

# Agile Systems Engineering

## A Case Study

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## What, When, Why

- Upgrade a major Army vehicle system-of-record
  - Multiple Variants
- Mission: Get to System Requirements Review (SRR)
  - Over 50 System Analyses, less than 5 Months
- Author’s company brought in as an “Engineering SWAT Team”
- Structured intensive analysis approach
  - MBSE-based development
  - Multiple Teams

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## Project Objectives

- Starting point: List of new system capabilities
- Develop: A comprehensive set of System and Subsystem Requirements
- Ensure buy-in from all stakeholders
- Rhapsody-based analysis of capabilities
  - Use graphical modeling techniques

*...do the impossible...  
...time-critical work...*

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## HOW TO ACCOMPLISH THIS???

- Effectively derive and communicate requirements
- Quick buy-in of requirements
- Diverse stakeholders
  - Customer
  - End-users
  - IPTs
  - Logistics

ALL AT ONCE

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## What is “All at Once”?

- Team-based analyses of Operational Scenarios
  - All stakeholders in the same room
  - Simultaneous concurrence
  - Live development of work products
- Short-turnaround time for each analysis
  - Daily meetings
  - Formalize work products, post-meeting




Repeat  
for all  
analyses


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## Logistical Planning

- The approach was organized and formalized



**SCHEDULING!**



- Multiple teams stood up
  - Facilitation/Leaders trained
- IPT Leads and Customer read-into the plan
- End-Users identified from the workforce

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## Getting Started...

### Phase 1: Develop User Needs

Develop current & desired use of the system

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## User Needs

- Developed list of scenarios (Backlog)
- Assigned each to a Team Leader (Scrum Master)
- Bring users with expertise into the meetings

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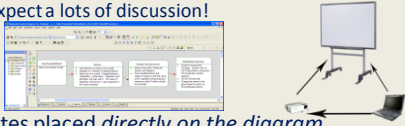
## Daily Meetings (Scrum Process)

- Scrum Master Lead:
  - Facilitates meetings
  - Cleans up model, integrates with other work
  - Ensures interface consistency
  - Publish results
- Development Team
  - Write validation methods
- At next meeting:
  - Review cleaned up work
  - Press ahead

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## Daily Meetings - Systems analysis

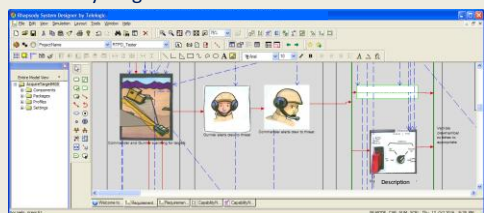
1. Prioritize capability list (Backlog)
2. Post source requirements
3. Model primary thread using Activity Diagrams to satisfy mission requirements
  - Expect a lots of discussion!
4. Notes placed *directly on the diagram*.
  - Constraints / scenarios / etc.
  - System-level requirements written for each activity



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## Between Daily Meetings...

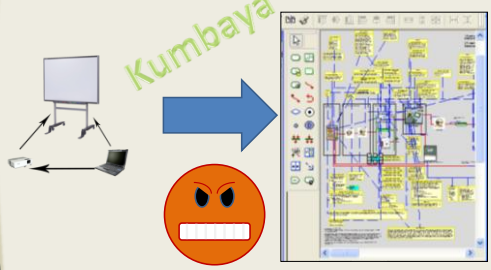
- Systems Engineer cleans up models
  - Formulate good requirements
  - Clarify diagrams



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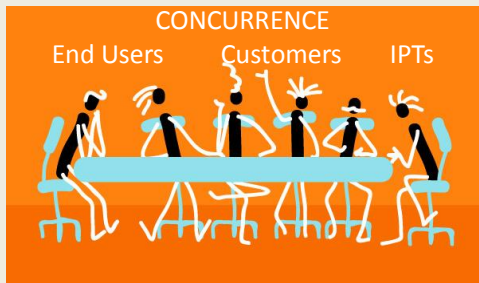
## WorkTempo

Kumbaya



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## Work Tempo



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## Work Products

- System Level Requirements...  
...based on *Analysis*
- Buy-in from all stakeholders
- Key factors:
  - Management backing effort
  - Even handed, calm facilitation
  - Thorough preparation for the next day's meeting

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## Phase 2: Develop Subsystem Requirements

Derive and Allocate subsystem requirements

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## Scrum Process - Daily Sprint Meetings - Subsystem Analysis

1. Decompose system behavior to subsystems
2. Use allocation (Sequence Diagrams)
3. Define / negotiate interfaces
4. Write functional descriptions/derived reqmts for each operation
5. Allocate behavior to subsystems
  - Operations, Functions or States

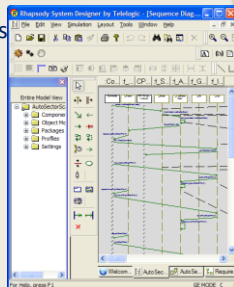
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## Work Tempo

- Different set of participants
- Significant IPT negotiation
- Include Test Engineering
  - Identify Verification Methods

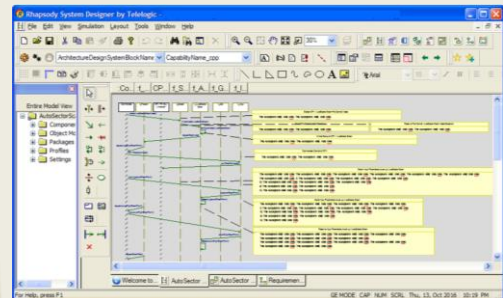


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## Requirements derived as part of analysis



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## Scrum Process Between Subsystem meetings

- Scrum Master Lead:
  - Cleans up model, integrates layer
  - Simulates thread, documents performance
    - Recommends performance requirements at next Scrum meeting
    - Ensures interface consistency
  - Publish results
- Development Team
  - Write their **subsystem requirements**
  - Write **verification methods**
- At next meeting:
  - Review cleaned up work
  - Repeat with next capability

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## Upon completion of each capability

- Integrate thread with previous work
  - Ensure self-consistent, complete model
- Backfill System analysis and requirements

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## At end of sprint

- Publish integrated Model
- **Publish subsystem specifications**
  - **Functional, Performance, Interface, Constraints**
- Publish views
  - Threads analyses
  - Requirements
  - Sequence diagrams

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## WHY IS THIS AGILE?

### DEFINING AGILE DEVELOPMENT

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## Agile Software Development Agile Manifesto

- Agile Manifesto <http://agilemanifesto.org/>
- Many methods and techniques
  - Scrum
  - Feature Driven Development
  - Extreme Programming
- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

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## Agile Software Development

- Scrum Development
  - Prioritized Requirements Backlog
  - Sprints – 3-6 weeks
    - Daily Standups to assess status
  - Update system during sprint
    - Design software
    - Implement changes
    - Test
    - Deploy / release

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## Agile Systems Engineering

- A **scrum** is organized into 2-6 week **sprints**
  - Iterative and Incremental Development
- Characterized by an incremental development against a list of capabilities (**Backlog**)
- **Secret sauce:** Agile SE develops a set of **systems engineering** work products during each sprint

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## SE Agile Scrum Structure

- Daily meetings
  - 1 hour maximum
  - Same time each day. Start on time
  - MBSE tool / Projector
- Interdisciplinary team
  - Scrum Master (*Systems lead and/or facilitator*)
    - Tool Jockey
    - Facilitator
  - Product Owner (*User*)
  - Development Team (*Subsystem and Test personnel*)
  - Other Stakeholders
    - Users, Customers, Vendors
    - Managers

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## Key elements relating to Systems

- Customer focus
  - Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
  - Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
- People
  - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
  - The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- Teams
  - The best architectures, requirements, and designs emerge from self-organizing teams.
  - At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

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## Benefits of Agile SE

### Management Benefits

- Greatly reduced development times
- Reduced re-work

### Technical Benefits

- Assures **Completeness** and **Consistency** of Analysis
- Quicker, higher quality development
- Fewer technical mistakes
- Traces and Documents Engineered Product Artifacts
- Specifications reflect collective knowledge
- Technique can be applied to other SE areas

**Faster, Higher Quality, Less Expensive**

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## Agile Systems Engineering *A case study*

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