Knowledge Management In Software Process Improvement

PhD Defence for

Finn Olav Bjørnson

Trondheim, 14th November 2007
Outline

• Background and Motivation
• Research Goals and Process
• Contributions
  – Previous Research
  – Process Workshops
  – Post Mortem Analysis
• Research Themes
Background & Motivation

- Software Process Improvement, the belief that improving the process will lead to improvement in the final product.
- Software development practice depends on the knowledge and competencies of the employees.
- To change developers practice we should focus on improve the knowledge of the practitioners.
Research context: The SPIKE Project

- SPIKE – Software Process Improvement through Knowledge and Experience.
- Main contractor: Abelia
- 3 Research partners:
  - NTNU
  - UiO/Simula Research Laboratory
  - SINTEF
- 10 Industrial Partners
- Goals of SPIKE
  - Empirical studies in industrial projects
  - Shared projects across companies
  - Dissemination of result
  - Active participation in national and international fora
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Goal and research themes

- **How can Knowledge Management be applied to Software Engineering in order to foster Software Process Improvement?**
  - RT1: Previous research on knowledge management in software engineering.
  - RT2: Application of knowledge management to improve the software process through codification of knowledge.
  - RT3: Application of knowledge management to improve the software process through personalization of knowledge.
Research Process
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Contributions

C1: An overview of the research literature on empirical studies of knowledge management in software engineering.

C2: A method for tailoring the **Rational Unified Process** to the development process of a software consulting company.

C3: Improvements of the **Process Workshops** method by contextualization.

C4: Improvement of the root-cause analysis phase of the lightweight **Post Mortem Analysis** for more effective project reviews.

C5: Proposed methods to increase the learning effect of **mentor programs** in software engineering.
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KM in SE

• Systematic review vs. regular literature review
  – Review protocol
  – Explicit search strategy
  – Explicit inclusion and exclusion criteria
  – Explicit strategy for what information to collect

• Searched 4 electronic databases, proceedings of all Learning Software Organisation Workshops and the book Managing Software Engineering Knowledge

• Initial result: 2102 papers
• End result: 68 papers
• Classified on two axis, according to research quality and theme
  – 29 empirical studies (4 outside the classification)
  – 39 Lessons learned
Publication trend for KM in SE
## Distribution of research for KM in SE

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[NTNU Logo]

[www.ntnu.no]
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Action Research Studies

• Based on five basic principles:
  – Researcher Client Agreement
  – Cyclical Process Model
  – Theory
  – Change through Action
  – Learning through Reflection

• 3 companies
  – Rational Unified Process
  – Mentoring
  – Process Workshops
Process Workshops (PWS)

1. Decide on process(es) to define
2. Invite participants
3. Process workshop
4. Delegate responsibility for implementation
5. Role-based reading of resulting process
6. Define sequence
7. Define input and output
8. Define roles
9. Identify activities
10. Find related documents
11. Define input and output
12. Implement the process in EPG
Industrial Contexts for PWS

• Alpha Company
  A leading producer of receiving stations for data from meteorological and Earth observation satellites.

• Beta Company
  A small software consulting company. Hiring out consultants for development, developing complete solutions, and hiring out advisors.
Difference in Action Research Method

Alpha Company
• Three cycles
• Initiation was collaborative
• Authority evolved from researchers to company
• Formalization evolved from formal to informal

Beta Company
• One cycle
• Initiation was collaborative
• Authority evolved from company to researchers
• Formalization evolved from formal to informal
Results of Process Workshops

• The premises of the company will strongly influence the execution of the process workshops.
  – If the employees are used to working according to a process, the workshops can be used to formulate the starting point of a new process based on best practice.
  – If no clear process exists, the focus of the workshops should be on reaching an agreement on the current process.
• If the PWS approach is used to reach an agreement on the current process, a good starting point is to focus the discussion on artifacts.
• If the PWS approach is used to specify future processes based on best practice, the discussions should be focused towards activities.
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Introduction to PMA

• Light-weight Post Mortem Analysis (PMA)
  – Used to elicit and discover experiences from projects.
  – A structured brainstorming technique, focusing on project experiences.
  – Demands little resources and can be performed on half a working day.
  – Focuses both on the positive and negative aspects of projects.
  – A PMA tries to discover:
    • What happened in the project?
    • Why did it happen?
    • What can we do to make it or not make it happen again?
  – A PMA should involve all project participants!
PMA Experiment

- Observed informally in SPIKE companies and used in a course on software architecture in 2004.
- Observed that participation dwindled towards the end of the method.
- Suggested to change the brainstorming technique and notation during the second part of the method.
- Changes tested informally in 2005
- Interesting results lead to a planned formal experiment in 2006
- Formal experiment carried out on 142 students!
Light-weight PMA process

• Typical steps:
  – Brainstorm on the positive aspects of the project using KJ-diagram.
  – Brainstorm on the negative aspects of the project using KJ-diagram.
  – Prioritize what elements of the KJ-diagrams that should be investigated for causes for the problem/success.
  – Root-cause analysis for a positive main element found in the KJ analysis.
  – Root-cause analysis for a negative main element found in the KJ analysis.
Revised Method

- Kept the KJ-diagrams
- Changed the Root Cause Analysis
  - More nominal brainstorming technique
  - More free form causal map notation
Results of the Experiment

• Revised method statistically significantly better.
  – Context of small groups
  – No experienced facilitator available

• The revised method was found to be more effective, since it produced qualitatively better results in the same timespan in the form of:
  – Deeper analysis.
  – more specific and practical issues that could be addressed in future projects.
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Research Theme 1

- **RT1: Previous research on knowledge management in software engineering.**
  - C1: An overview of the research literature on empirical studies of knowledge management in software engineering. (One paper P7)
  - A possible building block for further research within the field
  - A framework to categorize our own studies
Research Theme 2

- **RT2: Application of knowledge management to improve the software process through codification of knowledge.**
  - C2: A method for tailoring the Rational Unified Process to the development process of a software consulting company. (Three papers: SP6, P2, P5)
  - C3: Improvements of the Process Workshops method by contextualization. (Two papers: P1, P4)
  - Balance between artifacts and activities seem to be dependent on process maturity.
  - Ownership fosters process compliance.
Research Theme 3

- **RT3**: Application of knowledge management to improve the software process through personalization of knowledge.
  - C3: Improvements of the Process Workshops method by contextualization. (One paper: P4)
  - C4: Improvement of the root-cause analysis phase of the lightweight Post Mortem Analysis for more effective project reviews. (One paper: P6)
  - C5: Proposed methods to increase the learning effect of mentor programs in software engineering. (One paper: P3)

- Little research within this field in software engineering
- Individual learning effect seems higher
- Nominal brainstorming approach followed by interactive discussions seem to strengthen learning effects.
3 main directions for future work

• Extending the framework we have started in our systematic review.
• Follow the indications that process maturity seem to influence the balance between artifacts and activities in discussions relating to process improvement.
• Follow the use of PMA’s particularly in new agile projects where there is a clear need for effective dissemination of knowledge through short meetings.
Thank you for listening!
Facts

- This work was conducted as part of the SPIKE project, funded by the Norwegian research council under grant 156701/220.
- SPIKE funded 75% of the research while the remaining 25% was funded by mandatory teaching assistant duties at the department of computer and information science.
- The work was performed at the department of computer and information science under the main supervisor Reidar Conradi, and co-supervisors Torgeir Dingsøyr and Tor Stålhane.
- The research was carried out from 2003 to 2007.
- A total of 14 papers were produced as part of this work, 7 of which are included in the final thesis.
Included Papers

P1: Harvesting Knowledge through a Method Framework in an Electronic Process Guide
P2: Tailoring RUP to a defined project type: A case study
P3: A study of a Mentoring Program for Knowledge Transfer in a Small Software Company
P4: Defining Software Processes Through Process Workshops: A Multicase Study
P5: Tailoring and introduction of the Rational Unified Process
P6: Improving the Effectiveness of Root Cause Analysis in a Retrospective Method: a Controlled Experiment
P7: Knowledge Management in Software Engineering: A Systematic Review of Studied Concepts and Research Methods Used
Other papers, not included

SP1: Empirical Study on COTS Component Classification
SP2: An Empirical Study of COTS Component Selection Processes in Norwegian IT companies
SP3: An Empirical Study of Variations in COTS-based Software Development Processes in Norwegian IT Industry
SP4: Using Open Space Technology as a Method to Harvest Domain Knowledge
SP5: Future studies of Learning Software Organizations
SP6: Using Rational Unified Process in an SME – A Case Study
SP7: An Empirical Study of Variations in COTS-based Software Development Processes in Norwegian IT Industry