What Constitutes Good Design?
A Review of Empirical Studies of Design Processes

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Reasons for Understanding Good Design

- Offer a common set of effective design criteria
- Focus attention onto understudied areas in design
- Design as vehicle for learning
  - Project Based Learning (Doppelt 2003; Barak 2002)
  - Learning Styles (Gardner 1993)
- ABET Outcomes
  - B: Design experiments; analyze data
  - C: Design a system. Component, process to meet needs
  - Outcome E: Identify, formulate, solve problems
Methodology: Meta-Analysis

- Sample previous studies that characterize design
- Draw from authors’ experiences
- Construct framework of design activity descriptors
- Code empirical studies of design
- Validate and adjust framework using initial sample of empirical articles
Coding Scheme

• **Focus of article**
  - Factor a focus
  - Mentioned
  - Not mentioned

• **Reporting of significance**
  - Reported as positively significant (good design)
  - Reported as negatively significant (bad design)
  - Reported neither positively or negatively significant
  - Not applicable (because not mentioned as a focus)
Distribution of Sampled Journals

- International Journal of Human-Computer Interaction: 10
- Design Studies: 8
- Cognitive Science: 3
- International Journal of Man-Machine Studies: 3
- Behaviour & Information Technology: 2
- International Journal of Human-Computer Studies: 2
- International Journal of Technology and Design Education: 2
- Journal of Engineering Design: 2
- Applied Ergonomics: 1
- Ergonomics: 1
- Human-Computer Interaction: 1
- International Journal of Intelligent Systems: 1
- Journal of Applied Psychology: 1
- Learning and Instruction: 1
- Proc Insn Mech Engers: 1
- Thinking and Reasoning: 1

Total: 40
# Expertise

## Level of Expertise in Design

<table>
<thead>
<tr>
<th>Level of Expertise</th>
<th>Number of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginner</td>
<td>1</td>
</tr>
<tr>
<td>Novice</td>
<td>4</td>
</tr>
<tr>
<td>Expert</td>
<td>24</td>
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<tr>
<td>Expert/Novice</td>
<td>5</td>
</tr>
<tr>
<td>Various</td>
<td>6</td>
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</tbody>
</table>

## Level of Expertise in Domain

<table>
<thead>
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<td>Various</td>
<td>8</td>
</tr>
</tbody>
</table>
Distribution of Tasks

- Engineering: 19
- Computer Programming and Software: 15
- Various: 4
- Other: 2
- Total: 40
Real/Artificial Tasks

- Real: 59%
- Artificial: 38%
- Real & Artificial: 3%

Total: 40
- Real: 24
- Artificial: 15
- Real and Artificial: 1
Distribution of Methodology Types

- Case Study: 27% (11 cases)
- Verbal Protocol Only: 22% (9 cases)
- Verbal + Other: 23% (9 cases)
- Ethnography: 10% (4 cases)
- Interviews (Structured/Unstructured): 8% (3 cases)
- Video Protocol Only: 5% (2 cases)
- Written Protocol Only: 5% (2 cases)
- Total: 40 cases
Individual and Group

Individual: 52%
Group: 35%
Individual & Group: 13%

Individual: 21
Group: 14
Individual and Group: 5
Total: 40
Stage of Design Cycle

- Preliminary Design
- Requirements Construction
- Detail Design: Development; Coding
- Prototype Construction
- Detail Design: Test and Evaluation
- Usability and Evaluation
- Product Release

Progress percentages:
- Preliminary Design: 80%
- Requirements Construction: 73%
- Detail Design: Development; Coding: 73%
- Prototype Construction: 53%
- Detail Design: Test and Evaluation: 30%
- Usability and Evaluation: 25%
- Product Release: 15%
Factor Reporting

Percentage

Design Factor

Not Reported On
Factor Mentioned
Focus of Study

University of Pittsburgh  LRDC
Factor Significance: Unconditioned
Summary: Categories

• Reporting
  – High reporting (50%+)
  – Moderate reporting (25% - 50%)
  – Low reporting (<25%)

• Good for Design
  – Significantly Good (75%+)
  – Maybe (25% - 75%)
  – Unlikely (<25%)

• Bad for Design
Summary: Factors Requiring More Study (Low Reporting)

- Explore engineering facts
- Explore issues of measurement
- Conduct failure analysis
- Encourage reflection on process
Summary: High Reporting, Significantly Good

- Explore problem representation
- Use interactive/iterative design methodology
- Search the space (explore alternatives)
Summary: High Reporting, Maybe Good

• Use functional decomposition
Summary: Moderate Reporting, Significantly Good

- Explore graphic representation
- Redefine constraints
- Explore scope of constraints
- Validate assumptions and constraints
- Examine existing designs
- Explore user perspective
Summary: Moderate Reporting, Maybe Good

• Build normative model
Next Steps (General)

• Need more studies of what is bad for design (disconfirming cases)
• Look into underreported factors