Constructive Research

Methodology workshop 26.11.2001
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What is Constructive Research?

- Constructive research
  - Aims at producing novel solutions to practically and theoretically relevant problems
  - Managerial problem solving through the construction of models, diagrams, plans, organizations, etc.
  - Widely used in software engineering and computer science, rarely in management and social sciences
  - The engineering research tradition
  - Often involves other approaches (qual. & quant.)

- Construction
  - An entity, which produces a solution to an explicit problem
    - mathematical algorithm
    - Morse alphabet
    - activity-based costing (ABC)
Research Objectives

- **Key objectives**
  - Quality -- utility as well as functional correctness
  - Cost -- both of development and of use
  - Timeliness -- good-enough result, when it’s needed
- Address problems that affect practical software

Complete Research Result

- **Real World Practical problem**
  - Research Setting Idealized problem
    - Validation Task 1: Does the product solve the idealized problem?
    - Validation Task 2: Does the result help to solve the practical problem?
  - Research product (technique, method, model, system, …)
- **Real World Solution to practical problem**
  - Research Setting Solution to idealized problem
The Constructive Approach as a Methodology

- Is a type of applied studies
  - production of new knowledge in the form of normative applications
  - creates a new reality – does not try to understand, explain, classify, etc. the existing one

- Constructive approach vs.
  - basic studies have no explicit normative purposes
  - development of techniques purely aim at improving skills and means
  - analytic model building (applied studies) has unclear practical adequacy
  - scientific problem solving may produce unique solutions
  - consulting does not presuppose use of scientific methods

Phases of the Constructive Research Process

- Idealized model
  1. Find a practically relevant problem
  2. Obtain an understanding of the topic and the problem
  3. Innovate, i.e., construct a solution idea
     - heuristic process
     - theoretical justification and testing come later
  4. Demonstrate that the solution works
  5. Show theoretical connections and research contribution
  6. Examine the scope of applicability

- In practice the steps do not follow each other in a simple sequence - the process is both iterative and sometimes recursive
1. Finding a relevant problem
2. Preunderstanding

- Finding the problem
  - Sources of problems
    - Literature
    - Colleagues
    - Own experience

- The problem should be *practically* relevant!

- Preunderstanding
  - Practical
    - get your feet wet
    - empirical work, e.g., interview study or observation (participation)

  - Theoretical
    - scan "relevant" literature
    - talk to other researchers
    - get a big picture of existing knowledge
    - ensure *theoretical* relevance

3. Innovate
4. Test / Validate

- Innovate and test phases can be and often are intertwined

- Validation is perhaps the hardest part of constructive research

- Validation should be performed in industrial settings, whenever possible – to ensure practical relevance

- Validation employs other techniques, such as action research and case studies
Market-based Validation of Managerial Constructions

- Weak market test
  - a manager applies the construction in a company

- Semi-strong market test
  - constructions becomes widely adopted by companies

- Strong market test
  - systematic application produces better financial results

- Semi-strong and strong market tests require statistical analysis of a substantial amount of implementation data

Types of Research Validation

- **Persuasion**  I thought hard about this, and I believe...
- **Implementation**  Here is a prototype of a system that ...
- **Evaluation**  Given these criteria, the object rates as ...
- **Analysis**  Given the facts, here are consequences ...
  - **Formal model**  Rigorous derivation and proof
  - **Empirical model**  Data on use in controlled situation
- **Experience**  Report on use in practice
  - **Qualitative model**  Narrative
  - **Decision criteria**  Comparison of systems in actual use
  - **Empirical model**  Data, usually statistical, on practice
5. Show theoretical contribution & novelty
6. Examine scope of applicability & generalize

- **Novelty**
  - crucial, but don’t be too hard on yourself
  - Lots of possibilities
    - entirely new idea (rare)
    - cross-domain knowledge sharing
    - improved idea / implementation / solution
    - interesting research approach
    - ...

- **Generalize**
  - broad = good?
  - hypothesize as ground for further testing

- Knowing the field & positioning is crucial to novelty and theoretical contribution

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**Evaluation Criteria for Constructive Research**

- **Construct**
  - Relevance
    - Theoretical Relevance
    - Practical Relevance
  - Novelty
  - Practical utility
    - difficult to assess the practical adequacy of any new construction prior to its implementation
    - difficult because of organizational factors
    - technical success != practical success

- **Research process**
  - rigor
Is the Constructive Approach Scientific?

- Characteristic features of the constructive method
  - step-by-step procedure, where steps can be checked
  - serves some definite purpose, is goal-driven
- Objectivity, criticalness, autonomy
  - checking the steps
- Progressiveness, criticalness
  - shows concretely, which solutions work, and don’t work
  - working constructions tend to lead to new questions
- Relevant, simple, easy to use
  - inadequate solutions become eliminated by users
  - often the simplest idea is the most adequate one
### Building Blocks for Research

<table>
<thead>
<tr>
<th>Question</th>
<th>Strategy/Result</th>
<th>Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility</td>
<td>Qualitative model</td>
<td>Persuasion</td>
</tr>
<tr>
<td>Characterization</td>
<td>Technique</td>
<td>Implementation</td>
</tr>
<tr>
<td>Method/Means</td>
<td>System</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Generalization</td>
<td>Empirical model</td>
<td>Analysis</td>
</tr>
<tr>
<td>Selection</td>
<td>Analytic model</td>
<td>Experience</td>
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</table>

### A Common Plan

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<td>Technique</td>
<td>Implementation</td>
</tr>
<tr>
<td><strong>Can X be done better?</strong></td>
<td><strong>Build a Y</strong></td>
<td><strong>Measure Y, compare to X</strong></td>
</tr>
<tr>
<td>Generalization</td>
<td>Empirical model</td>
<td>Analysis</td>
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A Common, but Bad, Plan

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<tbody>
<tr>
<td>Feasibility</td>
<td>Qualitative model</td>
<td>“Look, it works!!”</td>
</tr>
<tr>
<td>Characterization</td>
<td>Devise a technique</td>
<td>Implementation</td>
</tr>
<tr>
<td>Can X be done better?</td>
<td>System</td>
<td>Evaluation</td>
</tr>
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Two Other Good Plans

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<tr>
<td>Can X be done at all?</td>
<td>Qualitative model</td>
<td>“Look, it works!!”</td>
</tr>
<tr>
<td>Characterization</td>
<td>Technique</td>
<td>Implementation</td>
</tr>
<tr>
<td>Method/Means</td>
<td>Build a Y that does X</td>
<td>Evaluation</td>
</tr>
<tr>
<td>Is X always true of Y?</td>
<td>Empirical model</td>
<td>Check proof</td>
</tr>
<tr>
<td>Selection</td>
<td>Formally model Y, prove X</td>
<td>Experience</td>
</tr>
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Sometimes a breakthrough (but sometimes nonsense)

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<tr>
<td>Feasibility</td>
<td><strong>Formulate new approach</strong></td>
<td><strong>Argue carefully on merits</strong></td>
</tr>
<tr>
<td>Change basic assumptions</td>
<td>Technique</td>
<td>Implementation</td>
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References
