The Illusion of Certainty

Grady Campbell

12 May 2010

Software Engineering Institute
Carnegie Mellon University
Arlington, VA 22203

Sponsored by the US Department of Defense
Summary

• Traditional acquisition practice relies on certainty in requirements
• Uncertainty is unavoidable but seen as a weakness to be eliminated
• Ill-founded resolutions of uncertainty provide an illusion of certainty, preempting proper analysis
• Some uncertainty, due to incomplete knowledge or information, can be resolved with due effort
• Some uncertainty, due to diverse and changing needs, requires changeable solutions
Requirements is a *model* of a product

A model exists to answer specific questions:

- What is the product’s purpose and value?
- What behavior does its users need it to exhibit?
- What is the context in which it operates?
- What interfaces does it have with other devices and systems?
- What are constraints on a solution?

Complete answers are possible only with

- The existing as-built product
- Full documentation of the product’s development
An empirical premise

Requirements certainty is always an illusion

- Incomplete knowledge or understanding
- Incomplete or inaccurate information
- Differing experiences and opinions (among subject matter experts or experienced users)
- Inability to envision all implications of a solution
- Needs and technology that change over time

Normal acquirer viewpoint

- Indecision causes delay
- Make decisions – eliminate uncertainties
When is a requirement not certain

• When it is tradeable (conflicts with a higher priority, costs too much, …)
• When it is only a preference (wished for, not essential)
• When it has unacceptable side effects (performance, security, …)
• When the need has since changed
The acquirer’s dilemma

Reactions to finding uncertainties in requirements:

• Indecision and delay ("somebody has to decide")
• An ill-founded decision, without proper rationale or exposure, for an inferior product and rework
• Acceptance and accommodation
  – Identify and document uncertainties
  – Analyze implied alternatives, tradeoffs, and rationale to reach a substantiated decision
  – Establish unresolvable uncertainties as product variabilities with decision criteria, enabling deferred change at will
Dealing with uncertainty

Uncertainty → Weak → Best “guess”

Investigate → Better → Best

Decision + Rationale

Changeable Decision + Criteria
Sources of uncertainty in requirements

Transient (second order) uncertainty

- Incomplete knowledge or information
- Disagreements among experts or users
- Complex alternatives requiring tradeoff analyses or experimentation

Persistent (first order) uncertainty

- Changing circumstances, capabilities, or expectations across time or place
- Differing needs or preferences of customers having similar needs (*a product line*)
Goals for addressing uncertainty

Awareness
• Expose and characterize all uncertainty

Understanding
• Analyze alternative resolutions and tradeoffs

Reduction
• Eliminate transient uncertainty, minimize persistent uncertainty, document rationale

Accommodation
• Track and manage implications of persistent uncertainty throughout the product life cycle
A traditional software process
A concurrent software process

knowledge

Requirements → Design → Coding → Testing → Install → Product
A product line software process

- Process Adoption
- Domain Engineering
- Application Engineering
- Product
- Product Uses

Business Objectives

Market and Project Needs

Customer Needs

Institute & improve a product line business

Develop and evolve a capability for building similar products

Build customized products for customers

source: www.domain-specific.com
DoD acquisition life cycle, recast

Mission Need

Concept & Technology Development

Requirements (RFP)

System Development & Demonstration

Production Capability

Production & Deployment

Customized Products (Mission Capability)

Operations & Support

Key

→ Baseline information

← Feedback