Families Task 1.2 CWD

A Cost Model for Software System Families

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This work is derived from the results of a working group at the Dagstuhl workshop 2003 with the participants Günter Böckle, Siemens AG; Paul Clements, SEI; John McGregor, Clemson University; Dirk Muthig, Fraunhofer IESE; Klaus Schmid, Fraunhofer IESE

System Family Transition Economy
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

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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: $C_{org}$

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

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

4. Re-use common parts: $C_{reus}$
Central Cost Model

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

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

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

Scenario 1: From 1 stand-alone system to 1 system family of 1 member

\[ C_{\text{org}} + C_{\text{cab}} + \sum_{i=1}^{s1} C_{\text{unique}}(P_i) + \sum_{i=1}^{s1} C_{\text{reuse}}(P_i) \]

Scenario 2: Building k1 systems as part of a family

\[ C_{\text{org}} + C_{\text{cab}} + \sum_{i=1}^{k1} C_{\text{unique}}(P_i) + \sum_{i=1}^{k1} C_{\text{reuse}}(P_i) \]

Scenario 3: Building k1 systems plus k2 new ones as part of a family

\[ C_{\text{org}} + C_{\text{cab}} + \sum_{i=1}^{k1+k2} C_{\text{unique}}(P_i) + \sum_{i=1}^{k1+k2} C_{\text{reuse}}(P_i) \]
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 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 \( n \) products, respectively

\[
C_{org} + C_{cab} + \sum_{j=1}^{n} \left( \sum_{i=1}^{n_j} C_{unique}(p_{ij}) + \sum_{i=1}^{n_j} C_{reuse}(p_{ij}) \right)
\]
Applying the Cost Model to the Scenarios

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

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