A Case Study in Product Line Implementation

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This case study reports the results of an independent review of a collaborative effort to institute product line reuse capabilities into a government development organization.
The organization’s mission is to produce high-quality flight software for space science missions.
Adopting a Product Line Process

Figure 1. Dimensions of technology transition adapted from [CMU/SEI-93-TR-3].
Step One: A Needs Assessment

The organization’s Product Line implementation team must identify required:

- skills
- procedures
- organizational structures
- strategies
- organizational cultural aspects

...are currently in place and those that are not present.
What’s Our Current Process?

- **System Requirements**
- **System Functional Requirements**
- **System Architecture Requirements**
- **System Detailed Design**
- **System Early SDL Integration testing**
- **System Early Integration testing**
- **System Integration Test**
- **System Beta Test**
- **Box Rqmts**
- **Box Design**
- **Box (auto)Coding**
- **Box Unit Test**
- **Box System Test**
- **Box Integration Test**

Notations:
- SDL: Specification and Design Language
- SL: "SL", data language
- eMSC: Extended Message Sequence Charts
- SDL (blocs): SDL (blocks)
The 3-Tier Product Line Engineering framework consists of:

- Enterprise Engineering,
- Product Line Engineering,
- Application Engineering.

The framework is further augmented by including an asset management layer to facilitate operational pragmatics of reuse strategies.
Barriers to Product Line Implementation - 1

Organizational

- Process maturity requirements
- EE, PL, AE focused skills, procedures, and structures
- Communication & collaboration requirements
- Effective setting/ negotiating of expectations
Process Maturity - 1st things 1st!

CMM Level - 2
- Requirements Management
- Software Project Planning
- Software Project Tracking
- Software Quality Assurance
- Configuration Management
- Subcontract Management

Level 1

Level 2

Level 3

Level 4

Level 5

Reuse
Process Maturity - 1st things 1st!

CMM - Level 3
- *Organization Process Focus*
- *Training Program*
- *Integrated Software Management*
- *Intergroup Coordination*
- *Peer Reviews*
State of the Practice: Process Maturity

Source: SEI Web Site SEMA Report for March 2000

Trends in the Community Maturity Profile

Based on a cumulative view of the most recent assessments of organizations up through the year indicated. This accounts for the difference from the figures on page 10.

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Process Maturity Profile of the Software Community 2000 Update - SEMA 3.03
EE - PL - AE - AM: Strategies

- **Enterprise Engineering**
  - Enterprise product line strategy: select high profit customers, target product selection and production, capitalize on competitive organizational strengths and advantages
  - Reusable assets financial allocation plan, capital investment, depreciable assets
  - Cross-project reuse management plan
EE - PL - AE - AM: Culture

- **Enterprise Engineering**
  - Enterprise driven development of reusable assets

- **Product Line Engineering**
  - Customer and contract selection that maximize profitability through optimizing reuse opportunities for high profit products
  - Across projects distributed reuse overhead and resource costs and benefits
EE - PL - AE - AM: Structures

• **Product Line Engineering**
  - Reuse Team (Reuse coordinators across projects)
  - Product Line Reuse Change Control Board
  - Automated metrics collection and analysis system

• **Asset Management**
  - Reuse library and librarian
  - Reuse/Product line metrics database
Effective Setting/Negotiating of Expectations

Product Line Goals - Achievable Steps

• The goals of the PL team are to create a flight software reuse repository that contains certified, reusable assets developed using specifically designed-for-reuse PL practices.

• To evaluate the alignment of goals and feasibility of the PL effort we identify the most critical and necessary factors to achieve these goals.
Barriers to Product Line Implementation - 2

Financial

- Adequate resource allocation and availability
- Sufficiency of cross-project resource allocation
Barriers to Product Line Implementation - 3

Technical
- Architecture and reuse asset certification process
Reusability Attributes Model (RAM)

- **Abstract**: provides a clear, concise description of the asset.
- **Change history**: describes changes to the code, who made them, the date of the changes, and why.
- **Dependencies**: describes prerequisite software and other software the component uses.
- **Design**: describes the internal design of the code and major design decisions.
- **Interfaces**: describes all inputs, outputs, operations, exceptions, and all side effects.
Reusability Attributes Model (RAM)

- **Legal**: provides a summary of legal information and restrictions for use, such as license and copyright information.

- **Sample**: provides a use-case scenario including use-case ID, description, actor(s), pre-conditions, flow of events and triggers, requirements, post-conditions, extensions, exceptions, concurrent uses.

- **Test**: documents the test history, procedures, results, and test cases.

- **Usage**: contains contextual information to assist in integrating the component.
Product Line Engineering
- Designing reusable assets
- Reusable asset management (across projects)
- Reusable asset coordination (across projects)
- Architectural modeling
- Domain analysis
- Reuse metrics review and analysis
- Reusable asset certification
- Regression testing for reusable assets
- Test traceability and analysis for reuse
- Interface specification analysis
- Code reusability analysis

Product Line Engineering (cont.)
- Scoping the domain
- Defining program family variability boundaries
- Optimizing program family commonality

Enterprise Engineering
- Business process re-engineering

Application Engineering
- Reusable asset identification and retrieval
EE - PL - AE - AM: Procedures

- **Product Line Engineering**
  - Asset certification procedures
  - Reuse library management procedures
  - Reuse metrics reporting procedures
  - COTS requirements analysis procedures
  - Reuse coordination procedures

- **Application Engineering**
  - Reusable asset development procedures
Adopting a Product Line Process

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Top Seven Should List

- There should be appropriate tailoring of the PL approach to the organization's practices.

- There should be significant effort to identify and improve weaknesses in existing practices that may inhibit the success of a transition to product line practices.

- There should be validated domain assessment results.

- There should be clear criteria for evaluating and comparing candidate domains. There should be a documentation of the variability boundaries for the program family.

- There should be complete and consistent asset certification criteria with procedures supporting that they are applied properly.

- Technical decisions must be documented and based on an agreed upon rationale and criteria.