Workshop
Design Science Research: Best Practices and Tool Support

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Your turn

What do you expect from this workshop?
Agenda

1. Introduction & Selected Best Practices of DSR
2. Tool-Support for DSR: MyDesignProcess
3. Open Discussion: Benefits of & Requirements for Tool-Support
4. Q&A
What is design today… many interpretations!

“A plan for arranging elements in such a way as to best accomplish a particular purpose.” (Charles Eames)

- Design has been defined as a …
  - *Thing*, characterized by its form and function
  - Creative *process* resulting in an artifact

<table>
<thead>
<tr>
<th>Engineering Design</th>
<th>Software Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Systematic intelligent generation and evaluation of specifications for artifacts whose form and function achieve stated objectives and satisfy specified constraints (Dym and Little, 2000)</td>
<td>• Design is a “thing” as well as a “process” which is conscious, keeps human concerns in the center, is a conversation with materials, is creative, has social consequences, and is a social activity (Winograd, 1996)</td>
</tr>
</tbody>
</table>
What is design science research?

Design science research is a research paradigm in which a designer answers questions relevant for human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The design artifacts are both useful and fundamental.

Hevner & Chatterjee (2010), p. 5
Behavioral vs. Design Research

**Behavioral Research**
- Gaining knowledge by means of direct and indirect observation or experience.
- Unit of study preexisting to research

**Design Science Research**
- Gaining knowledge in the process of building and applying solutions to specific problems.
- Unit of study is artificially created ("artifact") in the process of research.

**Descriptive knowledge**
("X causes Y")

**Normative and prescriptive knowledge**
("If you want to achieve Y follow principle X")
Selected Best Practices for DSR projects

- Structure the DSR project in cycles and phases
  - Plan and document activities
  - Document evolution of meta-requirements/design principles/decisions

- Understand the problem and the state-of-the-art in literature
  - Engage with the “real-world“
  - Run a systematic literature review

- Iterative prototyping and evaluation
  - Create multiple prototypes
  - Perform a multi-step evaluation
DSR Structuration Framework

- E.g. Design cycles according to Kuechler & Vaishnavi (2008)

Diagram:

- Knowledge Flows
  - Awareness of Problem
  - Suggestion
  - Circumscription
  - Operation and Goal Knowledge
- Process Steps
  - Development
  - Evaluation
- Logical Formalism
  - Abduction
  - Deduction

Opportunities for theory development and refinement
## DSR Evaluation Framework: FEDS

<table>
<thead>
<tr>
<th>Evaluation strategies</th>
<th>Circumstance selection criteria</th>
</tr>
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<tbody>
<tr>
<td>Quick &amp; Simple</td>
<td>If small and simple construction of design, with low social and technical risk and uncertainty</td>
</tr>
<tr>
<td>Human Risk &amp; Effectiveness</td>
<td>If the major design risk is social or user oriented and/or If it is relatively cheap to evaluate with real users in their real context and/or If a critical goal of the evaluation is to rigorously establish that the utility/benefit will continue in real situations and over the long run</td>
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<tr>
<td>Technical Risk &amp; Efficacy</td>
<td>If the major design risk is technically oriented and/or If it is prohibitively expensive to evaluate with real users and real systems in the real setting and/or If a critical goal of the evaluation is to rigorously establish that the utility/benefit is due to the artefact, not something else</td>
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<tr>
<td>Purely Technical Artefact</td>
<td>If artefact is purely technical (no social aspects) or artefact use will be well in future and not Today</td>
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Venable et al. (2016)
Two Examples

Requirements Mining System


Process Guidance System

Structure your DSR project
Example: Requirements Mining System

Perform Systematic Literature Review
Example: Requirements Mining System (I)

Perform Multi-Step Evaluation

- **Step 1: Simulation**
  

- **Step 2: Lab / Field Evaluation**

**Structure your DSR project**

**Example: Process Guidance System**

<table>
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<tr>
<th>General Design Science Cycle</th>
<th>Design Cycle One</th>
<th>Design Cycle Two</th>
<th>Design Cycle Three</th>
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<tr>
<td>Awareness of Problem</td>
<td>Expert interviews</td>
<td>Reflection of previous design cycle</td>
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<td>Instantiation of design principles as a prototype</td>
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<td>Conclusion</td>
<td>Qualitative evaluation of prototype (focus groups)</td>
<td>Quantitative evaluation of software artifact (laboratory experiment)</td>
<td>Qualitative and quantitative evaluation of software artifact (longitudinal field study)</td>
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**General Design Science Cycle:**
- **Operation and Goal:** Knowledge
- **Problem:** Awareness of Problem
- **Suggestion:** Synthesis of design principles based on empirical findings
- **Development:** Instantiation of design principles as a prototype
- **Evaluation:** Qualitative evaluation of prototype (focus groups)
- **Conclusion:** Focus groups analysis

**Design Cycle One:**
- Expert interviews
- Literature review

**Design Cycle Two:**
- Reflection of previous design cycle
- Refinement of design to research goal
- Implementation of design principles as software artifact

**Design Cycle Three:**
- Reflection of previous design cycles
- Refinement of design to research goal
- Implementation of design principles as software artifact
- Qualitative and quantitative evaluation of software artifact (longitudinal field study)
- Evaluation analysis and nascent design theory
Perform Systematic Literature Review Example: Process Guidance System (I)

Evaluation Episodes
Example: Process Guidance System

- Four evaluation episodes planned
  - DC1: Focus groups
    - Quantitative
    - Summative & artificial
  - DC2: Laboratory experiment
    - Quantitative
    - Formative & artificial
  - DC3: Field study
    - Quantitative
    - Summative & naturalistic
  - DC3: Interview and focus groups
    - Qualitative
    - Summative & artificial

Notation: 
- = Design/Construct
- = Evaluation episode
Example: Process Guidance System
Design Cycle One

- Expert interviews with eight employees of the case company revealed:
  - Lack of process (model) understanding
  - Difficulties in execution business processes

- Structured literature review on the concept “guidance” in IS research
  - Overview on existing research
  - Taxonomy of guidance in IS research

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<th>Using</th>
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<td>Suggestive</td>
<td>Quasi-suggestive</td>
</tr>
<tr>
<td>MODE</td>
<td>Predefined</td>
<td>Dynamic</td>
</tr>
<tr>
<td>INVOCATION</td>
<td>Automatic</td>
<td>User-invoked</td>
</tr>
<tr>
<td>TIMING</td>
<td>Concurrent</td>
<td>Prospective</td>
</tr>
<tr>
<td>FORMAT</td>
<td>Text-based</td>
<td>Image</td>
</tr>
<tr>
<td>INTENTION</td>
<td>Clarification</td>
<td>Knowledge</td>
</tr>
<tr>
<td>TRUST-BUILDING</td>
<td>Proactive</td>
<td>Passive</td>
</tr>
<tr>
<td>AUDIENCE</td>
<td>Novice</td>
<td>Expert</td>
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- Synthesis of design principles based on empirical findings
- Qualitative evaluation of prototype (focus groups)
Example: Process Guidance System

**Design Cycle One**

- Extraction of 11 Meta-Requirements from existing literature
- Derivation of 3 Design Principles based on the Meta-Requirements
- Selection of 6 Design Decisions to implement the Design Principles

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### Type of Guidance

- **MR1** – Invocation by user request
- **MR2** – Monitor user context
- **MR3** – Analyze user context
- **MR4** – Pre-defined guidance
- **MR5** – Suggestive guidance

### Guidance Realization

- **MR6** – Visualize business processes
- **MR7** – Lean and precise information
- **MR8** – Integrate into work environment

### Guidance Content

- **MR9** – Integrate process resources
- **MR10** – Offer detailed description
- **MR11** – Adapt process guidance to user

### DP1

Provide user requested, pre-defined and suggestive process guidance based on the monitoring and the analysis of the user’s business process context.

### DP2

Visualize lean and precise process guidance based on process standards integrated into the user’s work environment.

### DP3

Integrate detailed information about process standards and required process resources into the provided process guidance adapted to the user.

### Usage of plugins for users’ applications to extract the business process context and to call the PROGRESS application

### DP1

- **DD1** Usage of plugins for users’ applications to extract the business process context and to call the PROGRESS application

### DP2

- **DD2** Analysis of process context to provide appropriate process standard as process guidance

### DP3

- **DD3** Implementation of a standalone and lean Windows application

- **DD4** Visualize business process and process tasks

- **DD5** Provision of detailed information about processes and tasks and assigned process resources

- **DD6** Provision of two modes of granularity of process guidance

---

**Synthesis of design principles based on empirical findings**

**Qualitative evaluation of prototype (focus groups)**

**Expert interviews**

**Literature review**

**Instantiation of design principles as a prototype**

**Visualize business processes**

**Lean and precise information**

**Integrate into work environment**

**Analysis of process context to provide appropriate process standard as process guidance**

**Implementation of a standalone and lean Windows application**

**Provision of detailed information about processes and tasks and assigned process resources**

**Provision of two modes of granularity of process guidance**

**General Design Science Cycle**

- **Awareness of Problem**
- **Suggestion**
- **Development**
- **Evaluation**
- **Conclusion**

**Design Cycle One**

- **Extraction of 11 Meta-Requirements from existing literature**
- **Derivation of 3 Design Principles based on the Meta-Requirements**
- **Selection of 6 Design Decisions to implement the Design Principles**
Example: Process Guidance System
Design Cycle One

- Development of a Process Guidance System prototype

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- Synthesis of design principles based on empirical findings
- Qualitative evaluation of prototype (focus groups)
- Instantiation of design principles as a prototype
- Focus groups analysis

Notation: = Design/Construct = Evaluation episode

Artificial Naturalistic Formative Summative

DC1: Focus groups

- Functional Purpose
- Paradigm

Paradigm: Artificial Naturalistic Formative Summative

DC1: Focus groups

Notation: = Design/Construct = Evaluation episode
Example: Process Guidance System
Design Cycle One

- Qualitative evaluation of the prototype by two focus group workshops in the case company
- SWOT analysis
- Positive feedback by the participants

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<th>Strength</th>
<th>Weaknesses</th>
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<td>DP1 • Supports novices in vocational adjustments</td>
<td>• High effort in maintenance</td>
</tr>
<tr>
<td>• Keeps information up-to-date</td>
<td>• Information overload</td>
</tr>
<tr>
<td>DP2 • Enables to understand the entire process chain</td>
<td>• Decrease of social interaction with colleagues</td>
</tr>
<tr>
<td>• Provision of contextual information eases process understanding</td>
<td>• &quot;Use the help function&quot; instead of collegial support</td>
</tr>
<tr>
<td>DP3 • Automatically opens related systems</td>
<td>• Unclear benefit for experienced employees</td>
</tr>
<tr>
<td>• Description of the current process in real-time</td>
<td>• Low motivation to use the system for experienced employees</td>
</tr>
<tr>
<td>Threats</td>
<td>Opportunities</td>
</tr>
<tr>
<td>DP1 • Effort perceived as higher than benefits</td>
<td>• Visualization of even complex processes</td>
</tr>
<tr>
<td>• Tracking of user activity violates personal data security</td>
<td>• Expansion to the entire company and inclusion of all organizational processes</td>
</tr>
<tr>
<td>DP2 • No development or adjustments of processes</td>
<td>• Lean knowledge transfer</td>
</tr>
<tr>
<td>• High effort due to permanent data update and development</td>
<td>• Process-related details will be considered</td>
</tr>
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</table>

Artificial
Naturalistic
Formative
Summative
DC1: Focus groups
Notation: = Design/Construct = Evaluation episode
Functional Purpose
Paradigm

Notation: = Design/Construct = Evaluation episode
Example: Process Guidance System
Design Cycle Two

Development of a new PGS prototype and required applications for the laboratory experiment

Ticketing application

General Design Science Cycle | Design Cycle Two
---|---
Awareness of Problem | Reflection of previous design cycle
Suggestion | Refinement of design to research goal
Development | Implementation of design principles as software artifact
Evaluation | Quantitative evaluation of software artifact (laboratory experiment)
Conclusion | Experiment analysis

Artificial

Paradigm

Naturalistic

Formative

Summative

Notation:
- = Design/Construct
= Evaluation episode

Functional Purpose

DC2: Laboratory experiment

DC1: Focus groups

Notation: = Design/Construct = Evaluation episode

Evaluation

System

Exemples Resource Planning - ERP

Business Intelligence - BI

Ticketing application

Process Guidance System

Read email
- Description
Read the user’s request described in the email.

Check authorization
- Description
Verify that the user is part of the company, by checking the domain “user-company.com” of the email address.

Reject unauthorized user request
- Description
Reply that user is not authorized to submit a request.

Decision ticket type
- Description
Check if the user’s request exists in the Service Catalog and decide which ticket type is the proper one.

Ticket Type = SR | Get Service Catalog ID
- Description
Look up the Service Catalog ID for the user’s request in the Service Catalog.

Ticket Type = SR | Create SR Ticket
- Description
Select “Service Request” as ticket type, provide the Service Catalog ID, affected application and a ticket description.

Ticket Type = NSD | Select cost center
- Description
Select the user’s department according to the email signature, this will set the cost center automatically.

Ticket Type = NSD | Create NSD ticket
- Description
Select “Non-Standard Demand” as ticket type and provide a ticket description.

Set ticket status
- Description
Select the ticket status according to the ticket type, Service Request: in progress, Non-Standard Demand: approval.

Archive request as file
- Description
Save the user’s request as PDF file from the Email Client, save it locally and attach it to the ticket by clicking “Choose File”.

Inform user
- Description
Inform the user about the created ticket and its status in a short reply to the request.
Example: Process Guidance System
Design Cycle Two

- Laboratory experiment with 118 students to evaluate the effect of process guidance on their process execution

<table>
<thead>
<tr>
<th>Step</th>
<th>Introduction</th>
<th>Sampling</th>
<th>Pre-Experimental</th>
<th>Experiment</th>
<th>Post-Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No process guidance</td>
<td>Introductory session</td>
<td>Basic process guidance</td>
<td>Process knowledge before experiment</td>
<td>Process execution performance</td>
<td>Process knowledge after experiment</td>
</tr>
<tr>
<td>Extended process guidance</td>
<td>Quantitative evaluation of software artifact (laboratory experiment)</td>
<td></td>
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<td></td>
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</table>

| Data Collection | - | - | Multiple-choice test | Objective measures of time and outcome | Multiple-choice test |

Artificial Naturalistic Formative Summative
DC2: Laboratory experiment
DC1: Focus groups
Notation: = Design/ Construct = Evaluation episode

Functional Purpose Paradigm
Paradigm: Notation: = Design/ Construct = Evaluation episode
Development of a Process Guidance System for the ticketing application of our case company
Agenda

1. Introduction & Selected Best Practices of DSR
2. Tool-Support for DSR: MyDesignProcess
3. Open Discussion: Benefits of & Requirements for Tool-Support
4. Q&A
Tool-Support: Why?

- Little to no traceability of design decisions
- Little to no knowledge re-use
- Little to no accumulation of knowledge
- Little to no evolution of knowledge
- Little to no concurrent evaluation
- Little to no learning (and progress ;-))

We need tools to support Design Science Research processes to better do design Science Research :-) 

Again: it starts with transparency
MY DESIGN PROCESS

- Access your design projects on any devices, from anywhere and anytime
- Invite feedback from stakeholders
- Document design projects for publication
- Share results with co-workers and team members
- Supervise multiple projects at a time
- Learn from your private design log
https://mydesignprocess.com/
Design Canvas

Description
Within our practitioner lens in Digital Service Design, we are going to design a digital solution for video selling at BMW. Our task is to carry out all necessary steps in order to conduct the research data. Therefore, we are going to stay in touch closely with Werner Scheffler on the part of BMW, who will provide us with interview partners, resources, and the information needed.

Design Canvas

<table>
<thead>
<tr>
<th>Justification</th>
<th>Knowledge</th>
<th>Problem</th>
<th>Objective</th>
<th>Idea</th>
<th>Context</th>
<th>Scope</th>
<th>Design Knowledge</th>
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<td></td>
<td>Video selling has been successfully implemented for mobile phone contracts at Vodafone. Experts confirmed the feasibility of our proposed solutions in interviews. Relevant values for the Business Case have been gathered!</td>
<td>Does video selling work for higher-priced products (e.g. smartphones)? How to design the video system customer-centered? Do I invest more or not invest? Make or buy?</td>
<td>Create a delivery service which delivers a new buying experience for the customer and improves the success of the service and sales calls</td>
<td>Interactive video call with screen-sharing, incorporating嗜好 and sales-tracking of the Next Best Action by analyzing the video call</td>
<td>Customer journey with annual contact and observation of the product “energy” in limited market sales process of initial new innovation technology</td>
<td>Data Method</td>
<td>Some sales agents are willing to provide video selling prototypes and name the consumer’s need for empowerment benchmarks as promising</td>
</tr>
</tbody>
</table>

Design Process

- Complete interviewing, testing, and feedback on live business and prototypes.
- Evaluation: Testing, Questionnaire, Interview, Observation.

Artifact
- High-fidelity Business Model Canvas, Prototypes, Business Case

Iteration 1
With this iteration, we are creating a demo mockup, which gives a brief overview about the project’s outcome.

Discover Phase
DSR Project Space
Agenda

1. Introduction & Selected Best Practices of DSR
2. Tool-Support for DSR: MyDesignProcess
3. Open Discussion: Benefits of & Requirements for Tool-Support
4. Q&A
Open Discussion: Expected Benefits

- Where do you see benefits of using MyDesignProcess?
- What could be enhanced?
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