Collaborative Ontological Design of a Web Portal

Ankita Vij  
University of Illinois at Chicago  
vij.ankita@gmail.com

Siddartha Bhattacharyya  
University of Illinois at Chicago  
sidb@uic.edu

Arkalgud Ramaprasad  
University of Illinois at Chicago  
prasad@uic.edu

Abstract

The paper describes the collaborative development of an ontology for designing a web portal as part of a system development life cycle. Starting with the problem statement of the sponsors, the paper discusses the induction of the ontology from the requirements and the articulation of the ontology in wireframes for the system. Subsequently, the paper describes the multiple methods of external and internal validation of the ontology. The paper concludes with a discussion of future application of the ontology and recommendations for improvement. Thus it highlights the value of combining ontological analysis with the system development lifecycle (SDLC), conceptual modeling, and collaboration engineering.

1. Introduction

Web portal design is a systemic problem. The challenge of developing a systemic approach to the problem can be illustrated using the parable of the six blind men and the elephant. There are many versions of the story – at the core they are very similar. Each of the six blind men, wanting to know the elephant, touches a different part of an elephant’s body and declares the elephant to be like a rock (body), pillar (leg), rope (tail), arrow (tusk), fan (ear), and tree (trunk). While the men are debating their different perceptions, a wise man intervenes. He affirms all six perceptions and explains how each is about a part of a whole elephant which they do not see. The conceit in the parable, however, is that there is a wise person who sees the whole elephant.

The challenge in developing a systemic approach to web portal design is: The designer has to be the wise person who sees the whole system. How the system is envisioned will determine how the problem is formulated and solved. How then does one envision the system from these partial, natural-language descriptions of fragments of the system, they feel overwhelmed. They are unsure where to begin, how to organize the pieces logically, and how to connect them together meaningfully. Their portrait of the system which emerges is incomplete and unsatisfactory. Consequently, they fail to formulate and solve problems effectively. The method of systems thinking has to help them envision methodically and solve problems effectively.

Ontological analysis [1] is “the method of parsing the problem into its component dimensions and taxonomies to capture its complexity with natural language descriptions using a structured terminology” [2]. An ontology is a graphical textual representation which can be conveniently shared, and which allows all stakeholders to be "actively engaged in the construction and modification of [conceptual] models" [3, p. 61]. “With increasing complexity of systems and organizations, creating shared understanding and joint representations of those systems [such as for web portal design] becomes increasingly important” [3, p. 62]. Thus collaborative conceptual modeling using an ontology can be described as “[t]he joint creation of a shared graphical [and textual] representation of a system” [3, p. 62].

“An ontology has the advantage of visually representing the complexity parsimoniously at different levels of detail – thus allowing the collaborators to describe the system at different levels of granularity. Structurally it is scalable and extensible to fit the collaborators’ perspectives. It can be used to simultaneously represent the macro with the micro – the big picture with the detail, the whole and the parts, metaphorically and literally”[4].

These characteristics make an ontology an effective collaborative conceptual modeling tool for design: each system requirement can be interpreted as a partial description of the system, and the requirements of all the collaborators taken together represents an incomplete description of the system. By collectively inducting the underlying dimensions
of the requirements and the taxonomy of each dimension from the requirements, the collaborating group can encapsulate and extend the requirements using an ontology [4].

Thus collaborative design using an ontology can be a tool in Collaboration Engineering [5], for “collaborative learning of design” [6, p. 170], and “architectural decision capturing” [7, p. 15]. The entirety, the ontology, the dimensions, or parts of the taxonomies of each dimension can be used in “recurrent collaboration tasks”. [5, p. 611] Similarly, the dimensions of the ontology, the taxonomy of each dimension, and the ontology itself are design patterns which can be reused [8]. They can also provide focus for generating inquiry and synthesizing knowledge. The method will allow the designers to “integrate both ontological (top-down) and discursive (bottom-up) approaches to knowledge elicitation and structure” [9, p. 672] in designing a system. Above all, a major advantage of the method is that it can be implemented on paper or using simple tools like a spreadsheet.

We describe the collaborative development of an ontology for designing a web portal as part of a system development life cycle. Starting with the problem statement of the sponsors, we discuss the induction of the ontology from the requirements and the articulation of the ontology in wireframes for the system. Subsequently, we describe the multiple methods of external and internal validation of the ontology. We conclude with a discussion of future application of the ontology and recommendations for improvement.

The method can be used to generate a natural-language based, concise, and comprehensive map of the system. The map is modular and parsimonious, can be scaled to different levels of granularity, and adapted to the desired scope. In the following we will describe the method for systemically and systematically modeling the problem of web portal design collaboratively using an ontology.

2. Designing IT Projects’ Status Web Portal

The objective of the project was to design an integrated SharePoint portal to provide information about all the IT (Information Technology) projects in a large reinsurance firm’s risk solutions division. This portal aims to communicate project statuses and updates between IT teams and internal clients easily, thus acting as a common platform for increased transparency. Many stakeholders including business users, IT users, and vendors need periodic updates about project outcomes and status. Currently, most of the projects manage their own individual SharePoint site; the CIO and internal clients get status updates via ad-hoc e-mails and phone calls. Thus, for the portal to deliver its intended business value there was a need to determine in detail the information entities to be captured and presented, and ensure a consistent easily updatable and navigable design.

This case study describes the use of ontology for collaborative conceptual modeling to design an integrated SharePoint portal. There were many types of collaborations: among the design team members, the team and the sponsors (Business Analyst and CIO), the team and the developer, and the team and the users. Collaboration was vital because many different users are involved and incorporating their diverse inputs and that of other stakeholders was necessary for a successful system design. The project followed the Software Development Life Cycle model – requirement gathering and analysis, conceptual modeling, data modeling, design of the portal, and implementation of the design.

Initial information requirements obtained through a questionnaire sent to a broad user group helped determine the conceptual model. This initial model both facilitated detailed requirements gathering from users, and was itself further refined through discussions with users. The model, developed collaboratively, captured the full set of information entities and granularity of interest to the diverse user group, and helped establish system scope. It was also useful in validating application needs and understanding processing and user interface concerns from the users’ standpoint. A key advantage, at this stage, arises from requirements discovery that the conceptual model facilitates. In providing, from a users’ viewpoint, a comprehensive picture of the full information set, it fosters a broader consideration of scenarios than users might otherwise have thought through.

The conceptual model, with its comprehensive characterization of varied information needs, then formed the basis for the data design. Note that the ontology, representing a high level conceptual view of information requirements, is not intended for or amenable to any direct or automated translation from ontology to data schema, etc. Rather, it allowed analysts to develop a data design considering the full range of user interests. The conceptual model also facilitated an effective user interface design, through collaborative consideration of information presentation and interaction requirements of diverse users.
3. Development of the Conceptual Model

The conceptual model presents a comprehensive view of the information available/required about projects, the varied needs of many stakeholders, as well as the different information and reporting requirements of the users. It helps identify the most relevant pieces of information from the standpoint of a diverse set of users. Thus, a subset of the model can be carried forward in the design of the portal. The information can be viewed at the required level of detail and can vary for different users. The conceptual model can thereby help define the data model, as well as the user interface, and also the reports most suitable for the needs of different users.

3.1. Requirements Gathering and Analysis

An online survey was conducted by the team requesting users to state their information requirements from the portal in general terms. Following the survey, the team interviewed some of the identified end-users, in person and/or via conference calls and discussed their information requirements in detail.

Based on the survey and interviews, end-users were classified into six different groups, each with a different set of information requirements: Finance Executives, Business Executives, IT Executives, IT Project Managers, IT Business Analysts, and Vendors. The survey data showed that the end-users’ needs varied with regard to: (a) information entities, (b) type and granularity of information about the entities, and (c) frequency of interaction with the information. The information entities were categorized as Business Units, Programs, Projects, and Activities; Projects were further categorized based on their budget approval status as Approved, Requested, and In-pipeline. Information about the entities required by users was broadly categorized as: Business Case, Financials, Project Plan, Compliance and Strategy Initiatives, Global Initiatives, Major Activities List, Contact List, Calendar, Updates, and Analysis. Many of these categories were further subcategorized resulting in a three-level taxonomy. Last, the desired frequency of interaction was categorized as Weekly, Biweekly, Monthly, Quarterly, and Annually.

3.2. Conceptual Modeling

The above requirements were encapsulated in an ontology as shown in Figure 1. The taxonomies in the four columns from left to right represent the information entities, frequency of interaction, types of information, and users respectively. A requirement can be derived from the ontology by concatenating a category from each column with the words/phrases adjacent to the column. Two illustrative concatenations are shown at the bottom of the figure. The ontology represents all possible requirements of the proposed portal, and can include the ones not specified in the interviews with users. Some of the latter, although not articulated, may be relevant to the design; discovering and validating them were key to the effective design of the portal.

Business users found the information/requirements presented in the ontology intuitive and easy to understand, without needless technical detail. Moreover, the ontology captures enough details for SharePoint developers to help derive the data model design from it. The CIO found it useful to view the comprehensive set of requirements without being overwhelmed with the detailed technical specifications, as is typical in a traditional modeling approach.

4. Application of the Ontology

4.1. Data Modeling

The ontology can be readily used in defining the data requirements for a portal. The database schema and data definition are an important part of a portal design and this is managed in SharePoint using lists. Every list in SharePoint acts as a database table and every column name in the list corresponds to a column in the database table. The components defined under the “Information Type” column in the ontology were directly mapped to tables and column names with varied data types. For example, the “Business Case” information type can be a SharePoint list, with “Executive summary” as a descriptive text field, “Value to the firm” as a categorical field, or “Budget” as a numerical value field for the “Financials” list. Also, complex information like “High level timeline” can be handled as a Gantt chart list for “Project Plan” information type.

4.2. Design

The team created wireframes for the portal design on the basis of various project components defined in the ontology. The wireframes depict the screen design of various portal pages. An example of the Business Case (a business case captures the reasoning for initiating a project or task) view is as
### Ontology of Web Portal Requirements

<table>
<thead>
<tr>
<th>Information Entity</th>
<th>Interaction Frequency</th>
<th>Information Type</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Program</td>
<td>Weekly</td>
<td>Business Case</td>
<td>Finance Executives</td>
</tr>
<tr>
<td>Project</td>
<td>Biweekly</td>
<td></td>
<td>Business Executives</td>
</tr>
<tr>
<td>Approved Requested</td>
<td>Monthly</td>
<td></td>
<td>IT Executives</td>
</tr>
<tr>
<td>Pipeline Activity</td>
<td>Quarterly</td>
<td></td>
<td>IT Project Managers</td>
</tr>
<tr>
<td></td>
<td>Annual</td>
<td></td>
<td>IT Business Analysts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vendors</td>
</tr>
</tbody>
</table>

**Illustrative Combinations**
- Web portal for project level biweekly status of milestones and key deliverables for IT Executives
- Web portal for program level monthly status of dashboard of projects for Business Executives

*Figure 1: Ontology of Web Portal Requirements*
shown in Figure 2. The wireframe has various fields like Summary, Business sponsor, Driver, Business Units impacted, etc. directly mapped from the “Business Case” Information Type in the ontology. Similarly, the “Financials” information type can be mapped to another wireframe. The ontology also helped the design team refine these generic user interface or information views as per needs and constraints for different users. For example, the “Financials” view should only be visible to the “Finance Executives”, “IT PMs” and “IT BAs” user groups defined in the ontology. The ontology thus helped the team design the wireframes for the portal effectively and efficiently.

While validating the user interface design, the ontology helped end users develop a better appreciation of the information they need on the portal. The ontology along with the wireframes helped users realize the full set of information that can be made available to them through the portal. This is particularly noteworthy, given that end users are often unable to articulate precise and complete requirements, especially for new systems; the conceptual model in the form of ontology facilitated a more complete analysis of requirements.

If the ontology had not been used, the requirement gathering and analysis as well as the design phase would have involved multiple back-and-forth iterations for information captured amongst the design team and the different end users. This is usually time-consuming and it is nearly impossible to obtain a complete set of requirements with all the users on the same page literally, as has been demonstrated with a single-page ontology.

5. Validation of the Ontology

The ontology was validated in a number of ways both internally and externally. The first validation was the ability of the team to satisfactorily fit the detailed requirements from the surveys and
interviews on to the ontology. This is the equivalent of assuring the content validity and the face validity of the ontology.

The approval from the sponsors was a second source of validation – external validation. They found the ontology to be a new and useful way of presenting information and requirements. To quote one of the sponsors: “I thought it was extremely helpful. I have not seen it put that way before, so it was nicely laid out and easy to understand. I believe it can be applied to multiple projects and I think it was helpful in the sense that it was able to provide you with the framework for the requirements.”

The approval from the technical support person was the third source of validation, again external. He was able to relate to the ontology immediately in terms of the database model.

The approval from peer project groups doing similar projects was a fourth source of validation, quasi-external since they were part of the same course. They found ontology to be a useful concept and a presentation device. It provided a convenient way to depict comprehensive information requirements from different analysis points of view. They felt that the ontology could lead to more complete specification of the requirements and effective design.

Last, the approval from broader group of industry professionals who were presented the project at a Student Project Expo was the fifth source of validation, external. The visitors’ attention was drawn towards ontology because it was something new and different to them, they asked questions and sought explanations, and generally appreciated how it could be useful to represent and ensure a complete set of requirements.

6. Conclusions and Recommendations

The ontology is a comprehensive, concise, robust, and extensible framework for collaborative conceptual modeling of a web portal on a sheet of letter-size paper. We have demonstrated how it was used by the team members to collaborate with each other, and for the team to collaborate with the sponsors and the users to integrate and map their requirements systematically. Through the case, we have also demonstrated how the ontology can be used to specify the requirements of the system at different level of details; additionally, the granularity of the representation can be varied based on need. Further, we have demonstrated how it can be used to design the portal by deriving the wireframes from it. The above mentioned flexibility and extensibility allows one to map the wide ranging requirements of users by incorporating the appropriate categories and dimensions - if a category is excluded from the taxonomy, it can be added with little perturbation. Overall, we believe that the method is generalizable and repeatable.

The ontology was validated internally and externally from multiple sources. The application case study presented here, however, did not involve further steps for quantitative validation. While it is a good beginning, and adequate for the purposes in this application, in the future it may in general be useful to validate and expand the ontology for the web portal through user interviews and designer feedback. Maintaining the ontology by enforcing adherence to it on the one hand, extending or modifying it as necessary on the other can ensure the continuity and integrity of the system design. Such an ontology can be used for deriving the on-going design specifications, platform integration requirements, and above all, user validation and approval. With regard to user validation, the ontology has the advantage of communicating the big-picture as well as the details – to see the forest and the trees, to put requirements in perspective. Last, but not the least, the ontology can make the design efficient and effective. Efficient because of the nature of the structure it imposes on the process, effective because of its natural language interpretability. A systematic study of the pros and cons of incorporating an ontology as part of the systems development process, as highlighted in this case study, remains a topic of future research.

7. References

6. Bravo, C., et al., Collaborative environments for the learning of design: a model and a case study in