Towards a Process Ontology for a model based system for problem solving: the ontology bootstrap problem

Reference: HarmoniQuA

Prof. Adriaan (Adrie) J.M. Beulens and
Huub Scholten

Wageningen University

Social Sciences Group, Information technology Group

August 24, 2005

File:TranspCMS24082005

Contents

- Problem statement.
- Generic Project Aims.
- Main project phases.
- Dimensions for project Management.
- Generic Process Specification.
- Requirements for Automatic Project Support.
- Reference Strategy and Ontological Approach.
- ‘Bootstrap’ Problem: How to derive process ontology for knowledge base.
- Concluding remarks.

General problem statement and ‘bootstrap’ problem

General:

- How to manage effectively Development and Design Projects?
- How to make these projects transparent?

Related problem:

- What are functional and performance requirements for model based support for Project Management of Research and Design Projects?
- How to arrive at the content of the knowledge base of the model based support system? The ‘bootstrap’ problem.
- How to use that knowledge for practical problem instances.

Generic project goals

- A product and service with integrity and quality attributes as envisaged, negotiated and agreed upon in proposal.
- Timely Delivery of Product and Service within budgets and using allowed resource (quality assurance).
- Project administration and reporting with integrity for reasons of Accountability, Auditing, Quality Assurance and Control.

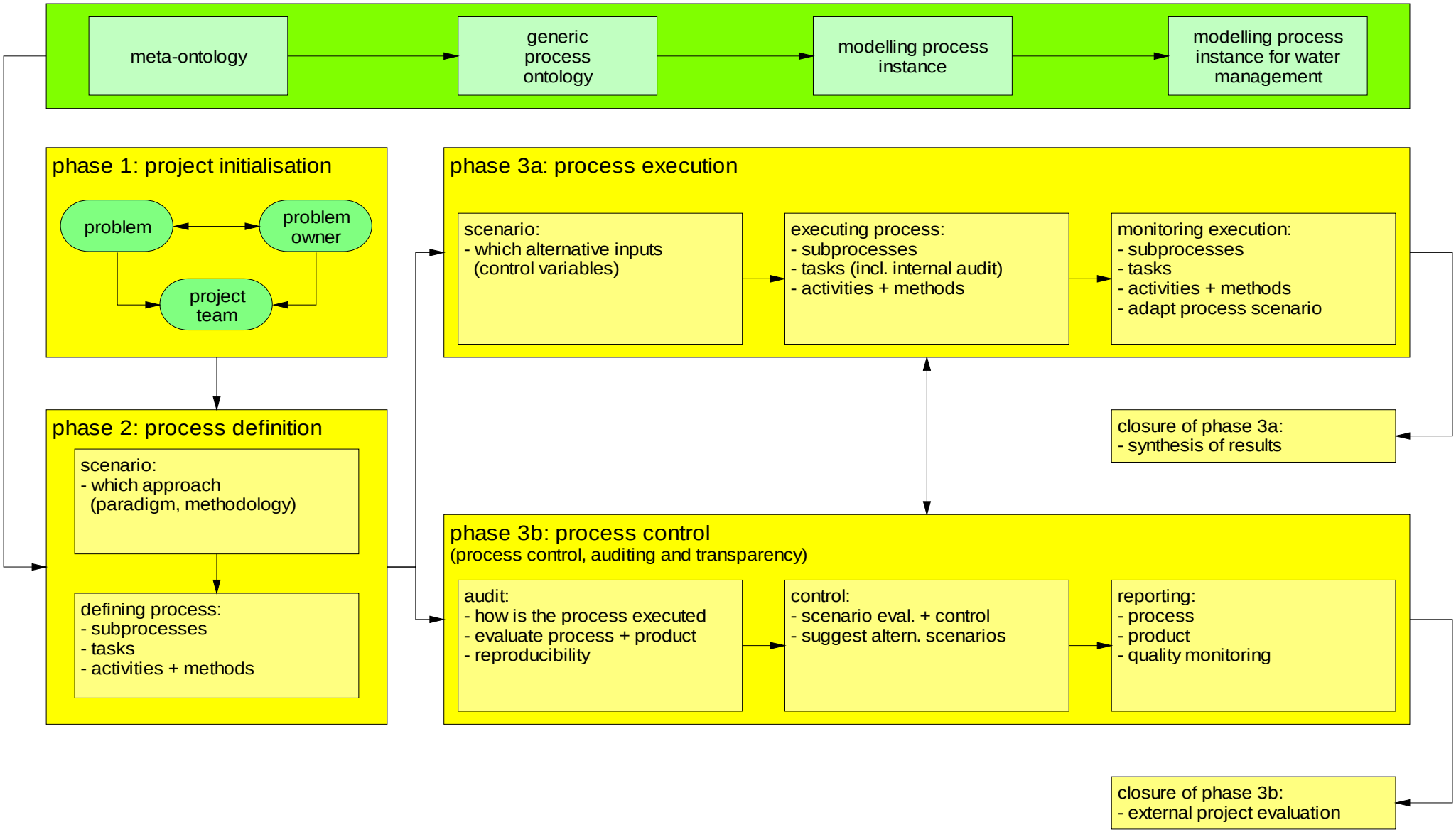
Major Project phases

- Initial Project Definition, Proposal and Acquisition.
- Project Execution and Delivery.
- Commonalities:
  - Problem Statement
  - Cost benefit
  - Approach to execute and manage phase of project.
- Differences:
  - Level of abstraction (less detailed– very detailed)
  - Norm resources versus specific resources during execution.
  - Choice of methods, models and tools not specific, allowed choice versus detailed choice during execution.
  - Etc.
- Remainder: look at execution.

Dimensions of project management

- Process Dimension: Participants need shared understanding of problem (domain) and process to tackle it.
- Content dimension: Choices of disciplinary contributions (models and approaches). Manage gap between what is needed, available and possible.
- Transparency and Quality dimension is concerned with:
  - Shared understanding about what is to be achieved (product, quality and process) and at what cost and when.
  - Complying with these specifications in Execution phase:
    - » Do as agreed upon---
    - » Administrate and be able to show that team has performed as agreed.

Main Components of Research Process



Supporting Project Management Task

Elements of PMT:

- Making specifications of project phases.
- Followed by execution and obtaining Meta Data about execution for monitoring and control.

Automated support calls for:

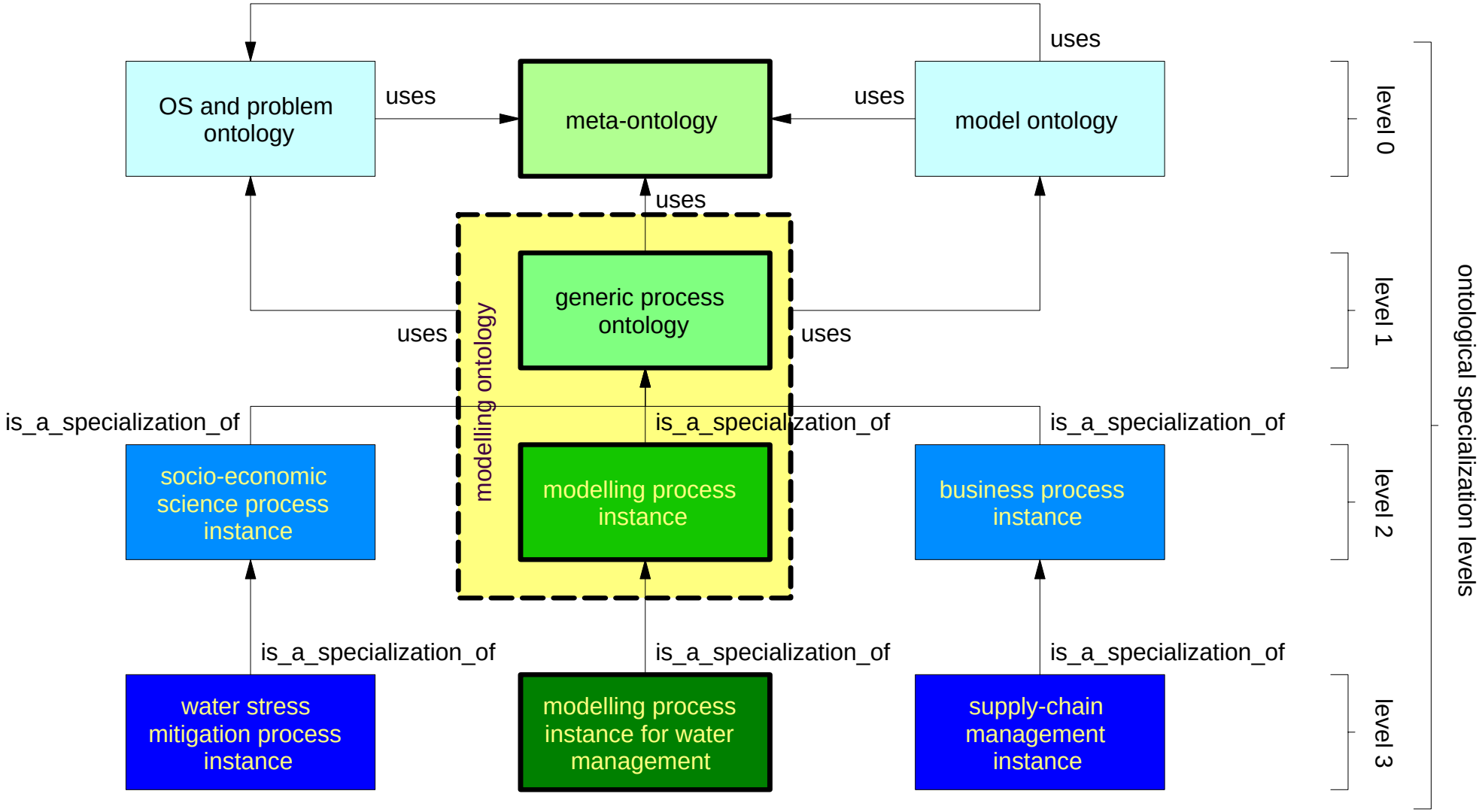
- Formal and precise description of specification .
- A specification using terms and relationships that are unambiguous for man and machine. That is obtained via ontological approach.
- A specification that is derived form a generic one in the (sub) problem domain. A generic one that is seen as ‘best practice’. This is called using a reference strategy.

Ontological approach

Ontology: Formal specification of a Shared conceptualization.

- Develop ontological structure which is the frame of the intended knowledge base. That is the ‘data structure’ for a certain domain.
- Some vocabulary terms in this context (see *Gruber*, *Borst*, *Uschold*, Chandrasekaran):
  - Terms/concepts and relations used to describe domain.
  - Relations organize concepts in a hierarchical or some self-defined structure.
  - Instance: actual knowledge.
- Thus arrive at sub-problem addressed:
  - How to develop the generic process description (bootstrap problem).
  - How to use that for problem instances.

Stepwise ontology specialization



The ‘Bootstrap’ problem (1)

- How did we arrive at a generic process ontology?

  ‘Bootstrap’ approach similar to Uschold *et al.* (1998).
  (That approach has similarities with approaches used in semantic data modelling (Date, 2004) and in Ontolingua’s ‘A Glossary of Ontology Terminology’)
- Our approach (see Figure 2):
  - Start with simple and well-defined language as vocabulary for a meta-ontology, required for generic processes in general and modelling project processes in specific.
    - » Uschold (1998) uses as basic terms for deriving the business ontology: *entity*, *relationship*, *role*, *subclass of*, *attribute*, *axiom* and *instance*.
    - » Date (2004) uses similar concepts such as: *entity*, *property*, *entitytype*, *relationship*, *subtype*, *domain* and *instance*.
    - » In Ontolingua they use *ontology*, *class*, *relation*, *slot*, *subclass*, *function* and *axiom*.
  - This vocabulary is then used to define new concepts and relations that we need to define further concepts and relations needed to describe (generic) process descriptions.
    - » That means that we created a new, more extensive and richer vocabulary. Together with the bootstrapping terminology we call this our meta-ontology.

The ‘Bootstrap’ problem (2)

- Our approach (continued):
  - Next we built a generic process ontology.
    Some of the concepts of the informal process description given in Figure 1 like *process*, *sub process, step*, *task*, *activity*, *method*, *tool* belong to this generic process ontology.
  - Specialising further for modelling processes requires that other concepts of Figure 1 have to be defined like model, domain, result, data scenario, process scenario and many others.
    These concepts and relations of importance between them in the context of projects need to be precisely defined using concepts and relations in the meta-ontology, including the bootstrapping terminology.
  - Subsequently we further specialise that generic modelling ontology for the problem domain of water management.
    Here we want to incorporate knowledge about best project practices in the problem domain, both on the level of project approach and, interdependently, on the level of methods, models and tools to be used in steps or activities of the project. Here we make the connection with the content and domain dimension as described earlier.

The ‘Bootstrap’ problem (3)

- For auditing and quality control we also introduce an interactive ontological knowledge base (called ‘model journal’) encompassing record specifications of what has to be done in the modelling process.
- This specialization process in combination with an ontology editor allows for dynamic adjustments of the process model and the model knowledge base.

  MoST facilitates to keep records for actual model-based water management projects in model journals. The water management specific modelling ontology containing water management modelling guidance and the tool to monitor actual projects embody together the KBS.
- The water management specific version of the generic modelling KBS for a specific project is used for:
  - » ‘Instantiating’ generic models in the KBS and filling them in by selecting from them and changing where appropriate.
  - » Execution, monitoring and auditing of the ‘instantiated’ process and metadata model.

Concluding remarks

In this contribution we have dealt with:

- Nature of Project Management for research and development processes.
- Nature of functional and performance requirements associated with model/knowledge based support for Project Management.
- The bootstrap approach for developing the knowledge base.