Basic Information RT35/35A

- Starting question: “How can we replace IMSs?”

- Researchers:
  - Richard Turner: Stevens; Boehm, Lane, Ingold: USC;
  - Madachy: NPS; Industry Working Group

- Task start: August 2011

- Deliverables: 4

- Conference Presentations: 13

- Papers Published: 8
  (all to refereed conferences or journals)

- Workshops: 4
Key takeaways of the research so far

• One definition of systems engineering: “The **Right People**, the **Right Information**, at the **Right Time**, Making **Good Decisions**”

• Understand Real Capacity for Work

• Continuously Value Work Holistically

• Use Service Model To Ensure Communications

• Share Value, Capacity and Status Information Across the Enterprise
Traditional systems engineering assumptions

• Requirements are predefined and generally stable
• Resources and technologies are predictable and stable
• Values remain stable
• There is sufficient time to complete the work
• Reductionism is the best way to approach large problems
The Results

• The V model
• Focus on plans/schedules rather than value and solutions
• Focus on requirement precision and coherence (if not accuracy)
• Change (and the customer who wants it) seen as the enemy
• Reductionism and deep engineering specialization
• Local process & design optimization
More Results

- SE Disengaged from SwE
- Poor management visibility into relationships between products, requirements, architecture, change impacts
- Operational environment overwhelms traditional governance methods
The World is Changed

- System contexts have multiplied
- Change in needs and solution technologies has accelerated
- Requirements are less tangible, evolving, and often emergent
- Systems are complex and constantly adapting
- Actual terrain has changed, we need new maps, tools and techniques
Need Proof Of The Change?

• The venerable PMI has (finally) “adapted”
  — 5th Edition of the PMBOK Guide provides for both predictive (plan-driven) and adaptive (agile) project lifecycles!
  — A new PMI/IEEE-CS SW Extension is now available that deals specifically with software management issues
Values

• Agile: Flexibility, Evidence
• Lean: Value, Flow

Principles

• Stakeholder Value-based Evolution
• Incremental Commitment and Accountability
• Concurrent Multi-discipline Engineering
• Evidence- and Risk-based Decisions

“Fundamental things apply”

Adapted from The Incremental Commitment Spiral Model
Boehm, Lane, Koolmanojwong, and Turner (2014)
Sticking Points

- Large-scale budgeting and estimation
- Long-lead items
- Operational systems of independently evolving systems
- Highly regulated domains (e.g. defense, financial, health)
- Command and control environments (low trust, bureaucratic)
• There is still no Silver Bullet
• ICSM principles
• Service orientation is promising
• Trust is a key ingredient and often difficult to find
• “Maybe...” is better than “Hell, No!”
• Executive/Management patience, not abdication
• Believing *Creativity and Collaboration* can be better than *Command & Control*
• Santayana was half right – it’s only the mistakes that you don’t want to repeat, not the successes
Caution! Specific Target Environment for the SERC Research Under Way

- Systems engineering where rapid response software development projects incrementally evolve capabilities of existing systems or SOSs

- That does NOT, however, preclude it from being applicable outside that target; of course it doesn’t guarantee it, either.
Predicted (Desired) Results

• Better *visibility* and *coordination* managing multiple concurrent development projects
• More effective *integration* and use of scarce SE resources
• Increased project and enterprise *value* delivered earlier
• More *flexibility* while retaining *predictability*
• Less blocking of product team tasks waiting for SE response
• Lower governance overhead
Agile/Lean Community Connections

Industry Working Group
— David Anderson (David J. Anderson and Associates)
— Jabe Bloom (The Library Corporation)
— Hillel Glazer (Entinex)
— Curtis Hibbs (Boeing)
— Suzette Johnson (Northrop Grumman)
— Larry Maccherone (Rally Software)
— Don Reinertsen (Reinertsen & Associates)
— David Rico (Boeing)
— Garry Roedler (Lockheed Martin)
— Karl Scotland (Rally Software, UK)
— Alan Shalloway (NetObjectives)
— Neil Shirk (Lockheed Martin)
— Neil Siegel (Northrop Grumman)
— James Sutton (Jubata Group)
Our Concept

• Pull (kanban) scheduling
  • Value-based selection
  • Limited WIP
  • Classes of Service
• SE as a Service
  • Scarce resource-driven
  • Collaborative/Negotiated
• Integrated work and data flow
• Information radiators at all levels

A Multi-level Network of Kanban-based Scheduling Systems
A Generic Kanban-based Scheduling System

Upstream Customers
Work (Backlog)

Ready Queue
(Limit=6)

Activity
(WIP Limit=8, Resources=4)

Completed Work

- Work Item waiting for selection
- Normal Class of Service Work Item (NCOS)
- Special Class of Service Work Item (SCOS)
- Expedite Class of Service Work Item (ECOS)
- Resource (Individually numbered)

Ex

WIP

NCoS, (WL=5)

SCoS, WL=1 (included in activity WL)

ECoS, WL=1, (extends activity WL if necessary)
Examples of Networked KSSs
Rationale for SE as a Service

- SE activities need to be defined and available for projects and the system owners to select for the ready queue
- The concept of services fits the need to encapsulate work, and provide a common value stream among project development personnel, SE, and the enterprise
• Maintaining prioritization across stakeholders is resource-intensive
• Kanban forces stakeholders to agree about next item in queue
• Stakeholders include customers/users, projects, executive management, and higher level systems engineering management
• Value functions balance local and SoS-wide priorities
• Custom software SoS constituent systems include patient management, pharmacy, laboratory, radiology, and telemetry
• Systems share a single database for all patients and personnel related to a given health care site
• Interfaces to other health care systems are maintained.
• Key overarching requirements are to ensure patient-safety and to protect patient information
Information/Work Structure
Proposed KSS Network Structure

Executive/Stakeholder Management (Customer)
- SLA establishment and monitoring
- Strategic planning
- Capability prioritization

Capability Engineering
- Analyze needs and alternatives
- Refine capabilities
- Develop requirements
- Allocate requirements
- Form cross organizational teams
- Cross-product and specialty engineering
- Validate and fully enable capabilities

Product/Domain Engineering
- Users
  - Customer relations
  - Initial Triage

Individual Product Team
- Product SE
- Identify SW Features
- Allocate features to SWDT
- Integrate features into requirements

SW Development Team

Pharmacy Domain Team

Network Domain Team

* All organizations can contribute to the Needs Backlog
## Classes of Service

<table>
<thead>
<tr>
<th>CoS</th>
<th>Description</th>
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<tbody>
<tr>
<td>Critical</td>
<td>Safety, security, or other emergency work items. <strong>Disruptive:</strong> requires necessary resources to stop current work and complete it.</td>
</tr>
<tr>
<td>Expedite</td>
<td>Very high priority work items such that this work takes priority over other work in the ready queue. Not Disruptive.</td>
</tr>
<tr>
<td>Important</td>
<td></td>
</tr>
<tr>
<td>Date Certain</td>
<td>Work items that must be completed by a specific date or there will be significant consequences.</td>
</tr>
<tr>
<td>Standard</td>
<td>The normal CoS for the development organizations work.</td>
</tr>
<tr>
<td>Background</td>
<td>Work that must go on but is usually not time critical. It includes things like architectural enhancements, low-level technical debt, or research and environmental scanning</td>
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Flow among and between KSSs
New Capabilities

• Interface to a new health insurance company
  — requires capture of additional information about patients, diagnoses, and physician orders

• Integrate and analyze information from multiple patient telemetry systems to improve diagnostic capabilities
  — COTS option: Identify and evaluate any COTS data fusion products that apply to the telemetry devices, select the “best” one, then integrate it into the enterprise
  — If no COTS available for all telemetry systems, two options:
    o Change non-compatible telemetry systems for more compatible ones and use a COTS product to integrate/analyze the desired information
    o Develop a custom application to do the integration and analysis.
Upgrade and Enhancement

• User response improvement
  — system response time is unacceptably slow and is potentially putting
  patient safety at risk
  — evaluate alternatives for improving the user response time and
    recommend one or more for funding.

• Periodic upgrade of pharmacy formulary information
  — Data on formularies and drug interactions updated quarterly
    (subscription service)
  — Updates analyzed against existing DB structures, any necessary updates
    to the data structures made, data structure updates tested and
    deployed, then populated with updated data
Normal Capability Development

- Stakeholders
- Users
- ESM
  - Demand
  - Ext. Source Request
  - Normal CoS Work Item
  - Important CoS Work Item

- CE
  - Demand
  - Ext. Source Request
  - Requirements to Teams

- US
  - Demand
  - Ext. Source Request

- Pharmacy DT
  - Demand
  - Ext. Source Request

- Database DT
  - Demand
  - Ext. Source Request

- Performance Issue Initiated
- Performance Issue Transferred
- Formulary Update
- Insurance and Telemetry Issues Initiated
Critical Issue: Interoperability Problem

• Feature to electronically send patient records to an external health care system was implemented, fully tested and seemed to function well during the first 30 days after deployment.

• Late one night, a physician noticed that an important entry by external health care system not entered properly in the time log.
Critical Task Operation
Results

• Aligned, unified view of work in progress and status of work
• Predictability through measures easily SPC’d and projected
• Value-based scheduling considers all priorities
• Better use of C/SE resources; better servicing of team SE needs
• Unlinks planning, scheduling, integration, and deployment cadences
• Enhances decision making
• Supports continuous improvement
• Provides for right conversations, right people, right time
Next Steps

• Proposal in coordination
  — Continue KSSN Research
    o Develop additional mechanisms to support value-based scheduling, SE as a service, etc.
    o Refine simulations to include new mechanisms
    o Build transition package
    o Build collaborations and infrastructure for *in vivo* KSSN piloting
    o Conduct pilots (Separately funded as sub tasks)
  — Support lean and agile enablers
    o INCOSE, NDIA, SEI and other organizations have working groups on agile-lean SE
    o Participate in and leverage working groups, conferences and Symposia


