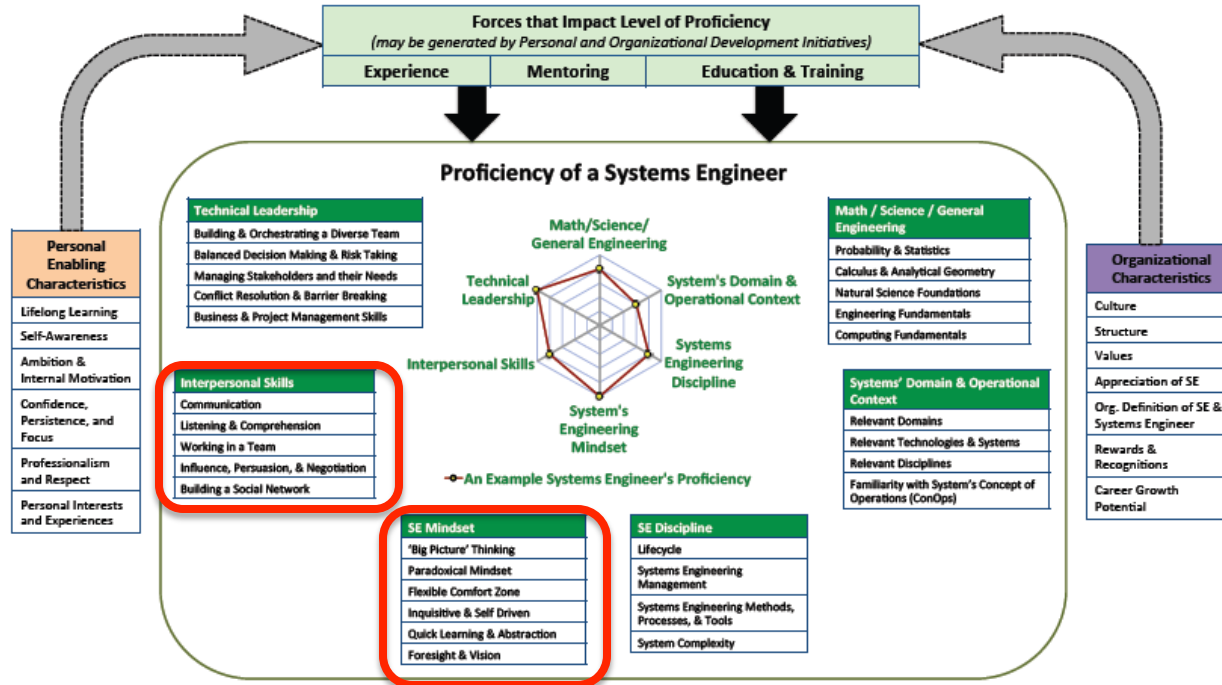- ✓ 51 Behavioral anchors

Behavioral Anchors

SE 4.0 Critical Thinking: Competencies and Behaviors

4.1 Frames Problems and Decision Making – Accurately frames complex and ambiguous problems, including key issues and critical stakeholder input. Uses creative approaches to synthesize separate pieces of data from multiple sources, to make sound and rational decisions in complex situations.

	Aware	**Skilled**	**Expert**	**Strategist**
Frames Problem	• Identifies and relates key issues to customer, market and business value.	• Identifies key issues, utilizing a systematic and methodical approach to prioritize problems.	• Accurately frames a complex problem, using foresight to sort out essential from detail.	• Accurately and confidently frames a complex system problem, appropriately engaging and challenging experts and advocates.
Trade Offs	• Recognizes that a problem exists tradeoffs between similar design criteria.	• Avoids jumping into problem solving before actually framing the problem and brainstorming scenarios and solutions.	• Balances traditional project management concerns of cost and schedules, with technical requirements, sound evidence and sources.	• Utilizes innovative approaches and relevant evidence to remove bias and identify predispositions.
Decisions	• Identifies correct data needed to make a decisions.	• Collaborates to logically examine facts and situations to arrive at a decision.	• Accepts decision making responsibility, balancing analysis and intuition, while considering program implications.	• Comfortable with uncertainty; experiments with innovative solutions, using logic , intuition and past experience to make system life-cycle decisions.

26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

Helix Model of Competencies

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How to assess some of the softer skills on the left?

- "Paradoxical mindset"
- "Flexible comfort zone"
- …

Harrison Assessment

- We used the managers assessment of the employee's technical skills (mixed with senior technical people's inputs)

- For leadership skills we complemented that with a 'work preference tool' (Harrison Assessment)
  - Measures 175 independent critical traits
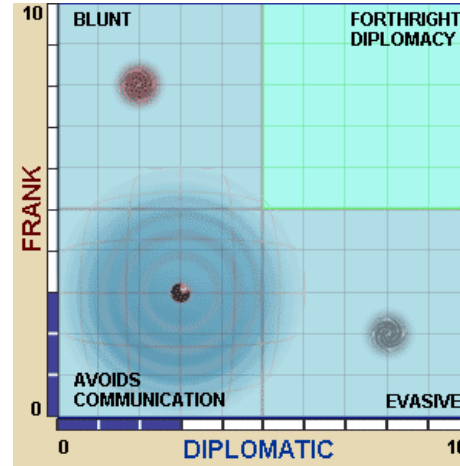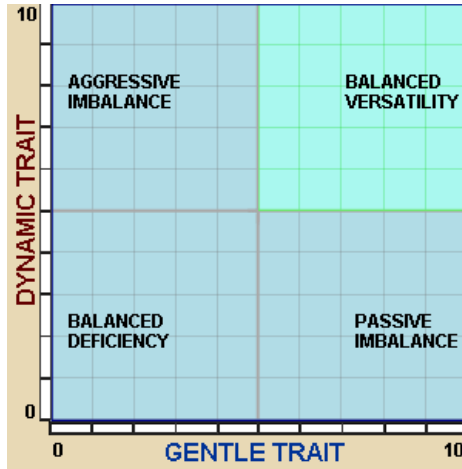 - Summarizes 12 "Paradoxes"…well mapped to the Helix study critical skills

Example "Paradox" - Communication
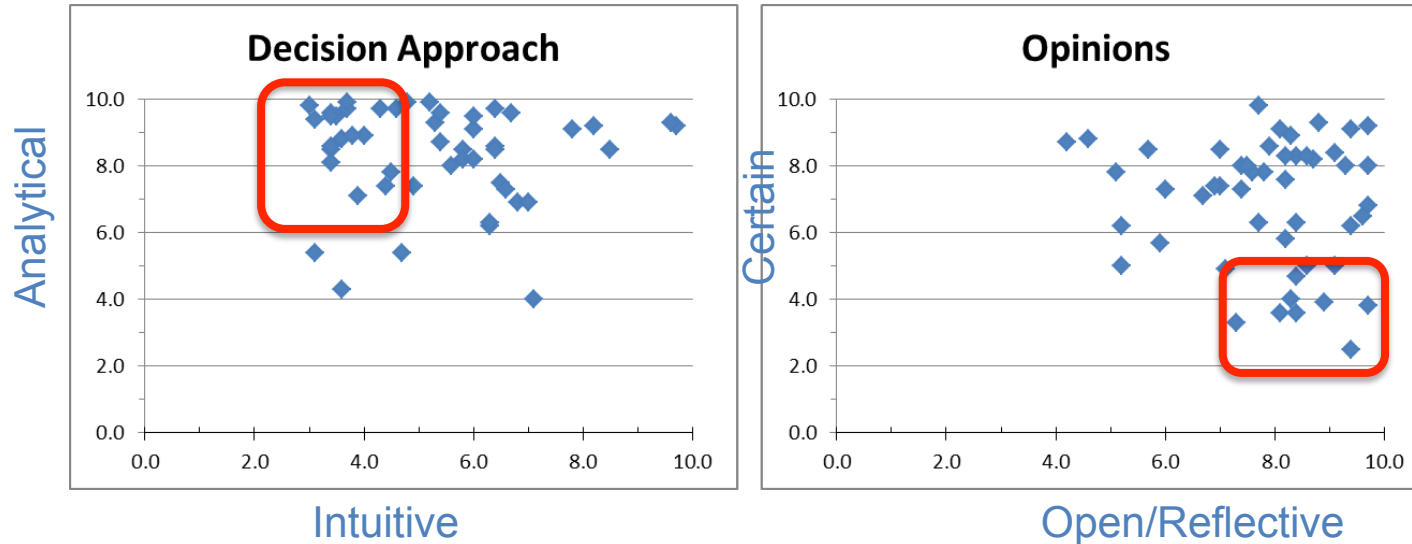

- Paradoxical traits are complementary, not contradictory
- Possible to be strong in both…and both are useful

Example GE Healthcare Skill Portfolio

- Employees are individuals
- Our SE leaders **tend** to be "laser logical" and "inconclusive"

Execution Monitoring

- Why do we monitor execution?
  - *To improve design quality, market impact and engineering productivity*

- What is an SE "Dashboard"?
  - A dashboard should include early (leading) indicators of quality, which are easily translatable directly to actions.
  - The dashboard helps you adjust real-time during program execution…
  - A scorecard displays event based performance vs. goals to you and stakeholders

Elements of a "Dashboard"?

Dashboard vs. Scorecard

Consider the difference in an auto race between an odometer/speedometer and the standings.

On the car's dashboard, the speedometer & odometer allow the driver to take actions to best 'finish the race safety and in first place'.

Or for the SE lead to deliver high quality differentiated features on time leading to satisfied customers.

Dashboard

Scorecard

POS. DRIVER	POINTS	DIFF.
1. DALE EARNHARDT JR.	744	0
2. MATT KENSETH	739	-5
3. GREG BIFFLE	738	-6
4. JIMMIE JOHNSON	736	-8
5. MARTIN TRUEX JR.	694	-50
6. TONY STEWART	691	-53
7. BRAD KESELOWSKI	690	-54
8. DENNY HAMLIN	683	-61
9. KEVIN HARVICK	681	-63
10. CLINT BOWYER	679	-65

DRIVER STANDINGS
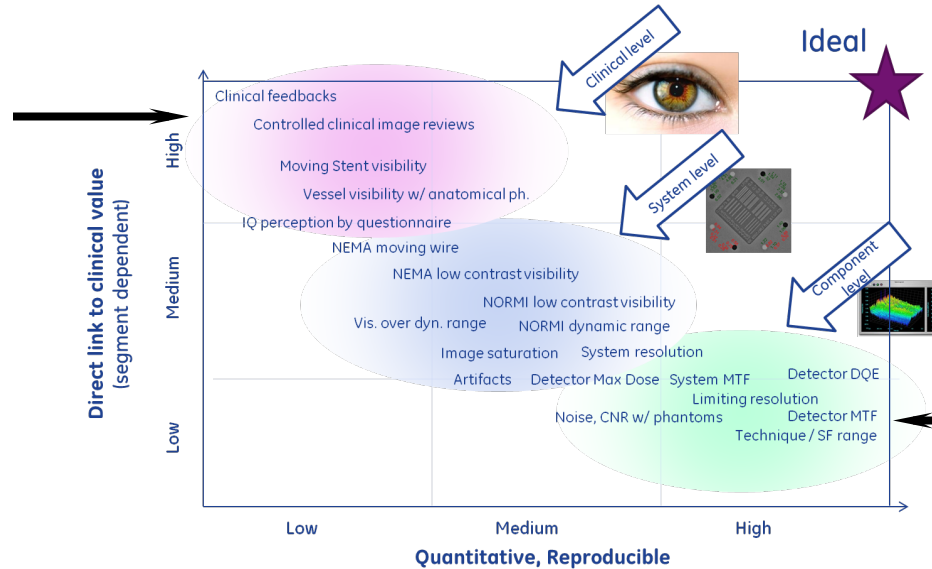AFTER 21 OF 36 RACES

Both are Important!

Dashboard vs. Scorecard

As engineers, we understand this…when it is purely technical

Scorecards
- "Goals"
- Customer based

Dashboards
- Controllable 'techniques'
- Internal/team focused

Example: DFSS Dashboard

Elements of a dashboard for 'variability' – Design for Six Sigma

Questions	Good/Poor Attributes	Actions
Are the critical performance criteria (CTQs) defined which capture the key market differentiation and enable the elevator speech?	System CTQs quantify all key competitive differentiation at M3. 10-15 CTQs at system level, 50-100 total). System CTQs do not don't cover all key parts of the marketing 9 block, don't have targets, or don't have competitive data	Trace CTQs from the marketing 9 block (not simply reuse from prior programs) Perform competitive analysis, and extrapolate to likely performance at M3 with Chief Engineer (don't assume no market evolution)
Are they flowed down to key subsystems with quality targets defined	Z-value quality targets; (typically Z>3-4.5) CTQs lack targets (limits, quality and confidence levels) System CTQs are not flowed down at least 1 level to subsystem	Set and flow down targets. Ensure the targets are realistic and customized to each CTQ.

- Not only do you get better program control…**we are trying to get people to "think",** not just go on autopilot
- Increase the organizational learning 'speed'

Conclusion

- We implemented Professional Development as a 'system'
  - Did not try to optimize the components of the model
  - Tried to optimize the overall model
  - Tried to manage the interfaces (consistency)

- Focused on the competency model
  - Formed the basis for the 'terminology' of the system
  - Simplified to fit the 'capability' of our global team
  - Used "Harrison Assessment" to measure some paradoxical thinking identified as critical in the Helix/Atlas model of SE professional development and effectiveness

- On execution monitoring, distinguished Scorecards from Dashboards
  - Reinforces thinking and learning in on the job assignments