



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



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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

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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**

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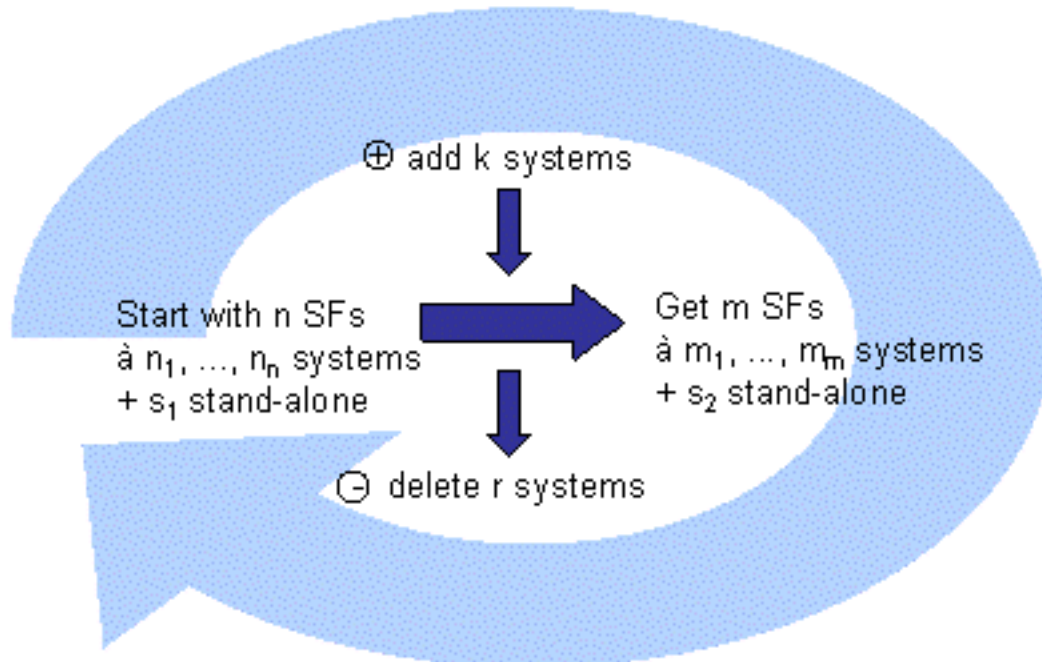
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General Scenario



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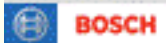
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Seven Concrete Scenarios

- **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.

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Cost Model: Determine Cost for Developing n Applications with System-Family Engineering - Four Cost Constituents

1. Adapt the organisation: C_{org}

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

System-Family Artefacts

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

4. Re-use common parts: C_{reuse}

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Central Cost Model

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

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

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- 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

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Applying the Cost Model to the Scenarios

Scenario 1:

From $s1$ stand-alone systems to 1 system family of $s1$ members

$$C_{org} + C_{cad} + \sum_{i=1}^{s1} C_{unique}(p_i) + \sum_{i=1}^{s1} C_{reuse}(p_i)$$

Scenario 2:

Building $k1$ systems as part of a family

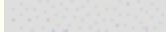
$$C_{org} + C_{cad} + \sum_{i=1}^{k1} C_{unique}(p_i) + \sum_{i=1}^{k1} C_{reuse}(p_i)$$

Scenario 3:

Building $k1$ systems plus $k2$ new ones as part of a family

$$C_{org} + C_{cad} + \sum_{i=1}^{k1+k2} C_{unique}(p_i) + \sum_{i=1}^{k1+k2} C_{reuse}(p_i)$$

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Applying the Cost Model to the Scenarios

Scenario 4:

Merging 2 families with n_1 and n_2 members, respectively

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

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Scenario 5:

Building a product p as part of a system family

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



Scenario 6:

New system family based on n existing ones with n_j products, respectively

$$C_{org} + C_{codb} + \sum_{j=1}^n \left(\sum_{i=1}^{n_j} C_{unique}(p_i) + \sum_{i=1}^{n_j} C_{reuse}(p_i) \right)$$

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Applying the Cost Model to the Scenarios

Scenario 7:

Cancelling a product in a family with sum products

$$(C_{\text{cub}} + \sum_{i=1}^{\text{sum}} C_{\text{unique}}(p_i) + \sum_{j=1}^{\text{sum}} C_{\text{reuse}}(p_j)) - (C_{\text{cub}} + \sum_{i=1}^{\text{sum}-1} C_{\text{unique}}(p_i) + \sum_{j=1}^{\text{sum}-1} C_{\text{reuse}}(p_j))$$

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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

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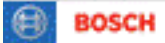
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