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

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

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

l   **15 were returned and tabulated.**

l   **Surveys were sent to Project Managers, Engineers, Engineering Managers appropriate for their respective organization.**

Background Information

- **Current job title? Manager (5), Director (3), Asst V.P. (1)**

- **Years of Rail Road experience? Average of 21 years.**

- **Type of Rail Road? Commuter Rail (9), Heavy Rail Transit (3), Light Rail (2), Freight (1).**

- **Years of S/W experience? Average of 17 years.**

- **When was your last S/W purchase? 80% within 3 years.**

- **What type of system? RR Cars (5), Car subsystem (3), Train control (4), Other(3).**

Project Management

l   Do you have PM procedures? 93% Yes

l   Are Project Management Plans developed? 80% Yes

l   Are Quality Plans Developed? 93% Yes

l   Who leads your S/W projects?

- Project Manager: 80%
- Engineer: 13%
- Consultant: 7%

l   Contract deliverables = Milestone payments? 100% Yes

l   Did your projects include multiple systems? 93% Yes

l   Project quality oversight was provided by? Average of 5.8

Specification

ℓ How much time for spec' development? 9 months (avg)

ℓ Specification developed in-house or outside?

  – 80% said "both"

  – 20% internal

ℓ Was the programming language specified?

  ℓ 78% said it was left up to the developer.

  ℓ 22% was specified.

ℓ S/W development standards specified? 80% Yes

ℓ Which ones? IEEE 730, 830, 1016, CMM, ATA A652 & 102, MIL std 498, ISO.

ℓ 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

l How much time for design? 14 months (avg)

l What type of design documentation? IEEE 1016, SRS, SDD, SFD, SVVP, S/W Fault Tree Analysis, MIL std 498, ATA 102, Flow Charts, Block Diagrams.

l What type of design reviews? CDR, PDR, FDR, Functional, S/W Req' Review, 30-60-90-final.

l Design phases = milestone payments? 100% Yes

l S/W architecture required? 57%

l S/W design walk-throughs done? 73%

l Formal reviews done after each design phase? 87% Yes

l Requirements for coding/programming notes included? 80% Yes

Verification, Validation, Qualification & Test

l Was IEEE 1012 specified? 36% Yes

l Did your company witness V & V activities? 87% Yes

l Formal test plans required?

– Reviewed & approved? 100%

– Prior to testing? 86%

l S/W qualification tests required prior to FAI? 36% Yes

l Regression testing performed? 58% Yes

Software Quality Assurance

l   Do you perform QA audits of your S/W developers? 73% Yes

l   Do you require developer's S/W QA plans? 87% Yes

l   Do you specify IEEE 730 for the developer's SQA plans? 67% Yes

   – If not are they based on any standard? ISO, MILstd 498

l   Perform documentation reviews using standard checklists? 73% Yes

l   Do you have First Article Inspections procedures? 57% Yes

Configuration Management

l Were CM requirements included in the spec'? 87% Yes

l Was it based on IEEE 828? 17% Yes

l Do you have internal CM processes? 75% Yes

l Are all S/W mods/changes approved:

   – Prior to testing? 80% Yes

   – Prior to installation? 100% Yes

Escrow

l   Are escrow requirements included in your spec? 60% Yes

If Yes …….

l   Are development environment components included? 78% Yes

l   Do you allow your S/W developers to escrow their own S/W? 56% Yes

If No ……

l   Submittal of S/W code at the end of the project? 86% Yes

Capability Maturity Models

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

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

Maintenance

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

l   Causes of maintenance:

  – Polishing (minor bugs)? 100 % Yes

  – Repairing (major bugs)? 100 % Yes

  – Enhancements? 80% yes

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

l   Was that a project requirement? 80% Yes

  – An established developer procedure?

  – Both? 85% Yes

What were the most successful tools used?

l   Extensive on-site testing.

l   Knowledgeable individuals.

l   Piloting

l   Periodic reviews.

l   "Requisite Pro".

l   "Labview".

l   IEEE standards.

l   SCMP, SRS, SDD

l   MS Visual SourceSafe

What areas need improvement?

l Improved S/W estimates.

l Bug tracking.

l Test plans.

l Configuration Management. (2)

l S/W documentation.

l Availability of source code.

l More development time.

l Optimization during warranty.

l Software architecture.

l Documentation of embedded S/W on EPROMS.

l Enforcement of contract.

l Better understanding of diagnostic S/W.

Do you have a formal lessons learned program?

ℓ 40 % Yes

Questions/Comments

Contact information:

Andrew Frohn

Deputy General Manager

Long Island Rail Road

Jamaica, NY 11435

Office:718-558-4548

Mobile:516-315-8786

Email: afrohn@lirr.org