Protégé In Modeling Management Systems

by A.Gehrmann and S. Ishizu,
Aoyama Gakuin University
QIS Laboratory
1. **Generic Management System Standards** provide requirements, guidance, models and conceptualization for company-wide management processes and organizational artifacts at highest level of abstraction;

2. 100,000s of organizations in all types of industries applying **GMS Standards** for diverse Management domains (E.g. ISO 9000 [Quality Management], ISO 14000 [Environmental management]), Information Security Management; GMS are independent from size, type and culture of organizations; Independent form industrial context;

3. More types of GMS standards gaining popularity: Information Security Management, Accounting, sigma project for sustainability Management etc.

4. Serve as Contractual requirements; good practice models;
3 types of Management System Standards

- Type A: management system requirements standards, both generic and sector-specific. E.g. ISO 9001, 14001, .. defines requirements about what to do. No requirements about how to do.
- Type B: management system guidelines standards, both generic and sector-specific. ISO 9004, 14004, … gives advice about how problems can be solved
- Type C: management system related standards; E.g. ISO 9000 (concept definition, approaches or guidance on related supporting techniques)

Refer to ISO GUIDE 72

- GMS standards embedding knowledge which can be applied in all organizations. They can be re-used in all types organizational modeling
Concepts used in standards are difficult to grasp – need for shared conceptualization-

- Customer; Who is it?
- Product Design; what is it?
- Delivery; What does it mean?
- Nonconforming product
- Contract
- Product
- Quality
- Effectiveness of processes and Systems
- In a jail; school?
- for a chemical product?
- in the service industry?
- For a software product?
- In an university?
- in the service industry?
- of a service? of an financial advice
- For an artificial conceptual system?
Concepts used in standards are difficult to grasp—need for shared conceptualization.

Effective application needs

Ontological Commitment
Problems with implementing GMS Standards
- an ontological solution -

Problem

1. Implemented systems reflect often organizational reality not sufficiently; inconsistencies tamper effectiveness of system

2. Documentation systems rather than Management Practice

3. Integration of TQM and general Management tools difficult

4. Deployment of IT systems not harmonized

Solution

1. Maintaining consistency as organizational ontology

2. Semiautomatic generation of system documentation in line with Management Practice

3. Implementing Management tools by integration of tool ontology in the overall model

4. Using model as communication platform for IT projects
Need for Ontology in GMS

- Lack of shared conceptualization
  - E.g. Concept of nonconformity, Intangible products, design in service sector
  - Language barriers in translation problems (servicing, contract)

- Organizational Modeling in compliance
  - Workflow, ERP, Security Models, IT solutions
GMS requirement standards and guidance documents as Problem solving methods (PSMs)

- GMS Standards provides not only concepts and roles in organizations; general applicable control processes to be applied in dealing with problems and also achieving goals.
- GMS standard requirements defines management context-independent reasoning.
- GMS specify management behavior which can be used across all industries.
- Industrial domain-independent reasoning components.
- Specify patterns of behavior which can be reused across different management systems.
Potential of GMS
- vision of a shared management conceptualization-

- Creating a globally shared conceptualization of organizational domains (quality, Information technology, environmental issues...) as reservoir of components for organizational modeling
- Reservoir for re-usable organizational concepts
- Using GMS as Generic upper management model for a formal conceptualization of methods and concept ontologies
- An ontology which embraces concepts from products to conceptual models like Management Systems
- Base for Generic organizational Management Modeling
- Reference model for defining constraints in IT development
Goal 1 - An Ontology Editor for the Management Domain

- Generating, maintaining, communicating, exchanging Organizational domain and Process Ontologies
- Designing Organizational Structures and Processes
- Maintaining Consistency of all organizational concepts
- Integrating Ontologies from Product/Service level up to Organizational Conceptual level
- Maintaining Compliance with diverse GMS
Goal 2 – Building a GMS ontology

- Create a generic ontology based meta-model which:
  - Support implementation, maintenance and operation of Management Systems based on GMS; especially requirement standard (A-type)
  - To integrate concepts related to all types of organizational artifacts in one consistent model; from product, service definition to organizational strategic concept
  - Building a library of Generic Management Problem Solving Methods (GM PSM)
  - To provide a framework for maintaining a sharable library of TQM and other organization tools so that they can be used in a manner like PSM
Generic Management Standards as Ontologies

- Generic Management standards (GMS) can be understood as upper domain ontologies of organizational realities
- Generic Management standards defines ontologies
- Requirement standards defines generic reusable Methods
Benefits

- Support for building Virtual enterprises in compliance with management standards
- Support for business process design
- Support for defining and communicating constraints on IT solutions
- Support for necessary Management System documentation
Advantages of the ontology

- Management of consistency in organizational model development
- Exchange of organizational models, visualization
  - horizontal, Vertically, domain expert - IT experts
- Machine-processable semantics of models
- Company-wide, cross-organizational process design
- Process/system auditing support
- Process Simulation
- Process Documentation
- Merging of domain ontologies
- Consistent Database design
GMS standards concepts and requirements overlap

Processes and concepts of different domains can be reused
Interrelationship between Upper Generic and specific Management Ontologies

GMS Task Ontology
E.g. ISO 9001 requirements

Mgt. Task Ontology
Organizational requirements

E.g. Improve Product X

Mapping

GM Problem solving Ontology
E.g. ISO 9004

Mgt. Problem Solving Methods
Organizational Methods

Method Ontology
E.g. QFD, FMEA

Mapping

Management Domain Specific knowledge

Mgt Domain Ontology
Quality System

GM Domain Ontology
ISO 9000 concepts

Application Model

Protégé In Modeling Management Systems by A. Gehrmann and S. Ishizu, QIS Laboratory
Used tools and concepts

- **GMS Standards** (Type A,B,C) as upper management domain ontology (ISO 9000, ISO 14000, BS 7799-2)

- **OPM(L)** as *ontology specification language*
  - Domain independent, used for product to conceptual systems, backward compatible to UML, fits to process approach of GMS; parts also used in Bio ontology

- **Protégé** as ontology editor
  - Visualization tools, UPML, PSM tab
Basic Generic Ontologies

- **Generic (Quality) Management Method Ontology** - specify the definitions of the relevant concepts and relations used for specifying the reasoning process (problem solving) to accomplish a generic management task (PDCA, Process approach). (ISO 9001:2000 requirements); For QM the domain ontology is composed of the definitions of all parts, features, relationships and concepts necessary to talk about QM.

- **Generic (Quality) Management Task Ontology** - specifies the terminology associated with the type of task to be solved in the (Quality) domain, design, review, etc. (ISO 9000:2000 concepts)

- **Generic (Quality) Management Domain ontology** – generic conceptualising the particular domain, e.g. quality, contract, (ISO 9000:2000 concepts)
Basic Management Ontologies

- **Management Method Ontology** - specify the definitions of the relevant concepts and relations used for specifying the reasoning process (problem solving) to accomplish a management task. Inheritance from Generic Ontology

- **Management Task Ontology** - specifies the terminology associated with the type of task, e.g. scheduling, planning etc. Inheritance from Generic Ontology

- **Management Domain ontology** - conceptualising the particular domain, e.g. job-shop scheduling in quality widget etc. Inheritance from Generic Ontology

- **Management Application ontology** - contains the essential knowledge in order to model a particular application under consideration.
Interrelationship between Upper Generic and specific Management Ontologies

- **GMS Task Ontology**
  - E.g. ISO 9001 requirements
  - Mgt. Task Ontology
  - Organizational requirements

- **GMS Problem solving Ontology**
  - E.g. ISO 9004
  - Mgt. Problem Solving Methods
  - Organizational Methods

- **Method Ontology**
  - E.g. QFD, FMEA

- **Management Domain Specific knowledge**

- **Mgt Domain Ontology**
  - Quality System

- **GM Domain Ontology**
  - ISO 9000 concepts

E.g. Improve Product X

Mapping

Mapping

Mapping
ISO 9000:2000 and Generic Domain Ontology

Consist-of

Year
- Winter
  - Spring
- Season
- Summer
- Autumn

Is-a

Season
- Spring
- Summer
- Autumn

UML Notation
ISO 9000:2000 provides generic concepts and relations which can be understood in ontological terminology.

Figure A.5: Concepts relating to management
ISO 9000 based Management Ontology

```
Contract
  consist-of* Requirements
    io deliveryTime
    isa Needs
    isa Expectations
```

Protégé In Modeling Management Systems by A.Gehrmann and S. Ishizu, QIS Laboratory
Example

◆ A WebTrading.Ltd Ontology with Protege
Modeling dynamic structures

- Processes needs to be modeled as Ontologies
- We use the same ontology as proposed by see John Georga
  (http://www.ics.uci.edu/~jgeorgas/ics225/proc model.htm)
Process requirements are modeled as dynamic structures - A process ontology

Based on (PML) :XXXXXXXXXXXXXXXXXXXXX
OPM as general Systems modeling language

- Need for a rich ontology specification language for GMS process modeling
- Implementation of Management Systems needs design of
  - Conceptual Systems,
  - Product design,
  - Process models
- As used in Biological Processes Ontology
- Details at http://dori.technion.ac.il/opm/
OPM fits naturally to the so-called process approach in GMS standards.
Object-Process Language as Ontology
Zoom-in the Product Realization Process

Fig. 6 Zoom-in of a product realization process
The Graph Widget visualize OPD
Interrelationship between Upper Generic and specific Management Ontologies

- **GMS Task Ontology**
  - E.g. ISO 9001 requirements

- **GMS Problem solving Ontology**
  - E.g. ISO 9004

- **Mgt. Task Ontology**
  - Organizational requirements

- **Mgt. Problem Solving Methods**
  - Organizational Methods

- **E.g. Improve Product X**

- **Mapping**

- **Method Ontology**
  - E.g. QFD, FMEA

- **E.g. ISO 9004**

- **GM Domain Ontology**
  - ISO 9000 concepts

- **Mapping**

- **Management Domain Specific knowledge**

- **Mapping**

- **Mgt Domain Ontology**
  - Quality System
ISO 9001:2000 8.5.2 Corrective action: The organization shall take action to eliminate the cause of nonconformities in order to prevent recurrence. Corrective actions shall be appropriate to the effects of the nonconformities encountered. A documented procedure shall be established to define requirements for:

a) reviewing nonconformities (including customer complaints),
b) determining the causes of nonconformities,
c) evaluating ..need for action to ensure .. nonconformities do not recur,
d) ..........
Interrelationship between Upper Generic and specific Management Ontologies

- GMS Task Ontology
  - E.g. ISO 9001 requirements

- Mgt. Task Ontology
  - Organizational requirements

- E.g. Improve Product X

- Mapping

- Management Domain Specific knowledge

- Mgt Domain Ontology
  - Quality System

- GM Domain Ontology
  - ISO 9000 concepts

- GMS Problem solving Ontology
  - E.g. ISO 9004

- Mgt. Problem Solving Methods
  - Organizational Methods

- Method Ontology
  - E.g. QFD, FMEA

E.g. Improve Product X
Integration of TQM Problem Solving Methods

- A repertoire of 60 TQM tools are used in Japan which specify how to solve organizational problems
- These tools can be configured to specific domain ontologies (in UPML)
- Artifacts are mapped to or instantiated from generic concepts (Quality characteristic, preventive actions (FMEA)
Potential Application of the GMS ontology

- Management System Documentation
- Auditing of Virtual enterprises for compliance issue (no chance in physical world)
- Design, development and Maintenance of Management System
- Knowledge representation
- Database design
- Information retrieval procedure
- Software engineering of Workflows consistent with Management Systems Requirements
- Information systems in general
Summary

- ISO 9000:2000 concepts modeled as ontology
- OPM(L) as language constructs for specification of all artifacts and organizational concepts
- GMS requirement standards to be modeled as PSM library
- Advantages:
  - Using ontologies to construct models in a principled manner
  - Universal modeling approach as reference for IT
  - Support of design, implementation and maintenance of management systems
  - Integration of TQM tools
References

Q&A

gehrmann@yhc.att.ne.jp
ishizu@ise.aoyama.ac.jp