DIAGRAMMATIC KNOWLEDGE MODELING FOR MANAGERS
Ontology-based Approach

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Abstract: Diagrams are an effective and popular tool for visual knowledge structuring. Managers also often use them to acquire and transfer business knowledge. There are many currently available diagrams or visual modeling languages for managerial needs, unfortunately the choice between them is frequently error-prone and inconsistent. This situation raises the next questions. What diagrams/ visual modeling languages are the most suitable for the specific type of business content? What domain-specific diagrams are the most suitable for the visualization of the particular elements of organizational ontology? In order to provide the answers, the paper suggests light-weight specification of diagrams and knowledge content types, which is based on the competency questions and ontology design patterns. The proposed approach provides the classification of qualitative business diagrams.

1 INTRODUCTION

Knowledge visualization proved to be an effective tool for knowledge creation, acquisition and transfer (Eisenstadt et al., 1990); (Eppler and Burkhard, 2007); (Gavrilova and Voinov, 1998). Diagrams constitute the basis for visual knowledge representation and elaborated diagrammatic techniques typically form visual modeling languages (Harel and Rumpe, 2000). The focus of this paper is put on the realm of management. Managers also frequently use diagrams in their work (Lengler and Eppler, 2007), but the choice of diagrams is often error-prone and inconsistent.

For the effective choice of the visualization method, several perspectives should be considered (Eppler and Burkhard, 2007). Type of content or knowledge type is one of the perspectives and is the focus of the paper. Any complex entity can be represented from several aspects (facets) and at different strata (layers) (Gavrilova and Voinov, 1998); (Zachman, 2003). The following "7W" question-based aspects can be proposed and differentiated (Eppler and Burkhard, 2007); Gavrilova and Voinov, 1998); (Kipling, 1912); (Zachman, 2003): WHAT-, WHAT_FOR-, HOW-, WHO-, WHERE-, WHEN- and WHY-knowledge types.

Today, there is no validated prescriptive framework that links business diagrams with the "7W" knowledge types and that offers specific diagram for every knowledge type. The problem is accentuated by the lack of knowledge types' specifications. This defines the first research question: **What diagrams/ visual modeling languages are the most suitable for the specific type of knowledge (content)?**

The second research question stems from the task of ontology visualization within different applications. Ontology is a formal, explicit specification of a shared conceptualization. Traditional graphical representations of ontologies do not consider a domain specific meaning (Katifori, et al., 2007). Special ontology-based frameworks are developed to visualize ontology using domain-specific notations (Karagiannis and Kühn, 2002); (Kudryavtsev and Grigoriev, 2011). Some of these frameworks are oriented towards managers. It defines the second research question: **What**

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diagrams/ visual modeling languages are the most suitable for the visualization of the particular ontology view?

2 RELATED WORK

Periodic table of visualization methods (Lengler and Eppler, 2007) provides a good top-level diagrams overview for managers. Lohse et al. (Lohse et al., 1994) reported a structural classification of visual representations. Some of the diagramming tools, such as Visio, Smartdraw, provide its own classifications of the templates. Also there exist several enterprise architecture based classifications, e.g. Archimate (Jonkers et al., 2003), MEMO (Frank, 2002), IBM Enterprise framework or populated Zachman Framework. But these classifications and frameworks do not include all the types of diagrams used by managers and are rather IT-oriented.

Unfortunately these classifications either are too general, or have rather inconsistent classification criterias, or have limited set of diagrams, which do not cover all the "7W" knowledge types. Besides the suggested categories are specified insufficiently, and it is quite hard to add new diagram into the existing classification.

3 METHODOLOGY AND RESULTS

We suggest using ontology-based specifications for knowledge types and diagrams. This approach will provide opportunity to select the diagram for the specific knowledge types, competency question and for the visualization of the required ontology view (elements of ontology).

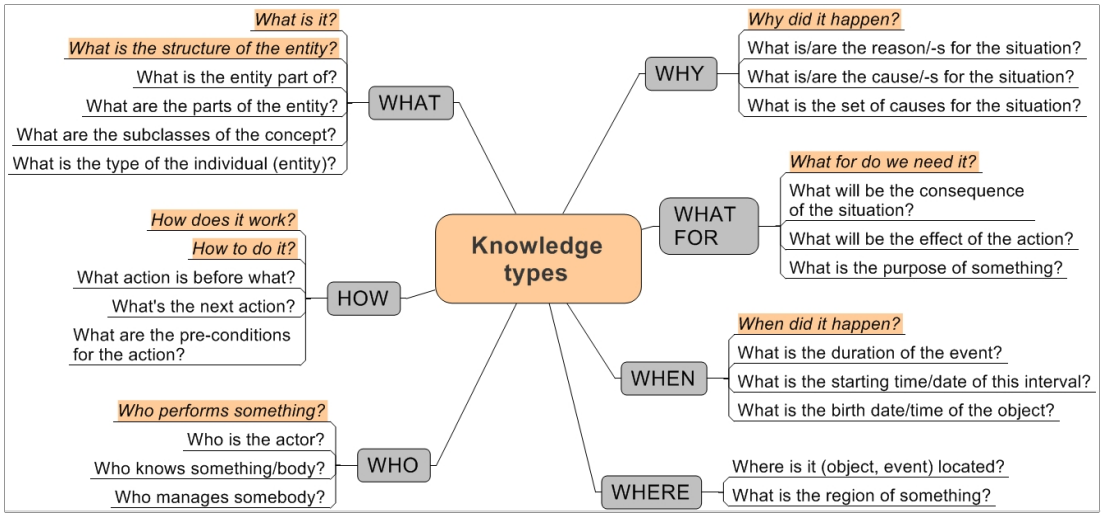
To describe informally the knowledge types we suggest to use competency questions technique (Gómez-Pérez et al., 2008).

Ontology-based knowledge types specification consists of a set of Ontology Design Patterns (ODP) (Gangemi and Presutti, 2009). ODP - a modeling solution to solve a recurrent ontology design problem. It is a template that represents a schema for specific design solutions (http://ontologydesign patterns.org/). Some ODPs can be extracted from enterprise-related ontologies, (Filipowska et al., 2009); (Uschold et al., 1998).

Ontology-based diagram specification is based on the ideas of (Guizzardi et al., 2006), but we suggest to use "light-weight" specifications of only the core diagram elements.

The following steps and their results summarize the suggested ideas:

1. Define the knowledge types using competency questions. The resulting informal description of the knowledge types is represented in Figure 1 (it includes just the main representative questions);
2. Specify the knowledge types using ODPs. The specifications include the lists of corresponding ODPs and their descriptions, e.g. "WHAT-knowledge" type can be specified using "part-of", "classification", "subclass" and "type" ODPs from http://ontologydesignpatterns.org/.
3. Identify and specify diagram types, which will



**non-specific competency questions are highlighted (won't be directly relate to ODPs)*

Figure 1: Knowledge types description using competency questions.

potentially correspond to the suggested knowledge types. Ontology-based specification of diagrams also includes the list of corresponding ODPs and competency questions.

4. Align ontology-based specifications of knowledge types and diagrams. Example alignment between ontology-based specifications of knowledge type and diagram is shown in Table 1.

5. Classify diagrams according to knowledge types based on the ODP alignment. The resulting classification may be useful for the practitioners in selecting the appropriate business diagram type (Figure 2).

The research findings correspond to this 5-step process and its results, both intermediate and final, and are represented below.

4 SCENARIOS OF RESULTS USAGE

The described approach allow us to sketch some patterns of use which may enhance the effectiveness of visual modeling. Thus we can introduce three possible scenarios of results usage.

Scenario A. The user choose the diagrams based on the competency questions only. These questions will either lead to diagrams directly, or will point to the required knowledge type with a list of associated diagrams.

Scenario B. The advanced user may choose the diagrams using ODPs and the competency questions can be used for preliminary filtering.

Table 1: Example alignment between WHO-knowledge and swim-lane diagram specifications.

Knowledge type specification			Diagram type specification	
WHO	Competency question/-s: Who performs smth? (informal) What roles are this task (action) of?	"Role task" ODP	Swim-lane diagram	

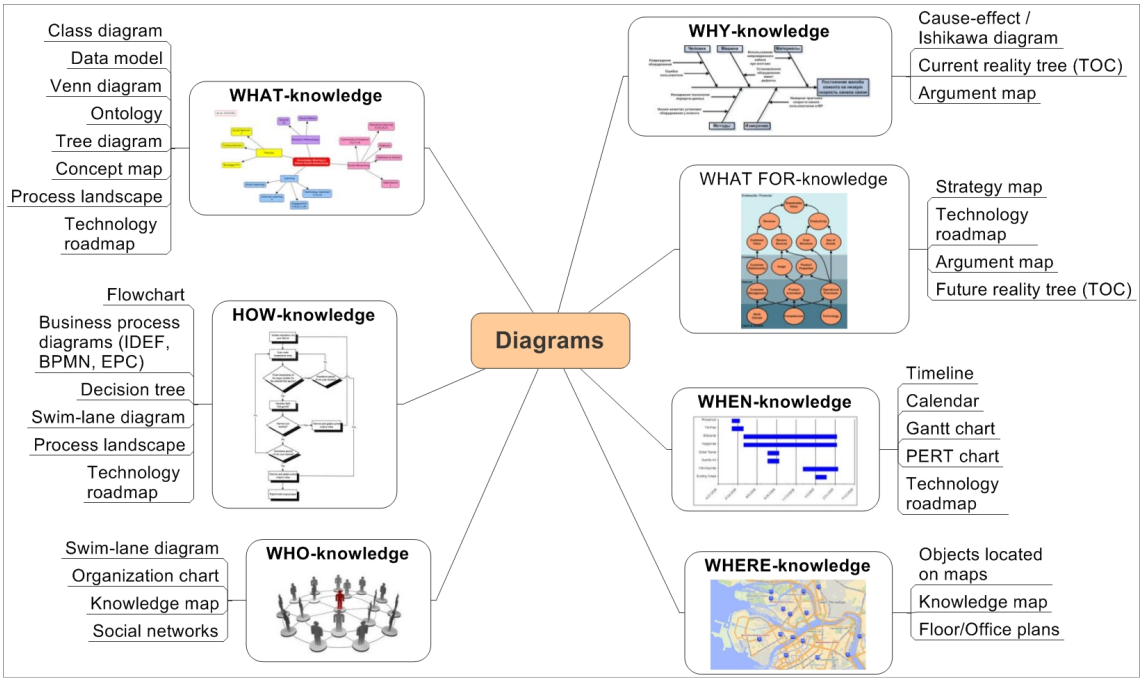


Figure 2: Diagrams vs. knowledge types.

Scenario C. The user or service wants to represent his/her ontology using domain-specific visual language. Then service aligns ontology, which must be represented, with ontology-based diagrams' specifications and then selects the appropriate diagrams for the ontology based on the alignment.

5 DISCUSSION AND CONCLUSIONS

The main research results of our paper are:

- Specifications for the "7W" knowledge types;
- Diagrams systematization, which is grounded on ontological specifications. Obviously, this classification is only the attempt as the list of diagrams for knowledge types is incomplete.
- 5-step process which makes it possible to extend knowledge types' specification and to classify new diagrams based on the content perspective.

Creation of the extended catalogue/repository for diagrams should be a collaborative effort based on the proposed 5-step process.

The main result of our papers for final user (manager) is the mapping between knowledge types and popular business diagram types. Such the mapping together with the suggested informal descriptions of knowledge types can support managers, while working with visual models.

The ODP-based approach can be considered as the first step towards pure ontologically founded usage of diagrams among managers. The ultimate goal is the design of a consistent organizational ontology or ontology network behind a collection of diagrams. This will allow organizations to have comprehensive ontology-based knowledge repository with domain-specific visual views.

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