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Comprehensive Approach to Systems Engineering Capability Development in GE Healthcare

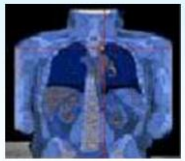
Chris Unger

Chief Systems Engineer, GE Healthcare

GE Healthcare

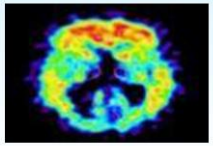
Broad Based Diagnostics

Diagnostic Imaging



- CT, PET/CT
- MR

Medical Diagnostics



- Contrast agents
- Molecular diagnostics

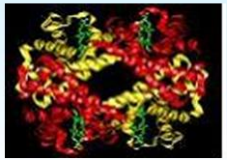
Clinical Systems

- 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

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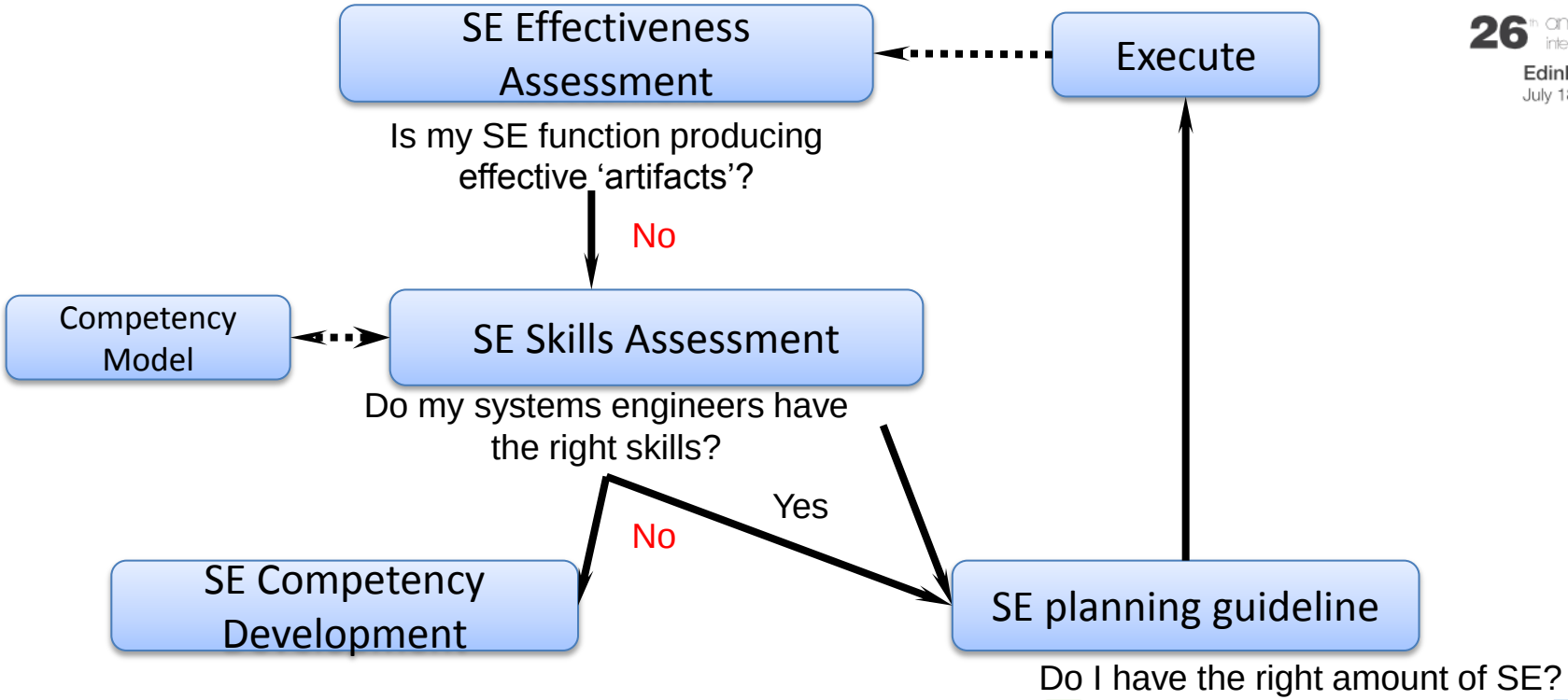
- ~20 businesses
- Many countries
- Systems Engineering teams ranging in size from >100 to <10 engineers
- No consistent way to assess and develop engineers

SE Handbook – Professional Development

Figure 2.9



Professional Development Response

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- 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

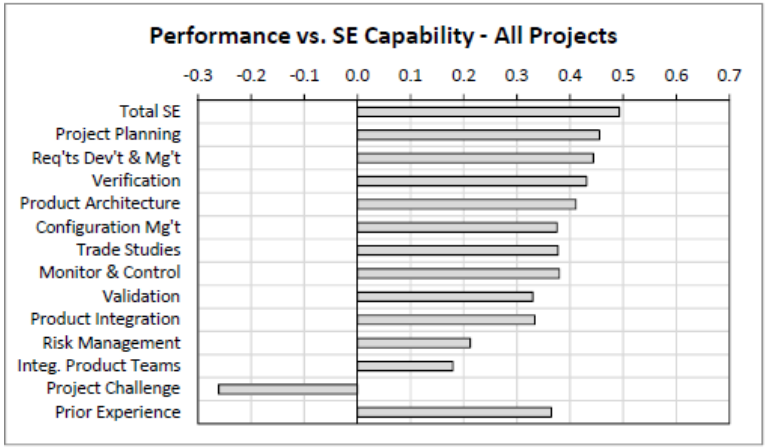
SE Effectiveness Assessment

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

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- 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)
- 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

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- 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

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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

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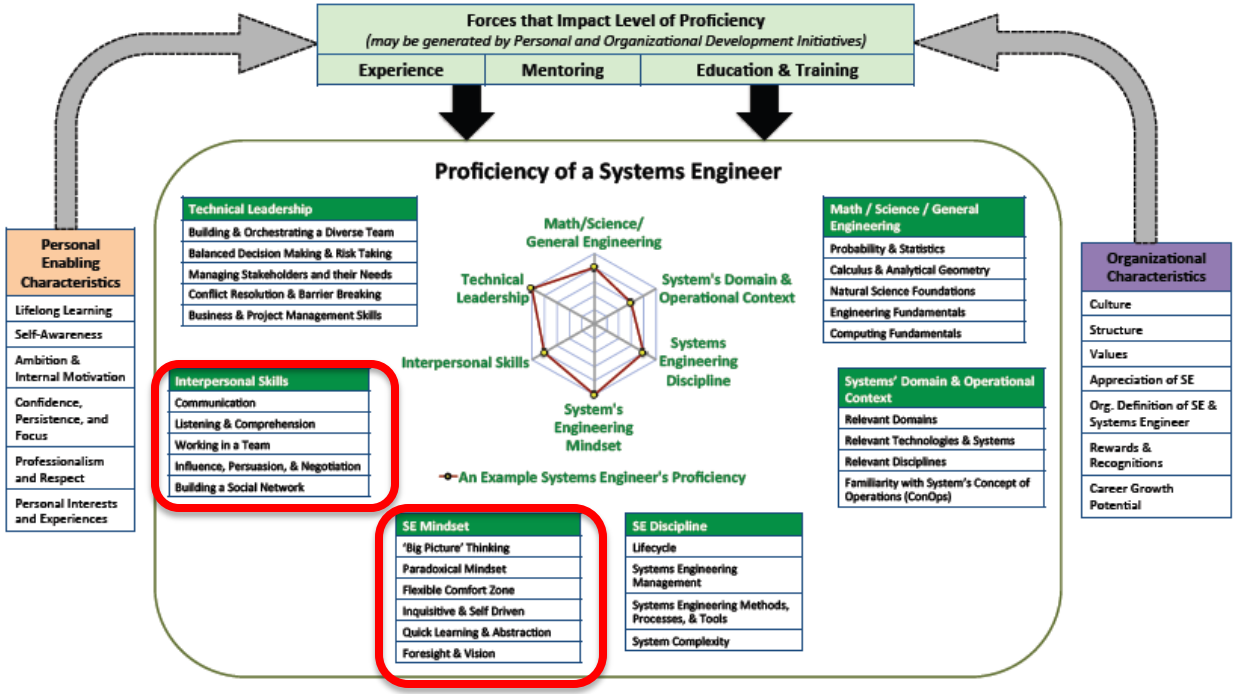
SE 4.0 Critical Thinking: Competencies and Behaviors

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.

Helix Model of Competencies



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

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

Harrison Assessment

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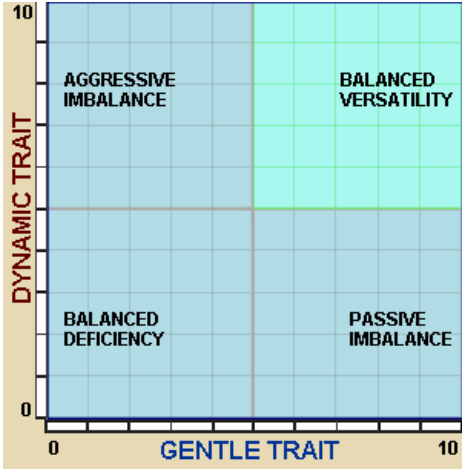
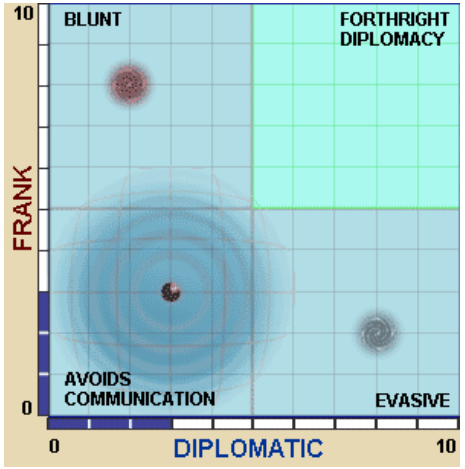
- We used the managers assessment of the employee's technical skills (mixed with senior technical people's inputs)
- For leadership skills we complemented that with a 'work preference tool' (Harrison Assessment)
  - Measures 175 independent critical traits
  - Summarizes 12 "Paradoxes"…well mapped to the Helix study critical skills

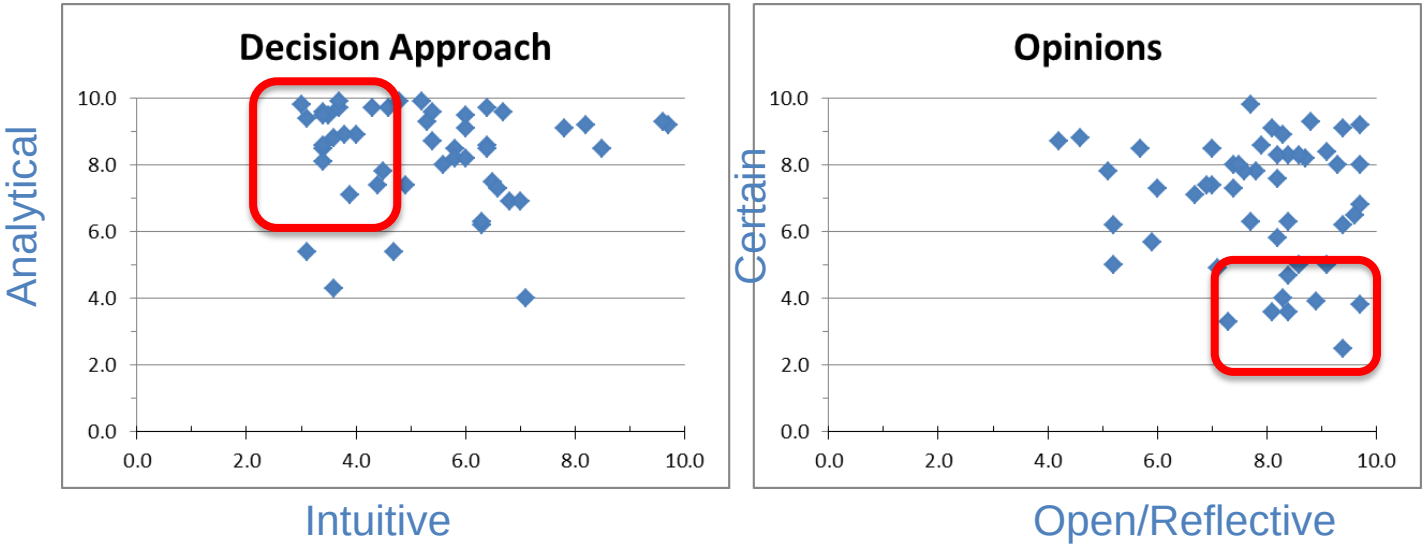
Example “Paradox” - Communication





- 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

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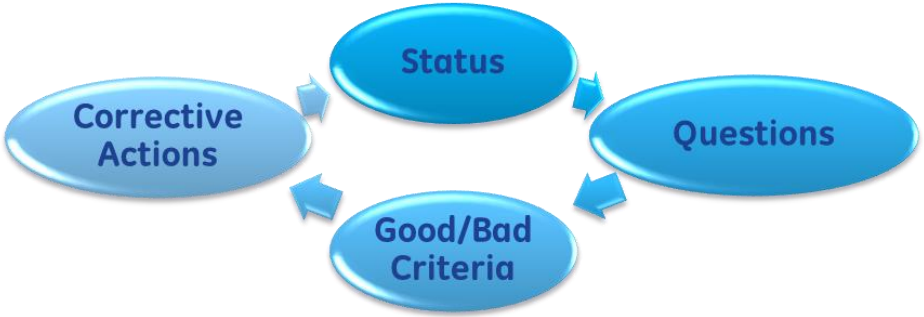
- Why do we monitor execution?
  - *To improve design quality, market impact and engineering productivity*
- What is an SE “Dashboard”?
  - A dashboard should include early (leading) indicators of quality, which are easily translatable directly to actions.
  - The dashboard helps you adjust real-time during program execution…
  - A scorecard displays event based performance vs. goals to you and stakeholders



Elements of a “Dashboard”?

Dashboard vs. Scorecard

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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

NASCAR Sprint — DRIVER STANDINGS

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

AFTER 21 OF 36 RACES

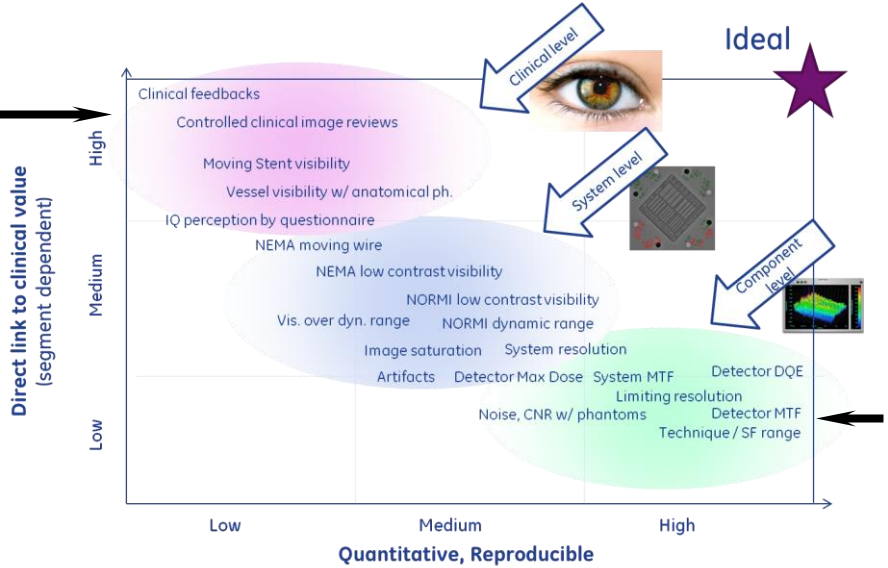
Both are Important!

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

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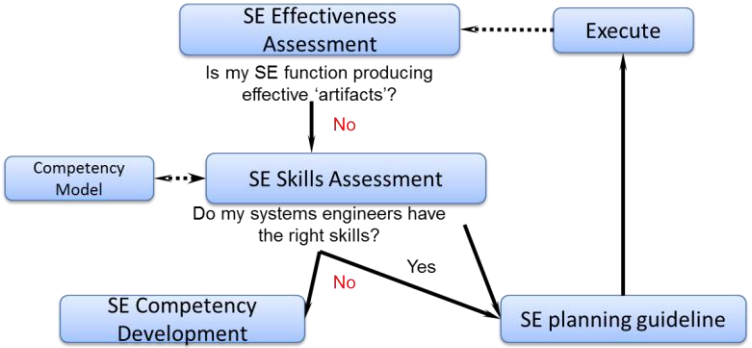
Elements of a dashboard for 'variability' – Design for Six Sigma

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