Information, Organization, and Management

Unit 5: Potential and Limitations of ICT

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Overview

• Computer Systems, Models, and the Real World
• Formalization
Formalization: Importance and Limits

• Formalization as a precondition of ICT
• Algorithms: Sequence of processing steps that solves a given problem
• Alternative means for formalization/modeling/representation
  – Human language (problem: actor- and context-bound)
  – Data Models
  – Ontologies

cf. Wigand/Picot/Reichwald (1997)
Computer Systems, Models, and the Real World

Abstraction for P1 \rightarrow Algorithm \rightarrow Abstraction for P2

Phenomenon P1 \rightarrow Space of Possible Transformations \rightarrow Phenomenon P2

Model
The Critical IT / Process Divide

Business Experts’ Perspective ("Reality"?)

Querying the Process Space

Manual Labor

IT Implementation Perspective (Models of Reality)

Process Implementation
Querying the Process Space

“Do we have a cost approval process for items below $200?”

“How many inventory management methods are currently in use?”

“In which of our food manufacturing machines are we processing meat or raw eggs?”

• Process Models
• Process Instances
• Resources and Actors
• Data
“We need to set up a billing process for our new Internet TV service”

Programming

(Web) Service Composition and Orchestration

Customizing of COTS Packages (e.g. SAP)

The Critical IT / Process Divide

Business Experts' Perspective (Reality 1)  IT Implementation Perspective (Models of Reality)

Querying the Process Space  Process Implementation

Manual Labor
Levels of Semiotics

• **Semiotics**: Scientific research of objects and functions of communication processes

• **Three levels:**
  – **Syntactic**: Analysis of signals and relationship between signals
  – **Semantic**: Analysis of signals and their meanings
  – **Pragmatic**: Analysis of signals and their effects

• **Example**

  cf. Wigand/Picot/Reichwald (1997)
Syntactic Level

• Signals and relation between signals
• Formal rules determining the structure (e.g. grammars)
• Example: XML Schema Definition, Backus-Naur Form (BNF)

cf. Wigand/Picot/Reichwald (1997)
Semantic Level

• Relation between signals and meanings (designata)
• Message: requires semantic agreement
• Example: Ontologies are such semantic agreements
cf. Wigand/Picot/Reichwald (1997)
Pragmatic Level

• Relation between signs and their effects
• Intended and actual effects
• Example: Ordering a book by sending a message „1 pcs of 'Information, Organization, and Management'“

cf. Wigand/Picot/Reichwald (1997)
Problem 1: Modeling Costs

- Models can be used to delegate the execution of a formal process to a machine.
- This may save resources.
- However, creating a model consumes resources.
- The total savings do not automatically and always outweigh the modeling costs.
A real problem...

Processes in enterprise applications | Processes unsupported by enterprise applications

Supporting long tail of business processes

ad hoc processes
Problem 2: Blurry means for specifying the intended meaning

- Many modeling notations and languages are not very expressive
- Misunderstandings possible and frequent
  - e.g. semantics of cardinality constraints in ERM
Status Quo: Lack of Formal Semantics

Errors in Control Software for the Ariane Rocket

**CH**: Altitude relative to the sea level of the Mediterranean Sea.

**D**: Altitude relative to the sea level of the North Sea.

Gap: 27 cm

\[ \text{Gap: } 27 \text{ cm} \]

\[ 27 - (-27) = 54 \]
Information Systems and Representation

- Hard- and Software, and mental models of actors (users) as representations of
  - objects (e.g. individuals, machines),
  - happenings (e.g. events), and
  - abstractions (e.g. social fictions).

- A large deal of challenges in Information Systems research can be reduced to managing the creation and maintenance of representations
  - between reality and the systems
  - between systems
  - between systems and their users
The Root of the Problem: Weak Ties between Reality and Abstractions of Reality

Weak, informal treaty

Reality

Treaty not accessible to computers

Model of Reality
• Data
• Processes

Symptoms:
• We can hardly validate whether a given ER model is correct
• We face difficulties making sure that the customization of SAP myERP matches the business needs of a given enterprise
IT represents reality and is part of reality

Reality := Reality + (relevant) Models of Reality

Model of Reality
- Data
- Processes

Reality

Reality := Reality + (relevant) Models of Reality
Consequences

• Unspotted semantic mismatches
• Broken processes and costly exceptions
• A lot of human labor for maintaining the treaty between reality and IT and between IT and IT.
  – Slow
  – Costly
  – Error-prone
Problem 3: Model Perspicuity

• If multiple business entities or individuals are involved, there need to be continuous agreement that model represents reality properly.
Radical Constructivism

World: Phenomena etc.

cf. Wigand/Picot/Reichwald (1997)
The Model Perspicuity and Agreement Bottleneck

Community creating the Model

Model

Model Usage

Stakeholders of the Model

Modeling
Problem 4: Dynamics and Evolution

• The world is subject to conceptual dynamics
  – new types of goods
  – new requirements
  – new laws and regulations

• We may not be able to yield a model fast enough to keep pace with change.

• It is hard to spot whether a given model (abstraction) is compatible with the current state of the world.
Example: Updating a Data Model

Conceptual Entities in the Real World

Elements missing in the model

Conceptual elements in the model

Initial Engineering Lag

Maintenance Lag

$t_0$

Initial domain capture completed

$\text{model released}$

$\text{t}_1$

$t_2$

Updated model released
Domain Dynamics vs. Modeling Lag

Coverage of a Fictitious Intel CPU Ontology 1/1997 - 1/2002
Maintenance every 360 days plus 7 days lead time

Ontology Coverage in %

MM/JJJJ

Possible Models

Degree of Detail and Expressiveness

Conceptual Dynamics

Possible Models

Number of Stakeholders
Problem 5: Computability

• Many typical business problems can be formalized, but cannot be executed at reasonable computational costs.

• This holds even for rather simple challenges.

• Example: Traveling Salesman Problem

• Also, in business contexts, the time for computing a result may not be available.

cf. Wigand/Picot/Reichwald (1997)
Example: Tool Path Optimization (1)
Example: Tool Path Optimization (2)

Simple ordering of hole coordinates by X- and Y-axis.

Same layout – optimized for shortest tool route:
80% shorter -> ~ 80% production time saved

Example: Yield Management for Airlines

- At what price should you offer an available seat?
- Influenced by
  - General demand
  - Special events at target destination
  - Alternative travel connections
  - Etc.
Thank you!

The slides of today‘s class will be available at http://www.heppnetz.de/teaching/img/ shortly.