Process Improvement for Product Lines

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Questions to Consider

What is a product line?

Why do organizations adopt a product line approach?

What is different about a product line process?

How does process improvement differ for a product line?
An Organizational Context

- Market: A set of customers having similar needs
- Product line: A set of similar products (to be) created by an organization for a market
Gain competitive advantage by being more responsive to diversity and change in customer and market needs

Improve productivity and product quality by focusing efforts on a set of similar products
Reuse-driven Process Improvement \((PI_r)\)

A method for the adoption and improvement of a product line approach

\((DsE \text{ in particular})\)
A Product Line Approach

Domain-specific Engineering (DsE)

A framework and discipline for the engineering and manufacture of similar products
Precursors to $P_{I_r}$

- Software Engineering Institute
  - *Capability Maturity Model® for Software* (1993)

- Software Productivity Consortium
  - *Reuse Adoption Guidebook* (1993)

- PHS work with Thomson-CSF (1996-8)
Definitions

**Capability**
The range of expected results that can be achieved by following a process

**Performance**
The actual results achieved by following a process

**Maturity**
The predictability with which performance achieves a targeted level of capability
**PIr, Refinements**

- Limit improvement scope to a product line business (not organization-wide or generic reuse)

- Integrate process improvement and reuse adoption efforts
  - Extend maturity models to address product line practices
  - add a capability model to aid process reconception
  - add a model for evaluating product line viability

- Emphasize fast start-up & rapid iteration

- Defer product line technical choices and effort to DsE
$PI_r$, Objectives

- DsE
- Manufacturing Discipline
- Engineering Discipline
- Product Line Market Focus
PIr Process

Commit

Product Line  Market Focus

Manage Quality

Engineering Discipline

Define Strategy

Manufacturing Discipline

Initiate Action

DsE

Perform DsE

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**Commit**

Objective: Establish a product line market focus

- Characterize the product line opportunity: products, customers, business challenges
- Evaluate viability: subjective factors, financial analysis
- Define business objectives
- Allocate resources to institute a product line approach
- Monitor progress and revise commitment as circumstances change
Domain Viability Model

Market opportunity
Are there customers for a line of similar products?

Technical expertise
Does the organization have the expertise to build envisioned products?

Business commitment
Is there a credible case for investing in this business?
Manage Quality

Objective: Establish engineering discipline

• Assess process maturity
  – Conventional criteria
  – Product line criteria

• Identify needed improvements

• Initiate improvement actions
  – Define action plans
  – Implement actions
  – Evaluate effects
## Process Maturity Model

### Conventional Factors

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organizational infrastructure</strong></td>
<td>Establish effective support for common (cross-PL) needs</td>
</tr>
<tr>
<td><strong>Project management</strong></td>
<td>Work within budget and schedule constraints</td>
</tr>
<tr>
<td><strong>Engineering methods</strong></td>
<td>Perform technical activities properly</td>
</tr>
<tr>
<td><strong>Product quality and integrity</strong></td>
<td>Achieve product quality goals</td>
</tr>
<tr>
<td><strong>Customer/supplier relationships</strong></td>
<td>Manage external interactions effectively</td>
</tr>
<tr>
<td><strong>Process predictability</strong></td>
<td>Reduce variation in results experienced across projects</td>
</tr>
</tbody>
</table>
Process Maturity Model
Product Line Factors

Product line strategy and management
How effectively do strategy and management actions support a product line approach?

Raw materials and assets
How effectively do available raw materials and assets contribute to product line needs?

Organizational and technical infrastructure
How well do infrastructure capabilities support a product line effort?
Define Strategy

Objective: Establish manufacturing discipline

- Target an appropriate level of process capability
  - Business objectives
  - Risks
  - Financial projections

- Create a product line strategy
Process Capability Model

Management Integration
Will projects have coordinated or independent planning?

Needs Orientation
Should efforts focus more on immediate or long-term payoff?
Should views of customer needs be unified or stay unique?

Product Integration
To what degree must projects focus on form and content of work products versus whole-product representations?

Stability–Optimization
To what degree can cultural stability be disturbed to achieve a streamlined process?
DsE Capability Levels

- Opportunistic
  - Enhanced Project-level Reuse
- Integrated
  - Integrated Products & Management
- Leveraged
  - Products/Process Standardization
- Anticipating
  - Domain-Market Coevolution
Product Line Strategy

Market/products focus

Business model
Tailored process (DsE + methods)

Organization
Support environment

Transition strategy
A DsE Process

Business Objectives

Domain Engineering

Domain

Market and Project Needs

Application Engineering

Application Product

Customer Needs

Product Uses

Create an infrastructure for building similar products

Build products using the infrastructure
PL Strategy

PL Organizational Functions

- Management
- Customer Relationships (Marketing & Sales)

**Domain**
- Management
- Engineering
  - Product Family
  - Appl. Process
- Project support

**Application**
- Management
- Engineering
  - Requirements
- Production
- Customer support
PL Strategy
Organizational Structures

Opportunistic

\[ \text{DE} \rightarrow \text{AE}_1 \rightarrow \text{AE}_2 \rightarrow \ldots \rightarrow \text{AE}_n \]

Integrated

\[ \text{DE} \rightarrow \text{AE}_1 \rightarrow \text{AE}_2 \rightarrow \ldots \rightarrow \text{AE}_n \]

Leveraged/Anticipating

\[ \text{DE} \rightarrow \text{AE}_1 \rightarrow \text{AE}_2 \rightarrow \ldots \rightarrow \text{AE}_n \]
Alternative Transition Strategies

Opportunistic

Integrated

Leveraged

Anticipating

productivity & risk

start

?
Initiate Action

Objective: Establish DsE (a streamlined ability to build similar products)

• Obtain funding and organizational support
• Augment staffing
• Provide documentation and training
• Implement infrastructure
• Resolve organizational/cultural and legal/contractual issues
Instituting PIₚᵣ and DsE

Organizational actions
– Evaluate utility
– Initiate pilot efforts
– Provide training and support

Domain-specific actions (3-4 month pilot efforts)
– Define a preliminary product line focus
– Evaluate domain viability
– Analyze commonalities and variabilities
– Develop selected adaptable components
– Initiate the PIₚᵣ process
For More Information on \( P_I \) or DsE

Prosperity Heights Software

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Domain Engineering in DsE

Organize, plan, and direct domain efforts to achieve business objectives

Domain Management

Domain Definition

Characterize buildable products in terms of commonalities and variabilities (decisions)

Product Family Engineering

Develop assets and the means to derive individual products

Project Support

Ensure that the domain meets business, organizational, and market needs

Process Engineering

Define an AE process and provide supporting tools
An Augmented Application Engineering Process

Requirements
Assets

Requirements
Analysis

Design

Implementation

Domain Infrastructure
A Streamlined Application Engineering Process

Project Management

Application Modeling

Application Production

Delivery & Operation Support

Domain Infrastructure

Product Specification & Evaluation

Product Generation & Evaluation

Product Distribution