A Process Research Framework:
Process Engineering

Link: http://www.sei.cmu.edu/library/abstracts/books/iprc.cfm

Bibliographic information:

Dieter Rombach, Ross Jeffery, Bill Peterson, Michael D'Ambrosa, Mario Fusani, Ho-Won Jung, Jürgen Münch, Alexis Ocampo. A Process Research Framework, chapter Process Engineering. Software Engineering Institute, 2006.

4

4.1 Introduction of Theme

This theme primarily looks at processes from a process engineering perspective. Incorporated in this theme is the allied topic of integrating systems development processes with domain-specific processes. The focus of the previous theme (relationships between process and product quality) is on product qualities, their definition, and the characterization of processes that promote particular product qualities. The focus of this theme is on processes *per se*—how to define a process, construct a process from process components, and then understand and model process performance with a view toward building predictive capabilities based on experimenting with process models.

4.2 Theme Rationale

This theme is concerned with providing a set of process artifacts and mechanisms for effective (re)use by activities described in the process deployment theme. This objective includes

- **specifying processes using evidence** (e.g., defining scope of process, deriving process goals from business needs, technology, socio-political environment, and domain; providing quantitative process or product relationships for relevant goals) based on results from "relationships between processes and product quality" and "deployment and use"
- **organizing processes for (re)use** (e.g., identifying process families, engineering processes from process components) with process lines as an optional architecture for process components
- **providing process engineering infrastructure** for selection, integration, tailoring, and learning (e.g., providing methods and tools, applying existing process frameworks)

4.3 Characterizing the Current State of the Practice

The current state of process engineering is based upon ad hoc selection, tailoring, and integration without credible evidence of process impact. While companies with processes operating at CMMI[6®] framework level 3 or above do have organizational standard[7] processes they tailor to

6 ® CMMI is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

7 This meaning uses the CMMI definition of a "standard" process: "A standard process describes the fundamental process elements that are expected to be incorporated into any defined process. It also describes the relationships (e.g., ordering and interfaces) among these process elements."

create defined[8] processes for specific projects, we know of little commonly agreed upon evidence to support the "goodness" of these processes.

Today, we have no commonly acknowledged way to build processes from process components and no clear understanding of how to define process component interfaces.

We also have no commonly acknowledged way to build processes from process components and no clear understanding of how to define process component interfaces or to assess the compatibility of linked process components. Processes are constructed often by crafting than by applying engineering principles.

In summary, with the current state of knowledge, we are unable to

- specify accurately the elements of a process having desired characteristics (functionality and capability or repeatability)
- confirm that a process model, if correctly implemented, will meet the requirements defined for its purpose (including business objectives)
- confirm the fidelity and suitability of a process from an analysis of its specification
- determine a strategy for constructing a process model from known or proven elements (subprocesses)

4.4 Characterizing the Desired State of the Practice

Process line engineering combines process engineering with the concept of product line engineering. Variant-rich processes contain process elements (e.g., activities, inputs, outputs, or roles). Process elements that contain variation points are called variant-rich process elements. They are organized in a process line infrastructure that is designed with strategic business goals in mind. Concrete processes are derived from the process line infrastructure (i.e., instantiating the process line and resolving the variation points contained in variant-rich process elements). Intelligent support increases the efficiency of evidence collection, process selection, tailoring, and integration.

8 Again, we're using the CMMI definition of a "defined" process: "A managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets."

4.5 Description of the Research Nodes

This theme has three research nodes:

- specifying processes using evidence (E.1)
- organizing processes for reuse (E.2)
- providing process engineering infrastructure (E.3)

The focus of this theme is on those processes for developing software-intensive systems or pure software systems.

4.5.1 Research Node E.1: Specifying Processes Using Evidence

The objective of this research node is to provide the abilities to specify, select, and evaluate processes based on evidence.

The first step in process specification is to identify needs for credible evidence. This step draws upon business goals, as well as linkages to evidence from process and product quality relationships and motivations from process deployment and use. The first of these linkages provides evidence of the applicability of a process to the needs for one or more specific product qualities. The second linkage provides feedback on process deployment and use and considerations of people competency issues. This research node, specifying processes using evidence, then integrates these sources of evidence and understanding so that we can reason clearly about the requirements or selection criteria for processes.

Research questions associated with this node include[9]

Scope of Specification	
E-1	How can usable best practices be identified?
E-2	What kinds of processes are needed for value-creating networks; virtual teams; partnering; outsourcing, multi-site development, end-user development?
E-3	How can we align processes with business goals?
E-4	How to perform a gap analysis between today's state and a desired future state?

9 We've given each research theme a letter identifier so that the quesitons associated with each theme can be more readily identified. We've identified this theme on process engineering with the letter E. Other themes on the relationships between processes and product qualities (identified with Q), managing project processes (P), and process deployment (D) feature the same treatment. In addition, questions associated with the effects of emerging trends are identified with a T and those in the example instantiation for security with an S.

Mechanisms for Specification

E-5	How can we best specify a process?
E-6	How can process definitions be packaged together with a quantitative/qualitative model describing their behavior?
E-7	What are appropriate process notations?
E-8	Can a process be analyzed to determine if it is implementable?
E-9	What process evidence is required?
E-10	What evidence is required with respect to process risks?
E-11	How can this evidence be specified and applied to the selection, tailoring and integration of processes?
E-12	How to combine evidence and "context"?
E-13	How does the context of a process (e.g., organization size, culture, process distribution) influence process selection criteria?
E-14	How can acquired process components be evaluated and certified (so that they can be trusted)?
E-15	How can knowledge from the related areas of organizational and behavioral studies be incorporated into the definition and specification of processes that can be effectively implemented?
E-16	How can we assure that a process will meet product/project requirements and standard compliance?
E-17	What does it mean to certify a process component and how could this be achieved? (For example, what criteria could such certification be made against?)

Process Specification Improvement	
E-18	How can we improve process specifications based on feedback from deployment and use?
E-19	How can the value of a process be determined and monitored?
E-20	How can the quality and cycle time performance implications of process decisions be evaluated?
E-21	What effects do different domains have on the selection criteria for processes? The critical issue here is the need for a clearer schema for classifying and categorizing "domains." There is confusion between business domains, application domains, and industry domains, as well as with factors incorporating cultural issues. Identification of critical domain characteristics is crucial. Once these are known, the process and systems engineering issues can be addressed.

4.5.2 Research Node E.2: Organizing Processes for Reuse

The objective of this research node is to engineer processes from reusable process components and other artifacts to meet specified process requirements. One approach is to frame the issue in the context of process lines.

Leveraging the business investment in processes for reuse in multiple projects, business units, and sites is a critical issue for process engineering. The multiple mechanisms to support reuse include process libraries, process tailoring, process standards, best practices, and expert experience-exchange networks. *Software product lines* target at strategic reuse in products linked to the business advantage instead of reuse as a goal by itself. Transferring the concept to process engineering is the key idea behind process line engineering:

- Generic process elements containing commonality and variability are organized in a process architecture that is designed with strategic business goals in mind.
- Concrete processes are derived from a process architecture, instantiating the process architecture and binding variation points of generic process elements.

Typical variation points of generic process elements are the application domain, project goals, and team competence. *Tailoring* of processes in a process line becomes mostly a variant selection activity. The process architecture and process component *integration* are the critical mechanisms to guarantee that tailored processes fit together and form a smoothly operational process landscape. Finally, the reusable process components of a process line require ongoing improvement and *evolution*.

Research questions associated with this node include

Process Lines

E-22	How can we define the scope of process lines?
E-23	How can we define the value of process lines?
E-24	How can we organize processes and evidence into one or more process lines (similar to the concept of product lines)? This includes domain-specific issues.
E-25	What is the appropriate degree of commonality of processes/ procedures (e.g., across multiple sites, disciplines, and cultures)?
E-26	How to understand the difference between different domains with respect to processes and measurement?
E-27	What effects do different domains have on the selection criteria for processes?
E-28	How can process line engineering be aligned with product line engineering?
E-29	How should a process architecture be constructed for a process asset base?
E-30	How can the right process elements be identified in the asset base for a specific project as a function of product requirements and team competence?

Tailoring

E-31	Can a formal approach, based on a sound theoretical basis, be developed to address the tailoring of processes for specific implementations?
E-32	What are the organizational and environmental factors that affect tailoring choices (e.g., tailoring for small enterprises or for agile development)?
E-33	How can we tailor processes with predictable effects on efficiency?
E-34	How can processes be designed for easy tailoring?
E-35	How to specify processes including variability?

Interoperability

E-36	To what extent is it possible to integrate different processes, in particular when they are based on different paradigms, for example, agile processes versus more waterfall-like approaches?
E-37	How can we harmonize the mental model of sequential development with the reality of continuous iteration?
E-38	How can processes be packaged together with a quantitative/qualitative model describing their behavior?
E-39	Are there mechanisms for understanding and improving interoperability between processes (composability analysis: pre/post conditions, inputs/outputs, styles, assumptions)?
E-40	How can domain-specific development processes (product dependent) and software/systems development processes be synchronized?

Evolution

E-41	How does the context of a process (e.g., organization size, culture, process distribution) influence process evolution?
E-42	How can we evolve process lines based on deployment feedback?
E-43	How can processes be made sufficiently adaptive to provide effective support in responding to domain-specific change?

4.5.3 Research Node E.3: Providing Process Engineering Infrastructure

The objective of this research node is to provide infrastructure to support process engineering. This infrastructure includes the appropriate support organization and integrated support for all the activities for specification, integration, tailoring, and learning.

The research questions are divided into two areas: (1) organization and training and (2) technology. The organization questions focus on defining organizational hierarchies that reflect the advances being proposed. In parallel the training questions focus on the related people skills. The technology questions focus on process lines and other technology approaches to support organizing processes for reuse.

Research questions associated with this node include

Organization & Training

E-44	What process infrastructures are appropriate to support the new technologies and concurrent engineering?
E-45	How do we create easy to use "experience bases" that allow knowledge to be stored, updated, and accessed by developers at varying levels (to facilitate the continuous evolution of problem domains and technical skills required as businesses move into new hybrid domains, for example)?
E-46	How do the team competencies affect the engineered development processes?
E-47	How do we educate people for process engineering in general and the use and/or development of process lines in particular?
E-48	How do we educate people in the need for and the use of evidence?

Technology

E-49	Which activities related to evidence creation, process line engineering, and usage can or should be automated?
E-50	What automated decision support is useful and how can automation and human (educated) creativity be balanced?
E-51	How do we perform process model configuration management?
E-52	How could "process patterns" be best used?
E-53	What is the role of process simulation in providing trust, scaling, and supporting process prediction, selection, tailoring, and integration?
E-54	What visualizations can support process management (including different views for different stakeholders and different business domains)?
E-55	What level of statistical analysis is feasible and reasonable to apply to process management?
E-56	What is appropriate support for automated metrics collection?
E-57	How can an inference engine for effective display and retrieval of processes be constructed?
E-58	How can we use process evidence to derive theories about process, product, and resource dependencies?
E-59	How do we define intellectual property for a process?
E-60	How can we integrate process engineering and workflow management tools?