Current SAT Work in Architecture Evolution

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Our View of Architecture Evolution

Architecture evolution is the process of designing an architecture to meet today’s and tomorrow’s business goals, while maximizing expected value, in the face of uncertainty.

Architecture evolution therefore has two foundations:

- Architecture design
- Software engineering economics

In this talk I will sketch our approaches to both.
Evolution with a Design Focus

The *design aspect* of architecture evolution investigates how to measure and analyze the difficulty of reaching a desirable future state given today's state and how to design the system so that desirable states are easier to reach.

We wish to be able to answer questions such as:

- *How can the quality of a deficient architecture be improved?*
- *What alternative architectures provide the greatest flexibility to support future requirements?*
- *How resilient is the system to change?*
Evolution with a Design Focus – 3

Consider the following design scenario:

- We have an important feature to implement for our new system.
- We intend to implement it in the 2nd release. This feature depends on an “unimportant” piece of infrastructure, which doesn't get done in release 1.
- This means that you have to do the unimportant infrastructure in release 2, and delay the feature to release 3 (by which time it is of less value).

What is the point of this example?

In designing for evolution we need to think about trajectories and dependencies, not single design steps.

*Shameless plug*: we will be discussing just such situations in the Evolution Workshop. Come join us!
Evolution with an Economics Focus

Software architecting cannot take place in a value-neutral setting.

Architecture decisions are the results of trade-offs and economic factors influence such trade-offs constantly.

Economics-driven architecting is a direction that must be rigorously pursued to produce systems that meet *all* their business goals. It is based on the following principles about architecture:

- *Principle 1*: Quality attribute requirements are a driving force for software and system architecture design.
- *Principle 2*: Using architectural patterns and tactics is a way to achieve quality in software.
- *Principle 3*: Business and mission goals endow quality with value.
Architecture evolution involves:

- exploring the design space, looking for risks and opportunities
- maximizing expected value of “reachable” designs under conditions of uncertainty
- minimizing the expected loss of “unreachable” designs under conditions of uncertainty
- staging of architectural strategies and features (release planning)
## Related Work in Evolution

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<th>Transformation</th>
<th>Value</th>
<th>Sequencing</th>
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**KEY:** Relevance to architecture evolution: ■ - very relevant, □ - relevant, □ - somewhat related. Square size indicates amount of activity/efforts. * - SEI-related approaches.
Our Work in Evolution (with an Economics Focus)

Cost Benefit Analysis Method (CBAM)/Utility theory

Real options for valuing flexibility

Release planning and optimization

Architecture patterns/tactics as value-creating design operations.

Common to all the work is the application of value-based activities

- that are practical and easily implemented
- on a firm, principled basis
- with simple, clear rationale

Consider how economics enters into evolutionary design decisions...
Quality Attributes, Utility and Business Goals

Different patterns exhibit different quality attributes which in turn offer different levels of utility.

Future utility curves are affected by uncertainty.
It is necessary, but not sufficient to consider the strengths and weaknesses of patterns with respect to quality attributes.

Economics Influences Architectural Strategies

- Current business goals
- Uncertainty in future business goals

Key Concepts in Evolution

Evolution trajectory

System

Business and Mission Goal

Uncertainty

Architecture

Design strategies

Utility

Resources

Feature

Quality Attribute Concern

Quality Attribute Scenario

Explicit focus and use of techniques to better incorporate economic considerations into the process of architecting

Design the evolution trajectory, which endows multiple instances of the system throughout the life cycle of the system

Focus on architecture-centric practices to design the evolution trajectory for each instance of the system

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A Proto Architecture Evolution Method

1. **Ellicit the Business and Value Context**
   - Elicit business goals
   - Elicit quality attribute scenarios

2. **Generate Utility Curves**
   - Elicit cost and schedule constraints
   - Business and mission goals induce a preference relation over quality attributes.

3. **Explore the Design Context**
   - Review current architectural approaches
   - Generate future state architectural approaches

4. **Explore Evolution Directions**
   - Identify interactions between approaches

5. **Explore Opportunity Enablement**

6. **Allocate Architecture Trajectory**
   - Explore real options
   - Identify evolution steps
   - Use real options to develop architectural strategies for managing uncertainty for future evolution.
   - Use architecture to understand cost and resource constraints. Use release planning to design the architecture evolution trajectory.
   - Architecture design exploration and analysis may reveal exploitable core competencies.
Goals of Our Ongoing Work

Here are some of our goals for the coming year:

- Package our existing techniques as a method.
- Give guidance to practitioners to allow them to reason about uncertainty vis-a-vis architecture.
- Give guidance on the ramifications of design decisions and trajectories of design decisions.
- Aid practitioners in making a business case for the value of architecture.
- Provide tool support for exploring the design space.
Further Reading


- [http://www.sei.cmu.edu/architecture/products_services/cbam.html](http://www.sei.cmu.edu/architecture/products_services/cbam.html)