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Research Prototypes versus Products: Lessons Learned from Software Development Processes in Research Projects

Dietmar Winkler **Richard Mordinyi** **Stefan Biffl**

Vienna University of Technology, Institute of Software Technology

Christian Doppler Laboratory "Software Engineering Integration for Flexible Automation Systems (CDL-Flex)"

http://cdl.ifs.tuwien.ac.at

Motivation & Goals

Motivation:

- Research Projects typically focus on prototype development investigating novel concepts.
  - Highly flexible processes, e.g., new ideas, concepts, and evaluations.
- Industry projects focus on the development of robust and high-quality products.
  - Typically more stable environment and processes.
  - Additional effort for quality assurance and usability needed.
- Different strategies and goals of researchers and industry people.

Key research question focus on:

- How can we bridge the gap between
  (a) research projects and industry projects and
  (b) research prototypes and industry products?

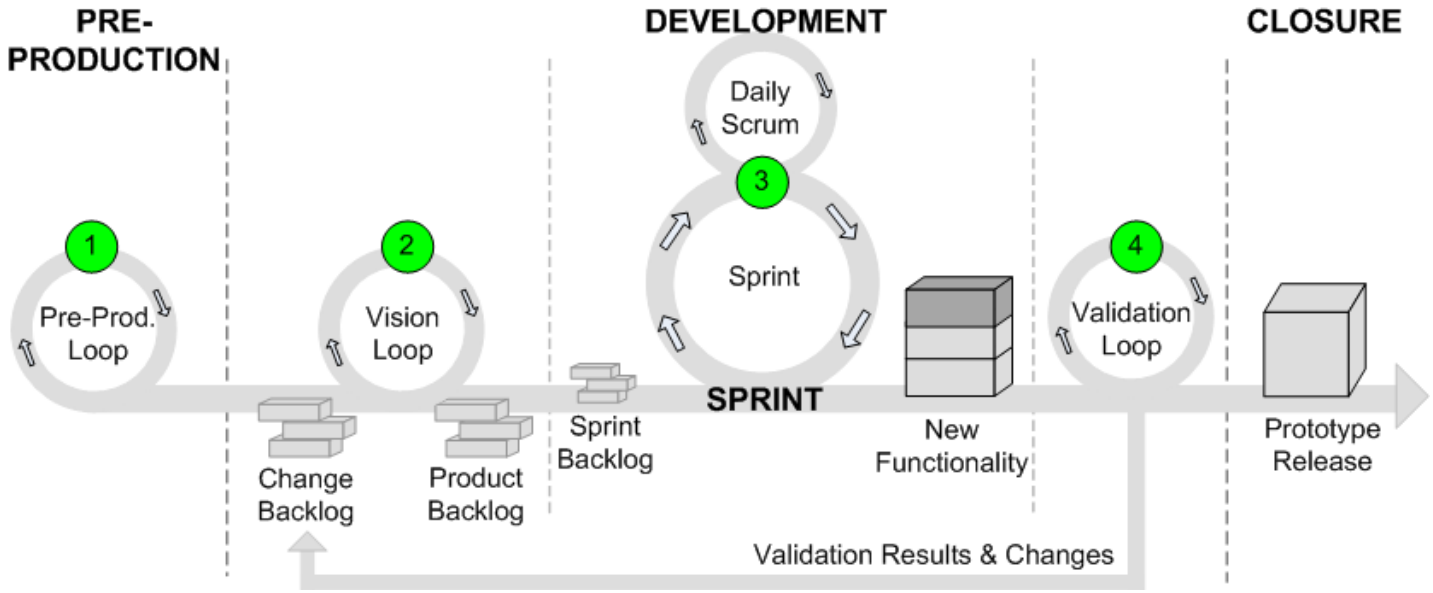
Goals of the paper:

- Comprehensive engineering process to support (a) research prototype handling, (b) industry product development, and (c) transition from prototypes to products.
- Summary of lessons learned after 3 years of a 7 year research project.

Related Work on SE Processes

Software engineering processes:

- Traditional approaches, e.g., V-Model
  → hardly applicable in a research project with highly flexible and unclear requirements.
- Agile approaches, e.g., Scrum
  → Basically applicable for prototype and product development within a stable environment.
  → In research prototypes tools, methods, and development environment may change.
- Extended Scrum model based on a gaming development process approach*.

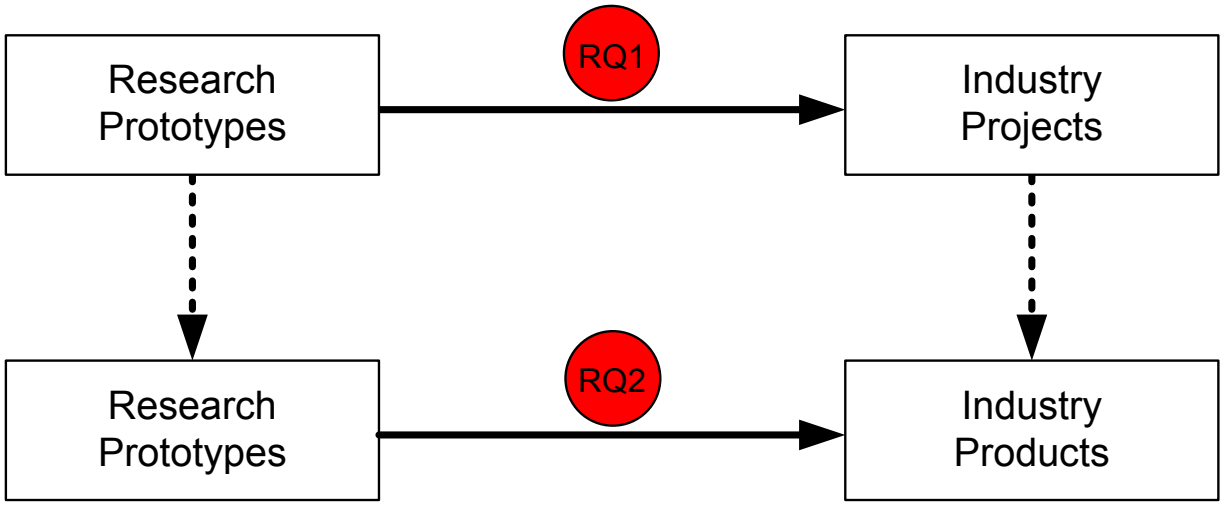


*Musil J., Schweda A., Winkler D., Biffl S.: Improving Video Game Development: Facilitating Heterogeneous Team Collaboration Through Flexible Software Processes", EuroSPI 2010.

Research Questions

Key research questions include

- RQ1. How can we bridge the gap between research projects and industry projects?
- RQ2. How can we transfer research project prototypes to industry projects?



CDL-Flex Research Project
Overview

Context:

- Automation Systems Development Projects, e.g., Hydro Power Plants
- Involvement of various disciplines, e.g., mechanical, electrical, and software engineers.
- Isolated tools and data models are not or loosely connected.

Project Goal:

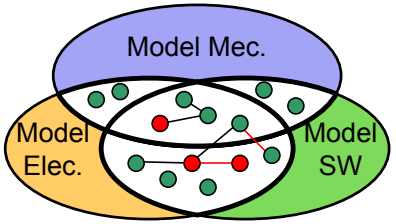
- Engineering process support in heterogeneous engineering environments.

Need:

- Efficient data exchange between heterogeneous tools and data models
- Comprehensive project support (project monitoring and control)

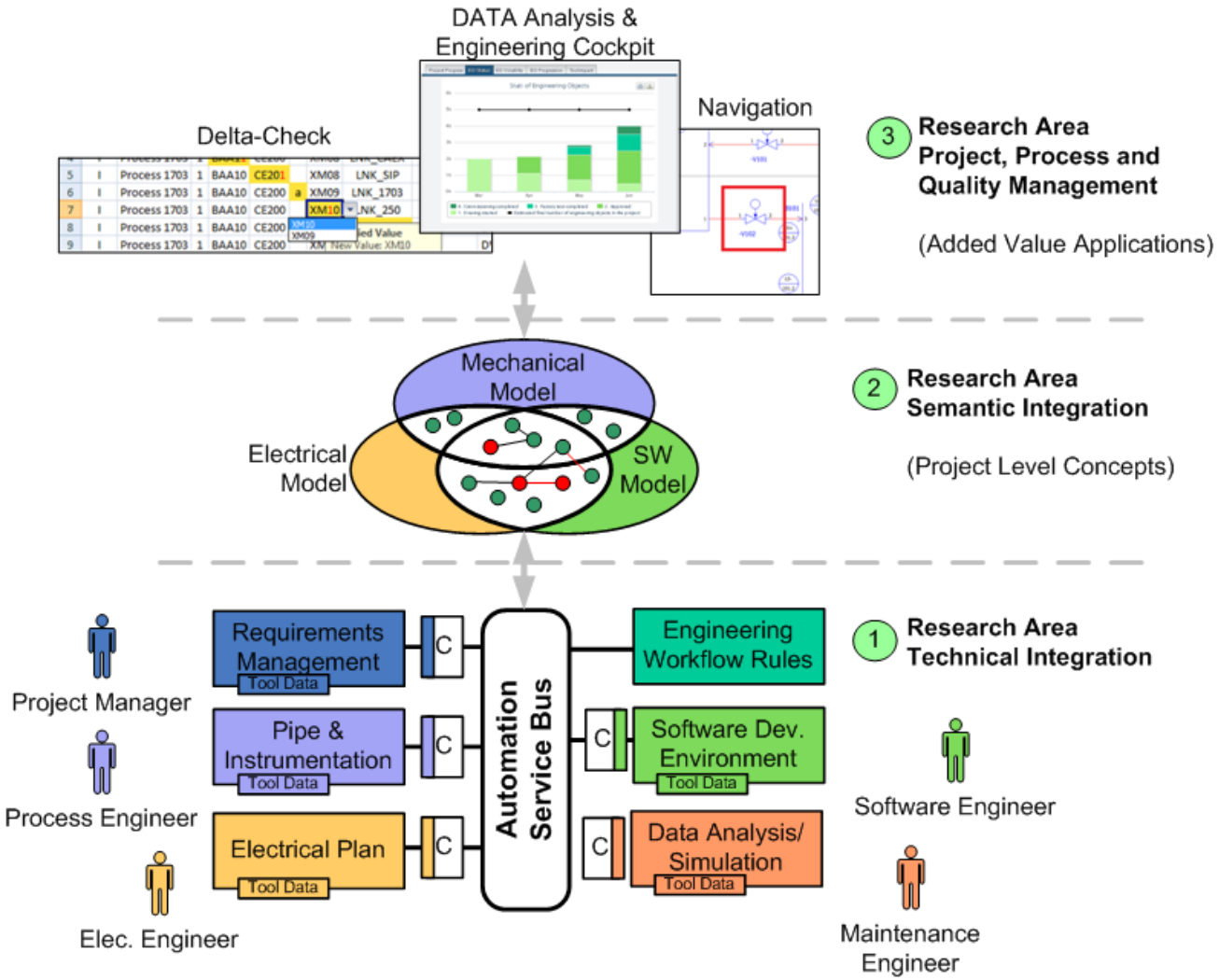
Challenges include overcoming

1. Technical heterogeneity of tools
2. Semantic heterogeneity of data models
3. Inefficient (manual) process and project management support



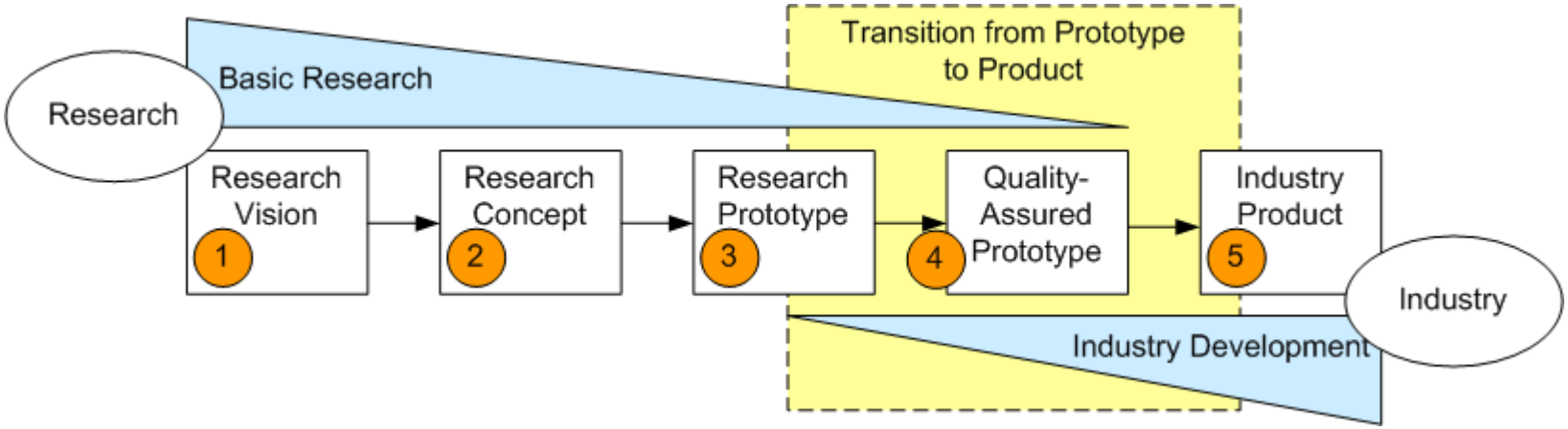
CDL-Flex Research Project

Research Area Overview



Prototype / Product Maturity Levels
Solution Approach

- Level 1: Creative Processes, Concept finding
- Level 2: Proof-of-Concept prototypes, Mockup prototypes
- Level 3: Functional prototype to show concept feasibility
- Level 4: Quality Assured Prototype including quality assurance activities
- Level 5: Application of industry-related environments.



- How to link maturity levels to software engineering processes to support (a) prototype, (b) product and (c) transition phases?

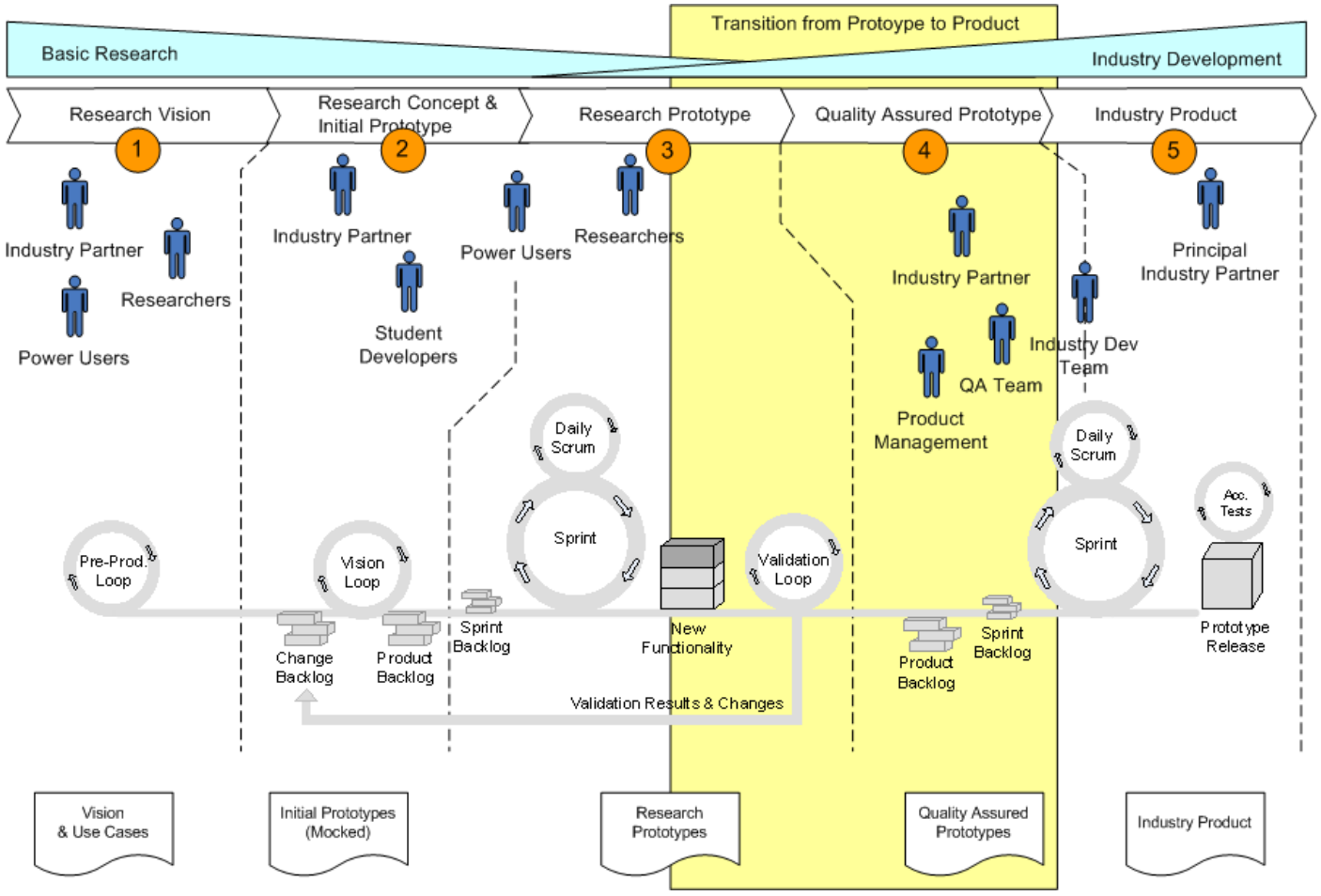
Comprehensive Engineering Process
Solution Approach

Prototype / Product Maturity

Key Stake-holders

Agile Eng. Process with Scrum Extensions

Key Deliverables



Lessons Learned and Key Findings

- Application of tools and methods for prototype and product development according to defined maturity levels.

	Vision	Concept	Research Prototype	Quality Assured Prototype	Industry Product
Outcome	Research Vision	Reserach Concept	Use Case / Features	Use Case / Features	Use Case / Features
		Mock-Up Prototype Proof of Concept Feasibility Study	Functional Prototype	Prototype: robust, stable, and fault tolerant	Industry product
Maturity Level	n/a	low	low	medium	high
QA approaches applied	informal feedback	systematic feedback test case definition	test case definition manual tests	automated tests QA metrics	According to engineering process definition
Users	Researcher	Researcher Developers	Researcher Developers Power Users	Industry Partners Power Users End Users	Industry Partners Power Users End Users
Evaluation	informal discussion	interviews and feedback	basic tests	Automated tests QA metrics Acceptance Tests	Automated tests QA metrics Acceptance Tests
Cost/Value evaluation	Estimation of experts and researchers.	Expected benefits based on state of the practice (Experts)	Basic measurement results from pilot applications,	Comparative evaluations in real world settings (pilot application)	Comparative evaluations in real world settings (pilot application)

Summary & Future Work

Summary

- Research projects vs. Industry projects
- Research prototypes vs. industry products
- Need to enable the transition from research to industry.

- Lessons learned after 3 years of a 7 years research project.
  - Five prototype and product maturity levels (from “research vision” to “industry product”)
  - Extended comprehensive engineering process.
  - Enhanced quality assurance activities on higher levels.
  - Appropriate set of tools and methods for every level.

Future Work

- Extending the approach based on project feedback.
- In-depth analysis of the implemented process and maturity level approach.
- Empirical studies with focus on individual levels in selected research sub-projects.

Thank you ...

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