



From Projects to Product Lines: A Product Line Economics Case Study

Prepared for Product Family Engineering Seminars:
Oulu 7.10 & Helsinki 12.10

Kai Vuolajärvi, Rauli Käppi, Prof. Jukka Heikkilä

kai.vuolajarvi@cc.jyu.fi, rauli.kappi@cc.jyu.fi, jups@cc.jyu.fi

System Family Transition Economy



[Next](#)

[Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Question and Objectives

- How to evaluate and quantify financial benefits (ROI) of transferring to product family engineering in a practical setting?
- Objective of this presentation and our work was to examine how to calculate and quantify the direct financial benefits of the product family engineering
- Previously developed calculation method used and applied in real company case study
 - Focus on how to calculate & evaluating the model
 - Non financial benefits excluded from the model

SIEMENS



FAMILIES Task 12 QWD, uO.1 draft

© Siemens, Fraunhofer ILIAS, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

System Family Transition Economy

Eureka! 2003 Programme, ITEA project IP02003, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Contents

- **Introduction to Cost Model**
- **Applying Cost Model in one Case Study**
- **Results**
- **Things to Consider when applying Cost model**
- **Further Information**

SIEMENS



FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer IEE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Ivorum Software S.A.

System Family Transition Economy

Burekas 2003 Programme, ITEA project IP02003, FAMILIES

5

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Previous Research

- **Product line engineering is claimed to bring order of magnitude benefits over the one-at-a-time project based product development (Clements & Northrop, 2002; Toft & al., 2000).**
- **Despite the claimed benefits, not all companies apply product line engineering approach.**
- **As shown in previous studies, moving from the current practices to the software product line engineering is risky (Schmid & Verlage, 2002), burdensome and costly (Reifer, 1997).**
- **Deciding on the shift can also be an awkward and highly contingent decision situation (Schmid & Verlage, 2002).**
- **Several articles and books have acknowledged these problems, but the articles focusing in on how to estimate the costs and benefits to justify the change are rare**

SIEMENS



BOSCH



FAMILIES Task 12 CWD, uO.1 draft

System Family Transition Economy

© Siemens, Fraunhofer ISE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

EuroKa2: 2003 Programme, ITEA project Ip02009, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Introduction to Cost Model

- Return on investment should be used as the basic decision factor when deciding upon product line engineering
- Therefore the model with correct formula, for calculating ROI is essential for product line engineering decision
- A return on investment calculation model for software product lines has been established in Cafe/Families project and published in 2004 [Böckle, Clements, McGregor, Muthig, Schmid, 2004]
- The model can be used to compare ROI of Traditional vs. product line approach in product development
 - ROI = $(\text{Cost of Old Way} - \text{Cost of New Way}) / \text{Investments}$

SIEMENS



BOSCH

ESI



FORUM SOFTWARE

FAMILIES Task 12 CWD, uO.1 draft

System Family Transition Economy

© Siemens, Fraunhofer ILIS, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

Eureka! 2003 Programme, ITEA project IP02009, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



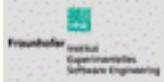
Introduction to Cost Model used

- The formula for calculating the costs of creating a product family is presented below: *(from article)*

$$C_{org} + C_{cab} + \sum_{i=1}^{n1} (C_{unique}(P_i) + C_{reuse}(P_i))$$

- Assumes that you have existing products that you transfer to PFE
- Four variables:
 - Corg : Organizational change costs
 - Ccab : Building a core asset base (platform)
 - Cunigue : Building unique parts of the product
 - Creuse : cost of reusing asset base

SIEMENS



FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer IEBE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

System Family Transition Economy

Europe's 2023 Programme, ITEA project IP00009, FAMILIES

11

[Previous](#) [Next](#) [Close Window](#)

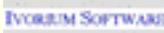
[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Case Description

- **High-technology manufacturing company**
- **Software major part of the products**
- **Focus on one unit, currently manufacturing 15 stand-alone products**
- **Company operates in turbulent, fast changing environment and products are changing rapidly**
- **Currently software engineering inside the unit is distributed to different sites and additionally several vendors provide parts of the SW**

SIEMENS



FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer ISE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Evolum Software S.A.

System Family Transition Economy

Burekas, 2023 Programme, ITEA, project ip02009, FAMILIES



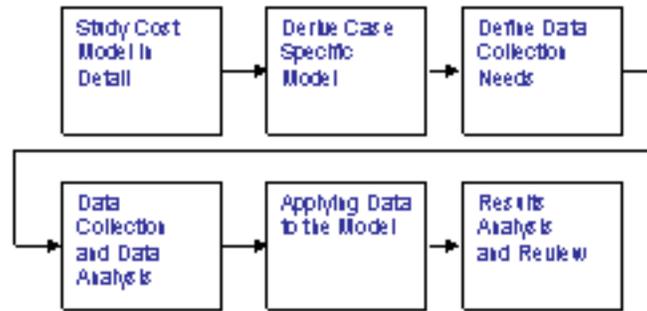
[Previous](#) [Next](#)

[Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Approach



SIEMENS



BOSCH

ESI



IVORUM SOFTWARE

FAMILIES Task 12 CWD, v0.1 draft

© Siemens, Fraunhofer ILR, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Ivorum Software S.A.

System Family Transition Economy

Eureka! 2003 Programme, ITEA project IP02003, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Collecting the Data

Table below presents the data collected for the case study

Cost of building one individual product without PL engineering?	Cprod	1
Number of existing products	Nprod	15
How big is the common part in to be product line? <i>(Rapidly changing, different technologies, distinctive features)</i>	Pcab	40 %
What is the cost of scoping exercise? <i>(Architecture, multisite, programming languages)</i>	Cscoping	1
How much one product changes in version update? <i>(Quality – testing, new technology standards, dynamic)</i>	Pvchge	30 %
How much core asset base changes in version update?	Fcab	10 %
How much effort is needed to train and change organization to adopt PLE? <i>(independent multisite, cultural issues, different standards, processes, to become effective with new code)</i>	Corg	20
How many times more expensive it is to develop software reusable (core asset base)?	Preusecostx	250 %

Note: Cost of Scoping and Cost of Org do not directly represent cost/effort, but is a hybrid of cost/effort, due to comparability issues
 FAMILIES Task 12 QVD, v0.1 draft System Family Transition Economy

© Siemens, Fraunhofer IEBE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Ivorum Software S.A.

Eureka! 2003 Programme, ITEA project IP02008, FAMILIES

SIEMENS



[Previous](#) [Next](#)

[Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)

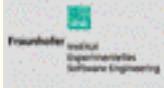


Calculating the variables

Data collected was used to calculate the cost model components

Effort needed to train and change organization to adopt PLE C_{org}	C _{org}	20
Core asset base cost (C_{reusecost} * P_{cab} * C_{prod} + C_{scoping})	C _{cab}	2
Cost of building each products unique part? (1-P_{cab})*P_{vdg}*C_{prod}	C _{unique}	0,18
Cost of updating the core asset base in version update (P_{cab} * P_{cab} * C_{prod})	C _{reuse}	0,04

SIEMENS



BOSCH



$$C_{org} + C_{cab} + \sum_{i=1}^{n1} (C_{unique}(p_i) + C_{reuse}(p_i))$$

FAMILIES Task 12 QWD, u0.1 draft

© Siemens, Fraunhofer ILR, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

System Family Transition Economy

Eureka! 2023 Programme, ITEA project IP02008, FAMILIES

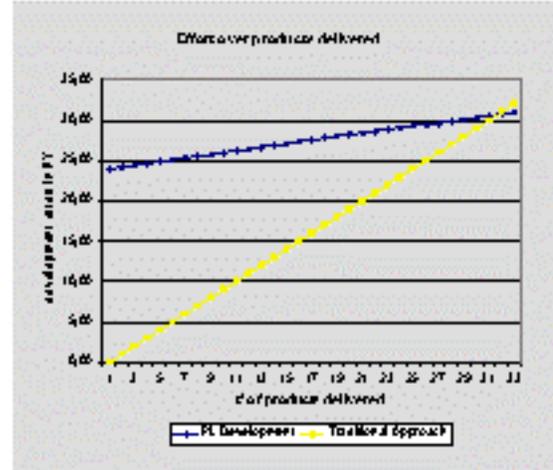
[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



The Results

- In this case model indicates that in transforming to product line engineering break even would be 29 products
- In this case 15 products, not beneficial
- ROI calculated in this case is -47 %



SIEMENS

Fraunhofer Institut Experimentelles Software Engineering

BOSCH

ESI European Software Institute

VTT

UNIVERSITY OF JYVÄSKYLÄ
FORUM SOFTWARE

FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer ISE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

System Family Transition Economy

Eureka! 2003 Programme, ITEA project IP02009, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Comments on the Results

- **The results suggested by the model are not very encouraging considering PLE**
- **Main reason for this is estimated high training and organizational change costs, reasons for high costs are:**
 - **Multisite development environment**
 - Requires large effort to gain agreement
 - Every site has own wishes, organizational boundaries, traveling costs
 - **Multiple tasks included**
 - Initial resource gathering
 - Architecture planning
 - Resource allocation for component project
 - Training about components for whole personnel
 - Common tools implementation (eg. version management)
 - Individual training + learning time to learn to use certain components
 - **Calculated as a time to become effective with new code & processes & standards**

SIEMENS



BOSCH



FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer ILIAS, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

System Family Transition Economy

Europe's 2003 Programme, ITEA project IP02003, FAMILIES



[Previous](#) [Next](#)

[Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) 12 [13](#) [14](#)



Conclusion & Outlook

- **The cost model used is very beneficial in calculating quickly rough estimate of the benefits of the software product line engineering (took 1 month, about 15 man days)**
- **Level of detail is sufficient for rough estimate, but in order to prepare detailed financial calculations to base decision on PLE more detailed model is needed**
- **Anyhow we found the cost model useful for every organization considering PLE approach. Model can be applied very quickly to yield first estimates on the financial effects of the PLE**
- **Model is still 1st revision, limitations exists:**
 - Model does not consider non-financial benefits of product line engineering, e.g. faster time to market, higher product quality
 - Assumes big bang approach
 - Lacks time effect on investment
 - Sensitivity analysis not built in

SIEMENS



FAMILIES Task 12 QWD, uO.1 draft

System Family Transition Economy

© Siemens, Fraunhofer IESE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Forum Software S.A.

Europe's 2003 Programme, ITEX project IP02003, FAMILIES

[Previous](#) [Next](#) [Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#)



Further Information & Contacts

• Original cost model presentation

- Bockle, G. Clements, P. McGregor, J.D. Muthig, D. & Schmid, K. (2004). Calculating ROI for software product lines. *IEEE Software* 21(3), 23 – 31
- Clements P.C., McGregor J.D., & Cohen S.G. (2005). *The Structured Intuitive Model for Product Line Economics (SIMPLE)*, (CMU/SEI-2005-TR-003, ESC-TR-2005-003) Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 2005. (also in SEI website)

• Cost Model Case Study

- Jukka Heikkilä (Jups@cc.jyu.fi, primary contact)
- Kai Vuolajärvi (Kai.vuolajarvi@nokia.com)

SIEMENS



FAMILIES Task 12 CWD, uO.1 draft

© Siemens, Fraunhofer IESE, Robert Bosch GmbH, ESI, VTT, University of Jyväskylä, Ivorum Software S.A.

System Family Transition Economy

Europe's 2003 Programme, ITBA, project ip02008, FAMILIES

[Previous](#)

[Close Window](#)

[1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) 14