Software Design and Architecture

The once and future focus of software engineering

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Structure of the Paper

- Introduction
- Paradigms and Persuasions: How design has been approached
  - Prescriptive design methods, Notations, The wisdom of experience, HCI design, Design outside of software, Cognitive and social strategies
- Contemporary Currents
  - Agile methods, Aspect-oriented design, Design analysis, Component-based design, Software architecture
- Design, Designing, and Designers
  - The elements of design research, The community of designers
- Research Directions
  - Directions reflecting good recent progress, Directions from new capabilities, Directions from design imperatives, Directions from examining our past, Directions from looking outside of CS, Barriers to progress
- Challenges and Vision
  - Technical challenges, Community challenges, A vision for the long future
Structure of the Talk

1. What’s the deal with the subtitle?
2. Design of what?
3. Just what is Design?

Plus a little grab-bag of thoughts at the end, including “the long future”
Hic jacet Arturus, rex quondam, rexque futurus

Geoffrey of Monmouth, 12th century
Design is at the Center of SE

Goals and Dreams
"The Task"

DESIGN

"The Means"
Materials, Tools, and Mechanisms
Design Will Remain the Center

- Goals and Dreams
- "The Task"
- DESIGN
- "The Means"
- Materials, Tools, and Mechanisms
Consequences

- We can all stay gainfully employed!
- Design provides a “North Star” for
  - Our educational practices
  - Our research emphases
    - Essence v. accident: as we center on the former, design becomes pre-eminent
  - Our characterization of what we do to outside parties
- Design will remain as a worthy subject of study
Design of What?

- Past and current software design research
  - Prescriptive design methods, Notations, The wisdom of experience, HCI design, Design outside of software, Cognitive and social strategies
  - Agile methods, Aspect-oriented design, Design analysis, Component-based design, Software architecture
  - Point: almost all are focused on structure of software

- Design in other disciplines (automotive, architectural, fashion, consumer products)
  - ∃ at least as much emphasis on appearance and behavior - perhaps more so.

- We need to focus on design of structure and appearance and behavior
Application Design v. Software Design

- Is this a false dichotomy?
  - The software engineering literature seems pretty one-sided...

- Is it just HCI v. software design?
  - What issue predominates in the following:
    - An airline reservation website
    - Mashups (dynamically composed web apps)
    - GoogleEarth

- If it is not our job to design applications, who’s job is it?
When Does Design Happen?

● Simple test: When is the user interface to an application designed during your favorite software process?

● A problem: we still speak of “requirements, then design”. But design is being done in “requirements” -- much of the time.

● Kudos to the agile movement for the right focus here.
Where Did We Go Wrong?

- First, a little test from Math class:

3. Find x.

\[ x \]

[Diagram of a right triangle with sides 4 cm and 3 cm, hypotenuse labeled x]
One Student’s Answer…. 

3. Find $x$. 

Here it is
Find Design

[From W. Royce’s 1970 paper]
Find Design

Here it is!
Or Here?

[From W. Royce’s 1970 paper]

Figure 10: Summary
Or Here?

Here it is!
This Early Work Misled Us

- When something is labeled “Design” or “Preliminary Design” that implies that those things that are NOT so labeled are NOT design
- Especially when some of those other things are indicated as predecessors of Design
Requirements Engineering Involves Designing
Just What is Design?

- Design as Decision Making
  - Decisions of how to accomplish something; how to represent something
  - A solid approach to design should offer a solid approach to decision making
    - What are they?
    - Capturing them, and their rationale
    - Recognizing them when they are made, in the context
    - Analyzing, contrasting, and managing alternatives
    - Reflecting upon them to improve future designs (decision making)
    - Distilling them into practical, reusable design knowledge
Decision Makers: Who are the Designers?

- The software engineers
  - The “software designers”
  - The “requirements engineers”
  - The “implementers”
- The product/business strategist/analyst
- Domain experts
- Example: product-line architectures
You guessed it:

- Throughout a system’s lifetime
  - Conception
  - Detailed architecture
  - Implementation (think of the impact of choice of implementation framework)
  - Adaptation

Why does this matter? Because these decisions matter -- and should be treated with equivalent care and be part of the design documentary.
Research Directions Grab Bag

- Never underestimate the power of brute force
  - “GoogleDesign”
- Leverage technology
  - Networking: the collaboration enabler
  - Displays

The monitor on your desk should be at least as large as the flat panel HDTV in your home.
A Design Imperative

- What’s key in making explicit software structural design essential, credible -- and not busy work: a full, critical tie to implementation.
  - Works in low-level (structural) design (UML)
  - Works in generative approaches to system design/implementation
  - We must make it work more broadly.
The Long Future

- Co-design of software and organizations
- Software designers as the skilled designers of other intangible products
  - The driving experience
  - Controlling
  - Commerce
  - Law
Conclusions

1. What’s the deal with the subtitle?
   - Design is the central focus of software engineering

2. Design of what?
   - We design structure *and* appearance *and* behavior, *and* do it throughout

3. Just what is Design?
   - Designing involves decision-making by more than just software engineers -- and requires support
Acknowledgments

- National Science Foundation Grants 0438996 and 0536203
- Nenad Medvidovic and Eric Dashofy
- Lee Osterweil, Peter Freeman, Alex Baker, Michael Gorlick, Peyman Oreizy, David Redmiles, Alex Wolf
- Chuck Pelly, DesignWorks USA