# A Social Networking Website for AEC Projects

Mehrdad Niknam[1] and Saeed Karshenas[1]

[1]Marquette University, Department of Construction, Civil and Environmental Engineering, Haggerty Hall, Milwaukee, WI 53233, email: mehrdad.niknam@marquette.edu and saeed.karshenas@marquette.edu

## ABSTRACT

Architecture, Engineering and Construction projects involve a number of individuals and organizations with different roles and responsibilities. In a new project, participants may initially not know each other; however, to be effective, those with a common interest must be able to easily find each other to share their knowledge about the project. Another requirement for effectively managing a project is the ability to easily add new knowledge to the project knowledge base. The current format for representing, accessing, and sharing project data cannot take advantage of the full potential of the Internet. The Internet allows producing distributed information that can be easily combined and shared. It is also a powerful medium for communication among individuals with a common interest who may not know each other.

This paper presents a project social networking website that facilitates professional interactions among a project's participants and provides a dynamic project knowledge base that would allow combining knowledge created during various phases of a project lifecycle. The participants in a new project may join the project website using OpenID. The project website uses a Semantics-based approach to information modeling that allows project website members to add new knowledge to the project knowledge base and perform graph query on project data. The project website members can tag any piece of information in the project knowledge base to their social interactions.

## INTRODUCTION

Architecture, Engineering and Construction (AEC) projects are inter-organization projects where owner, designer, contractor, supplier, and other organizations form temporary teams to deliver the project (Chinowsky et al. 2008). A typical goal of project stakeholders is to enhance inter-organization teamwork (Solis et al. 2012). To solve problems related to a project, individuals who work in different organizations need to combine their knowledge about the project. The Internet provides the capability to combine distributed knowledge about a project. Since the individuals involved in a project may not initially know each other, the virtual social networking technology may be used so that all the project participants can easily find each other.

Currently, it is not easy for individuals who work in different organizations to combine their knowledge about a project. The knowledge about a project is mainly stored in individuals' memory or in computer program files that cannot be easily combined. To combine various individuals' knowledge about a project, those individuals need to find each other and initiate social interactions. In this paper social interactions refer to virtual professional interactions to exchange project related knowledge. Virtual social networking technologies allow individuals involved in a project to find each other, form virtual groups, and interact with each other.

A large amount of project knowledge is also stored in computer files. These files are created using different computer applications. Currently, it is not easy to combine project data stored in files because each file may have a different format and should be opened in a specific computer application. If data transfer between domain applications is required, it is achieved using bridge programs. With the large number of computer applications in AEC projects, it is not easy to combine the data created in various domain programs. For example, information about the design, schedule, and availability of a product are stored in files created by the project designer, the project scheduler, and the product supplier. Combining data from these sources to determine if the supplier product specifications match the design specifications and the supplier product is available at the scheduled installation time is not easy. This is because the formats used for representing the AEC project information do not allow easily combining data from different sources.

This paper introduces the idea of creating a project social networking website that would facilitate project knowledge sharing and interactions among project participants. The following sections discuss: (1) current approaches to project data modeling and its limitations, (2) semantic modeling and its advantages for project information representation and knowledge sharing, and (3) project social networking websites and how they can improve interactions among project participants and facilitate project knowledge sharing.

## CURRENT PROJECT DATA MODELING AND INFORMATION EXCHANGE

With the advent of 3D design software, different domains are able to use a digital model of a project as a shared data model. As Figure 1 shows, different organizations involved in AEC projects such as construction companies, supply chain companies, fabricators, and operation and maintenance organizations can query the project design model and utilize the data in their specialized software tools. For example, design data may be queried for use by scheduling, cost estimating, fabrication, or project control software.

Each software tool describes the project information using its proprietary modeling constructs and features. A software tool usually does not understand the data created in other software tools unless agreed formats and APIs are used for data exchange. The exchange of project data is increasingly demanding as software tools evolve; this has led to over 30 years of standardization efforts (Cerovsek 2011). The AEC industry spends billions each year on inter-operability issues (GCR 2004). There will be differences in the conceptual model syntax and structure when those are

created by different sources; the problem arises when the relationship between two schemas developed by different sources needs to be defined (Issa 2011).

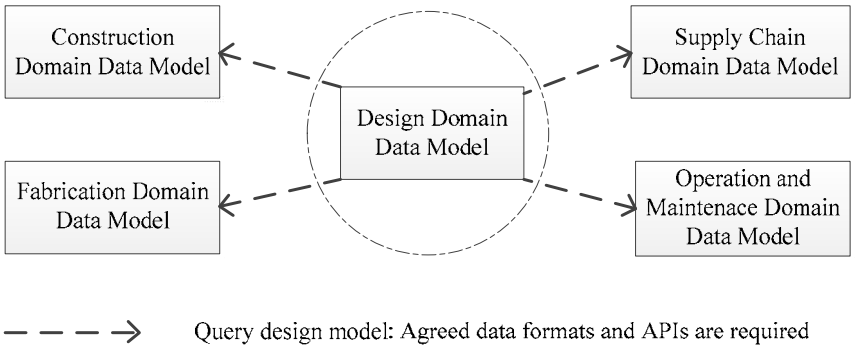


**Figure 1. Different domains query design model**

Currently, project information is modeled using object-oriented data models. The reusability of an object-oriented domain model is often limited because it is domain specific and only takes into consideration abstractions needed to solve an individual problem space (W3C 2006). For example, each construction domain develops a separate class hierarchy for the same set of project elements; however, in object-oriented systems, classes defined in different domains to represent the same object cannot share instance properties; therefore, the information created in different stages of a project life cycle using different software tools cannot be easily combined.

## SEMANTIC INFORMATION MODELING

The World Wide Web was intended to enable every one say anything about any topic by writing a document and publishing it as a web page. Semantic Web takes this infrastructure one step further and allows anyone to express a piece of data about some entity in a way that can be combined with information from other sources (Allemang and Hendler 2011). Therefore, a semantic representation of a project model would allow anyone involved in the project life cycle to add data to the project knowledge base in a way that can be combined with data that others provide.

During a project's life cycle, different types of information must be stored and shared among project participants. This information includes semantically defined domain data models (Karshenas and Niknam 2013), construction processes and supplier products (Niknam and Karshenas 2013), project knowledge items and information about individuals involved in the project (Zhang and Diraby 2012). When these types of information are semantically defined they can be easily combined and related to each other. For example, a product's specifications can be compared with its design specifications, or a supplier's product availability can be related to the product's installation schedule

Semantic Web uses ontologies (W3C a) to define the concepts and relationships among those concepts in an area of concern. Resource Description

Framework (RDF) (W3C 2004) is a standard model for representing ontologies and data in Semantic Web. RDF uses subject-predicate-object triples to represent information and can be seen as a graph where nodes are instance data and edges are object properties. RDF enables merging data from different sources with different schemas. RDF supports the evolution of data schemas over time without requiring any changes in the applications consuming the data. Figure 2 shows how the graph data structure of the Semantic Web allows integration of knowledge from two different project domains. In Figure 2, the design and schedule information about a wall element are combined. This capability of the Semantic Web technology allows various project participants create their own domain data in RDF and if necessary easily combine the data with those created by other project participants. Application of the Semantic Web technology allows creation of a distributed project knowledge base that evolves during the project's lifecycle and solves the interoperability problem among domain information.

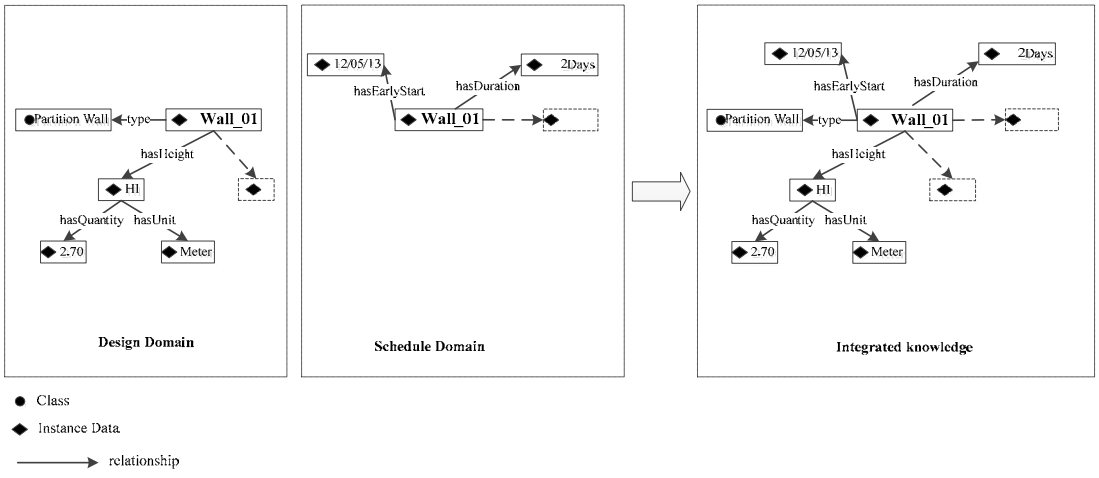


**Figure 2. Integrating domain knowledge**

## SOCIAL NETWORKING IN AEC PROJECTS

The social interactions between project team members can be modeled as a social network. In this paper, social network refers to a network of individuals in a project that can establish virtual social interactions for exchanging project related knowledge. Several studies have analyzed the social networks in design and construction projects (Keung and Shen 2012; Solis et al. 2012; Wambeke et al. 2011; Guha et al. 2010; Park et al. 2010; Chinowsky et al. 2009; Billingham 2007; Chinowsky et al. 2008; Hartmann and Fischer 2009; Howard and Petersen 2001). These studies have investigated the importance of social interactions between project participants but do not discuss project specific virtual social networking and the Internet's potential for facilitating creation of project virtual social networks for interaction among project participants.

Social media provide new opportunities for creating project social networks for sharing and exchanging information as well as clarifying misinterpretation of

information and ideas. Social media can be used in AEC projects to facilitate creation of project virtual teams. According to Ale Ebrahim et al. (2009), a virtual team is a small temporary group of geographically, organizationally, and/or temporally dispersed knowledge workers who coordinate their work predominantly with electronic information and communication technologies in order to accomplish one or more organizational tasks. Social media and virtual teams do not require individuals to be online at the same time to communicate; team members can collaborate in their preferred time. If virtual team members are present at the same time, real time communication can take place. Meanwhile, the exchanged messages are stored in a text-based format for future query and retrieval.

Zhang and El-Diraby (2012) developed a construction information and knowledge portal that uses social web to link people to roles, processes, and knowledge items (KI) in a project. They use aspects of online social networking such as personal profiling, tagging, voting, commenting, and collective rating of knowledge items and peers. Their system allows users to define user profiles, publish KIs, subscribe to interested KIs, browse and mark up published items and user profiles, query for particular need, and create communities of practice to communicate based on common interests. Their system then matches people to each other and KIs based on their interests.

This paper introduces the idea of using a social networking website that facilitates combining project information from various sources. The website must allow individuals interested in a project to easily join the website, create virtual teams, discuss project related issues, and share semantically defined project knowledge. Characteristics of an effective construction project social networking website are discussed below.

## PROJECT SOCIAL NETWORKING WEBSITE

A web site contains documents published for informing an audience; whereas, a social networking website is primarily created for interactions among individuals with a common interest. Figure 3 shows a schematic view of a project social networking website. The website includes members, virtual groups, and a knowledge repository. A member is an individual interested in the project; for example, an individual belonging to the project owner, designer, contractor, fabricator, or supplier organizations. A social networking website member may belong to a number of virtual groups. A virtual group includes members with a common interest. For example, a virtual group may form to discuss a window element used in a project and may include individuals from the project design team, a subcontractor, and a supplier.

The following are the main characteristics of an effective construction project social networking website:

1- Open participation.
2- Fast virtual group formation.
3- Semantically-defined information.
4- Storage and retrieval mechanism for fast access to information.
5- Information privacy

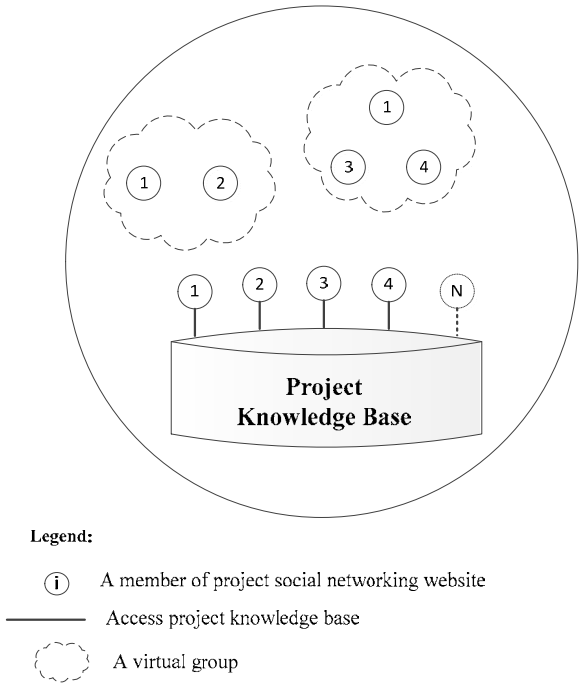


**Figure 3. A Project Social Networking Website**

For open participation, a social networking website should provide the underlying infrastructure for individuals interested in a project to easily join the project website. At the same time, there should be an identification mechanism that enables website administrator and other users of the website to identify website members. One possible solution is to use OpenID (http://openid.net). OpenID allows users to log in to a website using credentials from other organizations such as Facebook, Google, or Yahoo. With OpenID, one can join a website without the burdensome task of creating a new account and password (Oh and Jin 2008). OpenID uses an identity provider for confirming a user's identity and retrieving the user's name and email address.

Once a user joins a project website, he/she has to fill out a user profile form that includes questions about the user's organization, his/her roles and responsibilities in the project, and areas of interest. User profiles are semantically defined and stored in the project knowledge base. Forming a new virtual group involves querying the project knowledge base for members with a specified set of roles, responsibilities, and interests. Once a virtual group is formed, members can start social interactions such as posts, messaging, group conversations, tags, votes, and comments. For example, when a project manager and a window supplier create a virtual group to discuss a window in the project, all documents and messages that they exchange with each other are stored in the project knowledge base and may be tagged to any specific project data. The information in the project knowledge base may be retrieved using various attributes such as a member name, a project component ID (e.g., a Window

ID), a supplier name, a construction process name (e.g., window installation), or a discussion date.

Project knowledge base includes semantic information about the project design model (Karshenas and Niknam 2013), construction processes and supplier products (Niknam and Karshenas 2013), social networking member profiles (created using an extension of Friend of a Friend ontology, http://www.foaf-project.org/), knowledge items (Zhang and Diraby 2012), virtual group compositions, and virtual group interactions such as messages exchanged or documents uploaded by the site users. When these types of information are semantically defined they can be easily combined and related to each other. In this paper, project knowledge base is implemented using Sesame data store (http://www.openrdf.org). Sesame provides a SPARQL (W3C 2013) Endpoint interface for storing, editing and querying the stored RDF data. SPARQL allows performing graph query on data from different sources. The project social networking website provides a mechanism that allows each site user to manage the privacy of the information that he/she provides.

## SUMMARY AND CONCLUSIONS

This paper introduced the idea of using a social networking website for AEC projects. The website allows individuals from different organizations who work on the same project to easily find each other, form virtual groups, and have social interactions. This would allow project participants to combine their knowledge about the project and solve problems together as a team. Project participants can contribute to virtual group discussions in their preferred time or they can be online at the same time and engage in synchronous communications.

The social networking website developed in this paper includes a project semantic repository, also referred to as project knowledge base. The social networking website has the infrastructure to semantically define different types of information and add them to the website knowledge base. Semantically defined data allow website members to easily combine data from different sources and perform graph query on the combined data. A member of a project social networking website would be responsible for the information that he/she provides and sets the privacy of the his/her information.

## REFERENCES

Ale Ebrahim, N., Ahmed, S., and Taha, Z. (2009). "Virtual R&D teams in small and medium enterprises: A literature review." *Scientific Research and Essays*, 4(13), 1575-1590.

Allemang, D., and Hendler, J. (2011). *Semantic Web for the working ontologist: effective modeling in RDFS and OWL*. Morgan Kaufmann, .

Billingham, M. (2007). "Sociological Perspectives." *2007).Health and Social Care Book*, 1 336.

Cerovsek, T. (2011). "A review and outlook for a ‘Building Information Model’(BIM): A multi-standpoint framework for technological development." *Advanced Engineering Informatics*, 25(2), 224-244.

Chinowsky, P. S., Diekmann, J., and O'Brien, J. (2009). "Project organizations as social networks." *J.Constr.Eng.Manage.*, 136(4), 452-458.

Chinowsky, P., Diekmann, J., and Galotti, V. (2008). "Social network model of construction." *J.Constr.Eng.Manage.*, 134(10), 804-812.

GCR, N. (2004). *Cost analysis of inadequate interoperability in the US capital facilities industry*. National Institute of Standards and Technology, .

Guha, S., Biswajit, T., and Chakrabarty, S. (2010). "Collaboration in a web enabled design management system-a case study in Kolkata, India." *Journal of Information Technology in Construction*, 15 86-107.

Hartmann, T., and Fischer, M. (2009). "An ethnographic method to collect input data for formal social network analysis of project teams." *LEAD 2009 specialty conference on governance of global project organizations, CA*, 5-7.

Howard, R., and Petersen, E. (2001). "Monitoring communication in partnering projects." .

Issa, R. R. (2011). "FRAMEWORK FOR SEMANTIC RECONCILIATION OF CONSTRUCTION PROJECT INFORMATION." .

Karshenas, S. and Niknam, M. (2013). "Ontology-Based Building Information Modeling." Computing in Civil Engineering (2013): pp. 476-483.

Keung, C. C., and Shen, L. (2012). "Measuring the networking performance for contractors in practicing construction management." *J.Manage.Eng.*, .

Niknam, M. and Karshenas, S. (2013). "A Semantic Web Service Approach to Construction Cost Estimating." Computing in Civil Engineering (2013): pp. 484-491.

Oh, H., and Jin, S. (2008). "The security limitations of sso in openid." *Advanced Communication Technology, 2008. ICACT 2008. 10th International Conference on*, IEEE, 1608-1611.

Park, H., Han, S. H., Rojas, E. M., Son, J., and Jung, W. (2010). "Social network analysis of collaborative ventures for overseas construction projects." *J.Constr.Eng.Manage.*, 137(5), 344-355.

Solis, F., Sinfield, J. V., and Abraham, D. M. (2012). "Hybrid Approach to the Study of Inter-Organization High Performance Teams." *J.Constr.Eng.Manage.*, 139(4), 379-392.

W3C (2004). "Resource Description Framework (RDF)", <http://www.w3.org/RDF/> (Dec, 05, 2013)

W3C (2006). "A Semantic Web Primer for Object-Oriented Software Developers", <http://www.w3.org/TR/sw-oosd-primer/> (Dec., 05, 2013)

W3C (2013). "SPARQL 1.1 Query Language", < http://www.w3.org/TR/sparql11-query/> (Dec., 05, 2013)

W3C (a). "Standards: Ontologies", <http://www.w3.org/standards/semanticweb/ontology> (Dec. 05, 2013)

Wambeke, B. W., Liu, M., and Hsiang, S. M. (2011). "Using pajek and centrality analysis to identify a social network of construction trades." *J.Constr.Eng.Manage.*, 138(10), 1192-1201.

Zhang, J., and El-Diraby, T. (2012). "Social Semantic Approach to Support Communication in AEC." *J.Comput.Civ.Eng.*, 26(1), 90-104.