Continuous Innovation and Experimentation in Complex Problem Domains: Problem Solving and Decision Support as a Starting Point for a Unified Process Framework

Sebastian Klepper¹, Christian Grimm², Bernd Bruegge³

Abstract: Continuous software engineering enables experimentation and empirical research in complex problem domains. Existing process models describe different approaches for exploration, innovation, and refinement. We propose a new approach based on problem solving techniques and focused on decision support to serve as the starting point for a unified process framework.

Keywords: Continuous innovation; Continuous experimentation; Continuous software engineering; Hypothesis-driven development; Complex problem solving; Decision support; Agile development

1 Introduction

Historically, software engineering aimed to produce complete, consistent, and correct solutions. Agile methodologies improved on completeness and consistency through incremental and iterative development, respectively. Providing the correct solution to a problem appears to remain an issue (to this day⁴), especially considering cost-effectiveness. Lack of domain knowledge was identified as a root cause early on, causing a shift towards value-orientation and knowledge management techniques. [AW05, pp. 309-326, 427-452, 453-476]

New technologies and techniques utilized in continuous software engineering (CSE) reduce time and effort required for applying empirical research and the scientific method. Multiple models have emerged for using feedback, data, experiments, and more to generate domain knowledge for both exploration and refinement. [Bo12; Bo14; FS17]

In this paper we review existing models in dimensions to discover commonalities and differences as well as gaps. We subsequently present a complementary approach that combines existing concepts with new ideas to serve as the starting point for our vision of a unified process framework that is comprehensive but still easy to learn, apply, and tailor.

¹ Technische Universität München, Munich, Germany sebastian.klepper@tum.de
² Technische Universität München, Munich, Germany christian.grimm@tum.de
³ Technische Universität München, Munich, Germany bruegge@in.tum.de
2 Related work

We reviewed recently published process models that fit the definition of continuous innovation and experimentation. We differentiate between models focused on innovation and value prediction (HDE [ERD11], IES [Bo12], ESSSDM [BLB13], EVAP [FOB15]) and models focused on experimentation and continuity (HYPEX [Bo14, pp. 155–163], QCD [OB15], DVOCE [EÞ16], RIGHT [Fa17]). From this analysis as well as from the literature presented initially, we deem the following dimensions essential for a unified model of this scientific approach to continuous software engineering:

- **Continuity** Execute activities asynchronously and in parallel, but at least iteratively.
- **Opportunism** Learn from unexpected insights and seize opportunities for value creation.
- **Experimentation** Test hypotheses, measure effect of changes, compare alternatives.
- **Prediction** Validate critical assumptions before investing significant time and resources.
- **Innovation** Discover market conditions, customer needs, potential features, or technologies.
- **Refinement** Improve and optimize existing solutions, e.g., performance, quality, utilization.
- **Decision-making** Support decisions, e.g., regarding priorities, feature set, or technology.
- **Research methodology** Use research method and data source appropriate for the situation.

Models are rated on how comprehensively they describe these dimensions: scarcely (0), rudimentary (1), or detailed (2). Fig. 1 and 2 show our rating for both groups of models, illustrating the difference in scope, focus, and depth. We want to draw special attention to the need for integration of decision and execution processes — an integral part of CSE dubbed “BizDev” by Fitzgerald; Stol [FS17].

![Fig. 1: Rating of process models focused on innovation and value prediction](image1)

![Fig. 2: Rating of process models focused on experimentation and continuity](image2)

3 Proposed workflow

Since our goal is to unify existing approaches, the review results suggest starting with an overarching problem solving process. This process should focus on decision-making,
research, and prediction; later it should integrate with other dimensions. We draw inspiration from approaches to solving “wicked” problems with no clear definition or solution, replacing issues and arguments with problems and insights. [cf. Ku70] Our workflow recursively moves through the problem space by analyzing and breaking down problems, looking for solutions, and conducting research for decision support in the face of uncertainty.

Fig. 3: Workflow for continuous problem solving

Fig. 3 models this problem solving process as a flow of activities triggered by events. While their higher-level order is goal-oriented, individual parts can be invoked at any time and subprocesses run asynchronously, ensuring continuity. These subprocesses (omitted for brevity) find and validate problems; break them down; find, validate, and estimate solutions; handle stakeholder input; and react to unexpected opportunities. We model these activities as prioritization, selection, and classification problems. [see AW05, pp. 267-286]

These types of decisions are supported by invoking the empirical research process illustrated in Fig. 4 to answer questions or validate hypotheses. Research activities are also executed asynchronously, allowing integration with experimentation models like QCD or RIGHT, and available results are handled in the subprocesses accordingly.

Fig. 4: Workflow for empirical and scientific research
4 Conclusion

Our vision is a comprehensive and flexible process framework for continuous innovation and experimentation. After reviewing existing models we designed a complementary workflow for “continuous problem solving” and plan to leverage existing approaches for subprocesses like experimentation, value prediction, prioritization, or selection.

At the current stage our workflow primarily aims to optimize the benefit-cost ratio but is also able to react to opportunities like technological advancements. Future work includes refining the design of subprocesses, integration with other models, and thorough validation.

References


