Acquisition of Software Intensive Systems

A Best Practices Survey of the Rail Road Industry
Purpose

To survey the U.S. Rail Road industry to benchmark best practices in acquisition of software intensive systems.
Survey Results

1. 47 Surveys were sent to Commuter, Light Rail, Heavy Rail, and Freight Rail Roads in mid-August 2003.

2. 11 Agencies/Organizations participated (Bart, Metra, CTA, MBTA, MNCR, NJT, NYCTA, SEPTA, LIRR, WMATA, UP).

3. 15 were returned and tabulated.

4. Surveys were sent to Project Managers, Engineers, Engineering Managers appropriate for their respective organization.
Background Information

1. **Current job title?** Manager (5), Director (3), Asst V.P. (1)
2. **Years of Rail Road experience?** Average of 21 years.
3. **Type of Rail Road?** Commuter Rail (9), Heavy Rail Transit (3), Light Rail (2), Freight (1).
4. **Years of S/W experience?** Average of 17 years.
5. **When was your last S/W purchase?** 80% within 3 years.
6. **What type of system?** RR Cars (5), Car subsystem (3), Train control (4), Other (3).
Project Management

1. Do you have PM procedures? 93% Yes
2. Are Project Management Plans developed? 80% Yes
3. Are Quality Plans Developed? 93% Yes
4. Who leads your S/W projects?
   - Project Manager: 80%
   - Engineer: 13%
   - Consultant: 7%
5. Contract deliverables = Milestone payments? 100% Yes
6. Did your projects include multiple systems? 93% Yes
7. Project quality oversight was provided by? Average of 5.8
Specification

1. How much time for spec’ development? 9 months (avg)
2. Specification developed in-house or outside?
   - 80% said “both”
   - 20% internal
3. Was the programming language specified?
   - 78% said it was left up to the developer.
   - 22% was specified.
4. S/W development standards specified? 80% Yes
   Which ones? IEEE 730, 830, 1016, CMM, ATA A652 & 102, MIL std 498, ISO.
5. Did your spec’ contain a specific section for S/W?
Specification cont’d
Attributes Included in the Specification

IEEE software standards – 80%
Configuration Management – 80%
Escrow requirements – 60%
S/W Quality Assurance Plans – 73%
Bug tracking – 13%
Verification/Validation Plans – 73%
Failure Review Boards – 13%
Capability Maturity Models – 27%
S/W Development life cycle – 13%
S/W Maintenance – 33%
S/W Testing requirements – 67%
30/60/90/100 Design reviews – 60%
Change Review Boards – 27%
Requirements Management – 27%
Design

1. How much time for design? 14 months (avg)
4. Design phases = milestone payments? 100% Yes
5. S/W architecture required? 57%
6. S/W design walk-throughs done? 73%
7. Formal reviews done after each design phase? 87% Yes
8. Requirements for coding/programming notes included? 80% Yes
Verification, Validation, Qualification & Test

1. Was IEEE 1012 specified? 36% Yes
2. Did your company witness V & V activities? 87% Yes
3. Formal test plans required?
   - Reviewed & approved? 100%
   - Prior to testing? 86%
4. S/W qualification tests required prior to FAI? 36% Yes
5. Regression testing performed? 58% Yes
Software Quality Assurance

1. Do you perform QA audits of your S/W developers? 73% Yes
2. Do you require developer’s S/W QA plans? 87% Yes
3. Do you specify IEEE 730 for the developer’s SQA plans? 67% Yes
   – If not are they based on any standard? ISO, MILstd 498
4. Perform documentation reviews using standard checklists? 73% Yes
5. Do you have First Article Inspections procedures? 57% Yes
Configuration Management

1. Were CM requirements included in the spec’? 87% Yes
2. Was it based on IEEE 828? 17% Yes
3. Do you have internal CM processes? 75% Yes
4. Are all S/W mods/changes approved:
   - Prior to testing? 80% Yes
   - Prior to installation? 100% Yes
Escrow

1. Are escrow requirements included in your spec? 60% Yes
   If Yes …….

1. Are development environment components included? 78% Yes

1. Do you allow your S/W developers to escrow their own S/W? 56% Yes
   If No …….

1. Submittal of S/W code at the end of the project? 86% Yes
Capability Maturity Models

1. Do you require S/W development CMM requirements in your specification? 20% Yes

2. Has your company adopted the S/W acquisition CMM into its own business practices? 13% Yes
Maintenance

1. Were there any oversight activities performed during the maintenance phase? 67% Yes

1. Causes of maintenance:
   - Polishing (minor bugs)? 100 % Yes
   - Repairing (major bugs)? 100 % Yes
   - Enhancements? 80% yes

1. Did changes go through the same review as original developments? 80% Yes

1. Was that a project requirement? 80% Yes
   - An established developer procedure?
   - Both? 85% Yes
What were the most successful tools used?

1. Extensive on-site testing.
2. Knowledgeable individuals.
3. Piloting
4. Periodic reviews.
5. “Requisite Pro”.
6. “Labview”.
7. IEEE standards.
8. SCMP, SRS, SDD
9. MS Visual SourceSafe
What areas need improvement?

1. Improved S/W estimates.
2. Bug tracking.
3. Test plans.
4. Configuration Management. (2)
5. S/W documentation.
6. Availability of source code.
7. More development time.
8. Optimization during warranty.
9. Software architecture.
10. Documentation of embedded S/W on EPROMS.
12. Better understanding of diagnostic S/W.
Do you have a formal lessons learned program?

1 40 % Yes
Questions/Comments

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