Software Engineering Institute | Carnegie Mellon

Value-Driven Incremental Development

Research, Technology, and System Solutions

Late discovery of the effects of software changes on system qualities.

Industry data show that 70% of errors are introduced during requirements and architecture design, while 80% of errors are discovered during system-integration test or later, with a rework cost that is 300 or more times the cost of discovering and correcting the errors earlier. To tackle such issues, the Department of Defense (DoD) and industry turn to development methods that enable frequent iterations with smaller increments of functionality.

Orchestrating faster delivery with greater quality becomes harder when coupled with challenges of scale. Agile methods have reduced iteration time while increasing delivered value for small-scale projects. Achieving the same benefits at scale requires focusing on architectural analysis. Experience shows that insufficient analysis results in high rework costs during integration and test.

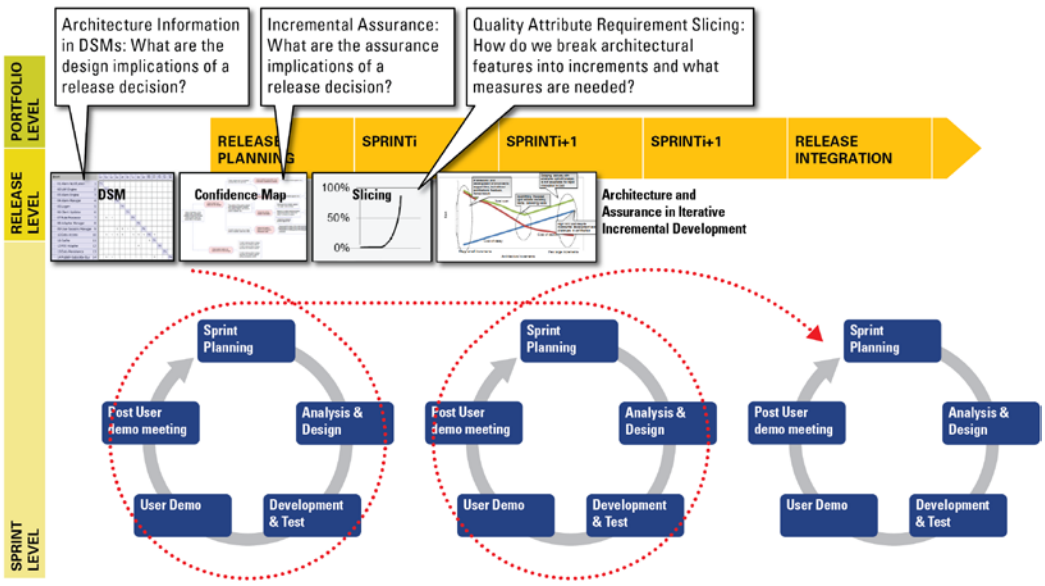
The objective of the Software Engineering Institute (SEI) Value-Driven Incremental Development project is to create quantitative engineering techniques to support rapid delivery of high-value, high-quality software capabilities to users. Managing agility and rapid development at scale means managing sustainable software delivery, resolving the tensions of decision making based on short- and long-term perspectives, and meeting productivity goals. To address this, the Value-Driven Incremental Development project investigates how quality attribute requirement slicing and dependency analysis inform the incremental development and assurance of a system. The SEI aims to provide techniques for improving visibility into engineering and the project life cycle (e.g., managing change, integration risks, design reviews, short- and long-term release planning, and rework). This will enable users to have the capabilities they need most, when they need them, while balancing speed of delivery, quality, value, and cost.

Challenges

Rapid fielding of high-quality capabilities is a shared goal for industry, the DoD, and its contractors. Typically, architecture analysis and assurance activities are conducted neither frequently nor early enough to give ongoing insights into the quality of the system being developed because such activities are not well connected with other software artifacts (e.g., requirements and design documents) and require additional resources to create.

Two extreme forms of decision making illustrate the problem. Focusing on value in the short term can lead to much rework if early decisions produce a suboptimal architecture and affect the product's ability to deliver new features. Focusing on investing for the long term can lead to analysis paralysis. The related cost of over-architecting delays delivery of features and results in missed market opportunities.

Architecture Assurance in Iterative Incremental Development



Value-Driven Incremental Development

Research, Technology, and System Solutions

This results in

- unanticipated rework that lengthens testing and integration cycles
- costly re-assurance activities when changes occur
- inability to plan for achieving stringent quality attribute concerns (e.g., performance, modifiability, or safety).

Research Approach and Innovations

The SEI is focusing on value-driven incremental development by forming DoD, research, and industry partnerships. The focus of the Value-Driven Incremental Development project is on system development that can enable incremental and faster fielding and resource-effective sustainment.

Current activities involve both assisting customers facing challenges with situated use of engineering techniques and creating innovations to improve the state of the art in how architecture analysis could be better incorporated with development artifacts. The SEI's approach emphasizes creating techniques to help monitor key, architecturally significant concerns and preserving essential runtime quality attributes while separating concerns that allow reduction in assurance efforts.

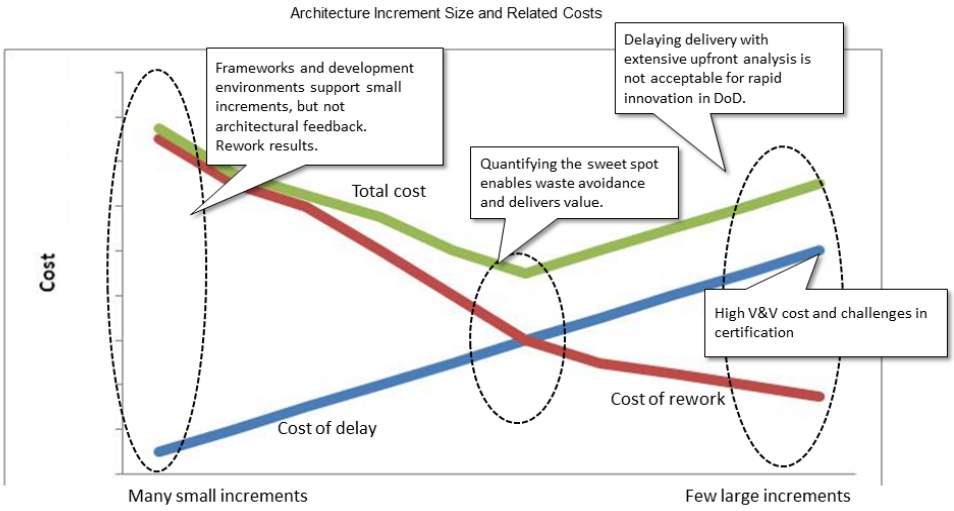
A typical scenario in the DoD is a program office trying to plan rapid delivery increments with little insight into the capabilities to be fielded in the early increments. Indeed, these needs often change before the scheduled fielding. This results in the inability to deliver capabilities to the field in the expected time frame. Even if a development team had these insights, systems are not typically architected with enough flexibility to integrate a new feature rapidly while maintaining the quality of the rest of the system. Critical static and runtime dependencies that can slow development of new features may not be identified. Even if they are, the features may require a lengthy certification and recertification.

This work builds on the SEI's established software architecture practices and quality time frame. Even if a development team had these insights, systems are not typically architected with enough flexibility to integrate a new feature rapidly while maintaining the quality of the rest of the system. Critical static and runtime dependencies that can slow development of new features may not be identified. Even if they are, the features may require a lengthy certification and recertification.

This work builds on the SEI's established software architecture practices and quality attribute reasoning approaches. The project team, using empirical research methods, focuses on developing techniques to monitor the developmental health through the quality of its architecture over time.

This project aims to provide information about the strategic value of early deployment of a capability with suboptimal quality and an understanding of the cost and benefit tradeoffs in an Agile context. How much quality and architecture is enough? To this end, the project focuses on

- integrating dependency structure modeling with architectural information to reason about safety-critical testing related work
- identify rules for structuring an assurance case and techniques to achieve incremental assurance
- techniques for decomposing and valuing quality attribute requirements during iteration planning



Related Website

www.sei.cmu.edu/architecture/

For General Information

For information about the SEI and its products and services, contact
Customer Relations
Phone: 412-268-5800
FAX: 412-268-6257
customer-relations@sei.cmu.edu
www.sei.cmu.edu

5/10/2013