Families Task 1.2 CWD

A Cost Model for Software System Families

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System Family Transition Economy

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Introduction & Problem Description

**Problem:**
- A manager of an organization shall decide about moving to system family engineering.
- How can the manager determine if such a move makes economical sense in the organization's current state?
- What kind of transition makes most sense?
- What is the most profitable solution?

**Goal:**
- Provide means to decide whether system family engineering is sufficiently profitable in the particular circumstances of an organization.
Relevance & Expected Benefits

- Many organizations made bad experience with opportunistic reuse: they require a profound economical case for system-family engineering!
- A transition to system-family engineering is even more far-reaching, with many financial and structural consequences!
- Therefore, the cost of a transition to system-family engineering must be determined before starting such a move!
- Using an economic model will provide a ballpark-number for the expected cost and thus save money by showing the right way to go!
- Varying parameters will provide the cost in certain circumstances and scenarios, thus suggesting the best alternative for maximum benefit!
Approach & Expected Results

- Identify the major scenarios that may occur when
  - switching to system-family engineering or
  - extending and evolving a system family or
  - merging system families

- Apply a divide-and-conquer algorithm to partition the model describing the cost into factors that can be easily derived from the organization’s experience and current data

- Determine for each scenario the constituent cost factors according to this algorithm and provide thus a cost model for each of these scenarios

- Provide an easy-to-understand example how to apply the formulas
Seven Concrete Scenarios

- Scenario 1: From $s_1$ stand-alone systems to 1 system family of $s_1$ members.
- Scenario 2: No products on the market yet. Compare the case of having one family of $s_2$ products versus $s_2$ single products.
- Scenario 3: Like scenario 3, but the organisation does not know the space of all products yet.
- Scenario 4: Merging two or more families.
- Scenario 5: New product – stand-alone or system family member?
- Scenario 6: New system family based on existing ones – how?
- Scenario 7: Cancelling a product.
### Cost Model: Determine Cost for Developing n Applications with System-Family Engineering - Four Cost Constituents

1. Adapt the organisation: $C_{\text{org}}$

2. Build the core-asset base: $C_{\text{cab}}$

3. Build product-specific parts: $C_{\text{unique}}$

4. Re-use common parts: $C_{\text{reui}}$

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Central Cost Model

The cost $C$ for developing $n$ applications with system-family engineering:

$$C_{\text{org}} + C_{\text{cab}} + \sum_{i=1}^{n} (C_{\text{unique}}(p_i) + C_{\text{reuse}}(p_i))$$

- $C_{\text{org}}$: Cost for the organisation, e.g. reorganization, process improvement, training
- $C_{\text{cab}}$: Cost for building the core asset base
- $C_{\text{unique}}$: Cost for specific development, without reuse
- $C_{\text{reuse}}$: Cost for reusing a core asset
Applying the Cost Model to the Scenarios

**Scenario 1:**
From $s_1$ stand-alone systems to 1 system family of $s_1$ members

$$C_{org} + C_{cab} + \sum_{i=1}^{s_1} C_{unique}(P_i) + \sum_{i=1}^{s_1} C_{reuse}(P_i)$$

**Scenario 2:**
Building $k_1$ systems as part of a family

$$C_{org} + C_{cab} + \sum_{i=1}^{k_1} C_{unique}(P_i) + \sum_{i=1}^{k_1} C_{reuse}(P_i)$$

**Scenario 3:**
Building $k_1$ systems plus $k_2$ new ones as part of a family

$$C_{org} + C_{cab} + \sum_{i=1}^{k_1+k_2} C_{unique}(P_i) + \sum_{i=1}^{k_1+k_2} C_{reuse}(P_i)$$
Applying the Cost Model to the Scenarios

**Scenario 4:**
Merging 2 families with $n_1$ and $n_2$ members, respectively

$$C_{org} + C_{cab} + \sum_{i=1}^{n_1+n_2} C_{unique}(p_i) + \sum_{i=1}^{n_1+n_2} C_{reuse}(p_i)$$

**Scenario 5:**
Building a product $p$ as part of a system family

$$C_{org} + C_{cab} + C_{unique}(p) + C_{reuse}(p)$$

**Scenario 6:**
New system family based on $n$ existing ones with $n_f$ products, respectively

$$C_{org} + C_{cab} + \sum_{j=1}^{n} \left( \sum_{i=1}^{n_f} C_{unique}(p_{i,j}) + \sum_{i=1}^{n_f} C_{reuse}(p_{i,j}) \right)$$
Applying the Cost Model to the Scenarios

Scenario 7:
Cancelling a product in a family with sum products

\[
(C_{\text{cal}} + \sum_{i=1}^{\text{sum}} C_{\text{unique}}(p_i) + \sum_{i=1}^{\text{sum}} C_{\text{reuse}}(p_i)) - (C_{\text{cal}} + \sum_{i=1}^{\text{sum}-1} C_{\text{unique}}(p_i) + \sum_{i=1}^{\text{sum}-1} C_{\text{reuse}}(p_i))
\]
Conclusion

- The cost model allows fast, rule-of-thumb estimations of the cost for producing products in a system family
- All relevant system-family scenarios are captured
- The cost model can be used for decisions about switching to system family engineering and for many kinds of cost decisions about product development in system family engineering
- It has been used to determine the return on investment (ROI) for switching to system-family engineering
References