Semantic tags for collaboration in construction formalized within a social network framework

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ABSTRACT: As construction projects require tracking an ever-increasing number of parameters to operate with suppliers, vendors, and the entire organization of a construction firm, particularly in exchanging, sharing, and integrating information, a semantically rich form to represent information is required. Semantic tags for interoperable construction workflows represent a novel approach to support the exchanging, sharing, and integrating of information. This approach proposes a semantic main form of representation of construction concepts to assist in the communication between actors. The proposed approach is based on the notion of the social network framework. The assumption is that construction actors' relationships in communicating information can be expressed by patterns of relationships defined in a social network structure. Semantic tags leverage the communication of information within the dynamic social network grid by employing a concept-description that contains metadata. The purpose is to semantically enrich the product or project data. It is expected that the inclusion of additional semantics will overcome inefficiencies within interoperability.

1 INTRODUCTION

The ability to successfully communicate information among individual actors is reduced. In a typical construction project for example, a subcontractor surrenders exceptions during routine constructability analysis activity for clarification of a construction product design. An exception occurs when the actor in a routine activity requires additional information to understand, act, or process information for the same particular activity. The assumption is that the actor is aware of or acknowledges the lack of information within the observed representation to be able to act in his or her capacity. Beyond the factor that caused the exception in the design, the subcontractor has to revise the actor's project relationships to remediate the exception. If the relationships between a designer and a subcontractor are established by contracts and by other legal relationships, the subcontractor appeals to any acknowledged relationships for additional expertise and information to solve the exception. However, the ability to identify with other actors within the network and to successfully communicate information is stymied by the dynamic of the social network relationships and other contextual factors of the construction project. The project conditions, the method of formalization of the relationships through legal documents, project size and its geographical location are examples of these factors.

Also, the existing conditions of these relationships affect the actors' accessibility to others and the actors' expectations of the responses. For instance, the degree of connections among actors can be poor, or the actors are not close enough to establish direct or indirect bonds within the construction project network.

Obtaining successful business communication rests upon each individual or actor's ability to manage the exceptions in the network. The facts that actors do not share the same physical space and do not act on the same temporal scenarios are natural construction project factors that raise the level of difficulty for managing and communicating the required information. Project delivery methods give shape to the network but do not solve the problems within the manipulation of information and do not define a social network.

1.1 *Actors, communication, and social network*

For clarity, the term *actor* does not refer to merely individual humans, but also refers to organizations or parts of organizations. Actors regularly and concurrently take action and made decisions at any time and place within their routine and non-routine activities that manipulate information during the project life cycle. This research refers to manipulation of information as the activities that process, handle, or manage information in routine or non-routine fashion. The assumption is that construction actors have

the ability to interact with others and perform activities related to the manipulation of information, such as sharing, exchanging, and integrating information. This research regards sharing, exchanging, and integrating information as essential activities for interoperability within the social network. Communication takes place at any time to support actors' information processing within the network. Communications are commonly analyzed according to specific frameworks and theories within multiple domains such as sociology, cognitive psychology, etc.

This research refers to communication as an activity defined in a fundamental dimension that aggregates other activities of information handling at a higher level. The activities of sharing, exchanging, and integrating information can be subsumed into a higher level. All these activities take place person-to-person, person-computer, or any multiple combinations within the network where they take place.

As research focuses on the analysis of the social network, it is anticipated that the further understanding of the nature of social network will facilitate activities that manipulate information and the management of routine and non-routine activities within the network. For example, the understanding of the social network should denote an efficiency of the management of errors and of the management of lack of information in the observed representations. The starting point of this study is that the deficiencies that inhibit sharing of information within the network rest within the actors' interpretation of the construction concept representations (Mutis and Issa 2008). To overcome these deficiencies, additional semantics to represent concepts, which we name *semantic tags*, are explored in the context of social networks.

An analysis of the role of the current representations that are shared, exchanged, and integrated amongst actors within the social network is conducted in this study. To introduce the notions of semantics and the content of construction concepts, examples of construction concepts and their reification through forms of representation are included. Finally our semantic tag proposition together with its significance and illustrated with examples is presented.

2 INFORMATION, ORGANIZATIONS, AND VIRTUAL ORGANIZATIONS

2.1 *Convergence of organization and information*

In the literature, the idea of converging information and organization was initially formulated by J. Galbraith (1974) . The manipulation or process of information was related to the structure of social organizations in an information management process. Under Galbraith assumptions, organizational characteristics determine the information processing needs and the information requirements through the creation of slack resources, through the designation of self-contained work-groups, and through the initiation of task forces to facilitate lateral communications. Galbraith's work explains that individual actors process information at certain levels of performance and make decisions under uncertainty. He identifies an exception-handling problem when the goal of the actions cannot be planned to execute an activity, which limit the ability to process actors' information.

In the construction domain, Raymond Levitt, John Kunz, and their research team have applied the Galbraith idea of information processing limitation and exception handling within organizations to model unplanned coordination and communication activities between project actors from organizations (Jin and Levitt 1996; Kunz, Christiansen et al. 1998; Levitt 2004). Exceptions in processing the information arise and will create additional load for actors in project organizations (Levitt and Nissen 2003), when they require additional information, skill, or expertise to process the information. Their research was based on computer models to simulate micro-behaviors of virtual teams. The analysis of the resulting models has been further extended to develop theories. The Virtual Design Team (VDT) (Jin and Levitt 1996) is the model from which experiments have been developed. The Virtual Team Alliance (VTA) (Thomsen, Raymond et al. 2004) is an example or an extension of the VDT. The relationship of the organization-information has been explored in VTA approach under information processing theories within organizations and extended to economy agency frameworks. However, further study has not been explored towards social network frameworks.

Virtual Organizations (VO) is a common concept that refers to electronic collaboration to share and communicate information among agents, and it has been defined from multiple angles. In the construction industry, the VO concept has been explored in the context of interoperability. Examples are the approach of Katranuschkov, et al. (2007) that develops a Semantic Framework that mediates between grid technologies and the business layer of VO. Other research focuses on the creation of environments for data creation and rework to support business process through an integrated virtual organization system (Han, Chin et al. 2007). The application of the social network concept in the construction domain can be understood as the study of VO in the context of the electronic exchange, share, and integration of information (Mutis and Issa 2009).

2.2 *Construction project organization and social network*

Construction project actors constitute social networks at different scales in time and in space that require a dynamic information workflow for exchanging, sharing, or integrating information. The actors' achievement of these inter-operations is critical in making the communication of information possible to coordinate processes and exchange resource constraints. The complexity of social network hinders the successful deliverance of the construction products and processes information. The exploration of this network complexity promises a better understanding of actors' interactions to communicate information.

The study of the actors' relationships defined within a social network takes into consideration two elements that are essential to communicate and process actors' information: (1) the form of representation of information, and (2) the factors that define the actors' relationship within the network. The assumption is that actors' relationships in communicating information can be expressed by patterns of relationships defined in a social network structure.

Within a social network structure, it is proposed that social roles and formal definitions are expressed as relational processes. Their explicit formalization provides a vocabulary to analyze the linkages of the unit of analysis, which are the construction project actors. Social network analysis underlies the central principles regarding the network perspective of construction projects.

3 POINTS OF DEPARTURE

3.1 *Information processing activities*

The actors' understandings of the construction relationships that compose the social network generate an environment where additional factors can be considered to support decisions over any information handling or processing activities. The actors' identification of errors and lack of information for the representation, for example, are problems within the network handling activities. Within these activities, actors need to re-interpret the information they receive from other actors, find inconsistencies and errors, and perform corrective actions. The reinterpretation, rework, or execution of additional actions significantly influences the actors' productivity. This situation is found in interpreting representations of construction concepts such as designs, which are generated with the purpose of communicating the concepts within the social network.

Actors continuously generate representations to communicate construction concepts within the social network, which are further interpreted and perceived by other actors in the network. It is anticipated that actors can arrive at better decisions regarding any type of information handling activities with the knowledge of social network composition. A reduction in the cost associated to access additional information in order to reach decisions is expected.

Sharing, exchanging, and integrating activities are information process or information handling activities that are defined under the interoperability concept among actors. The characterization of the actors' relationship within the network makes interoperability a difficult process, which can be defined as the exchanging, sharing, and integrating of information (Mutis 2007; Mutis and Issa 2007). It is anticipated then that this research directly benefits information handling activities such as ones of sharing, integrating, and exchanging information.

3.2 *Semantics in the social network*

The complexity of social human network hinders the communication to deliver the information regarding construction products and processes. Semantic tags support the exchanging, sharing, and integrating of information and leverage the communication of information within a dynamic social network. A semantic main form to represent construction concepts assists actors' communication by employing a concept description that holds metadata. This semantic approach represents construction concepts, which are, for example, represented and shared through construction documents. Semantic tags are ontological descriptions defined by the actor's relationships within the social network. Semantic tags, therefore, have the ability to represent the required information for particular interpreters by holding categories of concepts employed in the construction domain.

3.3 *Interpreting representations within the network*

Actors' relationships within the social network play an important role in successfully interpreting and communicating representations that are intentionally generated by the source. Social actors share a representation and interpret the semantics of the observed representation. Individual actors or a cluster of actors share, exchange, or integrate information and further perform actions after interpreting such information. The representation is generated by the source, and further shared to other clients within the network. For clarity, Figure 1 shows a scheme of the interpretation of a representation within a network. Although the logic in the Figure is trivial, the purpose is to contrast to models of integration of information that provide services to clients to support business processes and problem solving. The "R" in Figure 1 refers to the representation that is shared and interpreted within the network. The representations are shared and exchanged along the path of the connection within the network. The representation

contains information regarding the connections and the relationships of the path.

The successful interpretation of the information and the resulting action of its interpretation is named *interoperability act* (Mutis and Issa 2008). The social network approach explores the relationship between the actor and the representation. When actors are considered human agents and the representations are shared electronically, then the social network approach intersects with Human Computer Interaction (HCI) research. The *interoperability act* is the first step in the articulation of HCI and in processing information within a given organization in the construction domain.

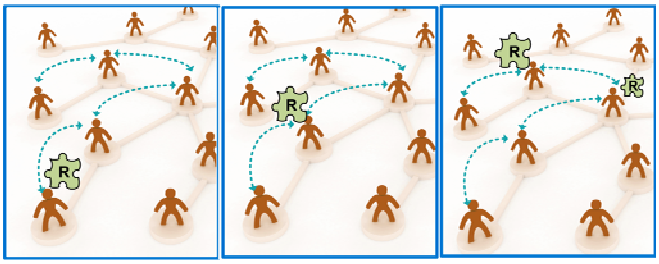


Figure 1. Three instances of sharing and interpreting a representation within a social network

Unsuccessful interpretations of representations of construction products or processes drive the interpreter to search for additional information sources or to seek out other references to support the actor's interpretation. Individual actors look for bonds within the network to facilitate the search process. This search process is performed between single actors or performed between clusters of actors. The bond's nature does not refer to the method to connect actors within the network, but to the purpose and intention of the relationship. The study of the nature of these bonds has not been considered to overcome deficiencies in communicating semantics by current efforts that support interoperability in the construction industry (Howie, Law et al. 2000; C. Lima, Ferreira-da-Silva et al. 2005; Grilo, Jardim-Goncalves et al. 2006; Barresi, Rezgui et al. 2008).

3.4 *Contrasting models of consensus and social network*

The generation of common models, standards, and vocabulary, for example, is based on the reaching of a consensus among experts and members of the community. Its final purpose is to achieve automation within interoperability activities. The resulting consensus sets up rules within a model where the actors are able to generate their information and to plan their interoperability activities (Eastman, Teicholz et al. 2008). The Industry Foundation Classes (IFC) (IAI 2009) is an extensible reference model that provides broad definitions of objects from which more specific models can be developed to support exchanges within workflow activities. Actors, for example, generate their information based on a set of rich classes. The objective is that multiple construction participants ultimately recognize the shared models and set a universal language. The implementation and the use of models and common vocabulary provide the possibility of reusing information by the project actors. However, the *modeler's view* is limited to his or her *social* and *physical contexts*. Therefore, the consensus on setting a common model or vocabulary limits the final user's view or actor's view of the social network. The generation of information under the actor's view is limited by the modeler's view through the social network.

The set of entities that represent the model has to be further adjusted and extended by the final user to reflect the detail they require from the construction firm for a particular project. The modeler or expert sets up a universal language and common models by consensus. However the social and physical contexts of the individual actors are not embraced through consensus. The consensus strategy opposes the *uniqueness* of construction projects, as a feature of their nature. This fact is manifested as a fragmentation of the construction industry's workflow (Taylor and Levitt 2004) and the agents' systems (Anumba, Ugwu et al. 2005; Bakis, Aouad et al. 2007). For example, as multiple actors and project teams participate within multiple workflows, these reference models have to contain thousands of definitions of workflows in order to define the exchanges of information within particular contexts.

Actors are able to use models and common vocabulary as a reference, but they need to represent their view of the concept to be shared, exchanged, and integrated to other actors even if the information is generated from common models and standards. These efforts do not address interoperability from a social network perspective. In consequence, the study of the nature of the actor's bond is not explored.

3.5 *An alternative from the collaborative approach*

This investigation challenges other approaches that are based on actors' collaborations that share the same space and time to interpret representations. These approaches require actors to share at the same time and at the same geographical space the exchanging and sharing of individual interpretations of observed representations. These are exchanges of individual experiences regarding the representations, and they are similar to those exchanges of cognition communication of passive representations, which are those that are incapable of being subject of any change without human activity (Norman 1993).

During collaborative sessions that share the same time and space, actors arrange and process interpre-

tations about representations. These representations serve the cognitive process of communication in a mediation fashion, as they are the mean for interpretation of the intended concepts. Actors share the same workspace, observe, and perform interpretations, so that any actor can analyze and consider others' interpretations at the same time. An observations and analysis in this scenario is the lack information regarding the relationships of the path, which is determined by the connections of the social network. These representations do not contain additional semantics to facilitate interpretations by the different actors along the path. They do not explicitly represent the contents of the information exchanged and shared along the path within the social network. Information regarding the relationships between the source and the client is not explicitly represented.

The rationale of the collaborative approach is to share knowledge, contrast other actors' interpretations, and learn and build consensus over a common goal of interpreting representations with the purpose of initiating individual or collective actions. The collaborative approach contrasts with the proposed social network approach as the nature of the actors' relationships and the actor-representation relationships are explicitly defined in the social network approach. The collaborative sessions are based on the observation and interpretation of a passive representation that does not contain the explicit descriptions that are defined in the social network.

An scenario of the collaborative approach, for example, are the ones required to interpret Building Information Modeling (BIM) with the purpose of overcoming inefficiencies produced by disruptions in construction activities when multiple actors interoperate. They require extraordinary collaborative effort to *interpret* the described geometry of the model. Highly intensive sessions for interpretation of the models, within a shared space such as a trailer or a technology room, are required for multiple actors who participate within the construction project. These sessions, then, require human participation to interpret the representation of the parametric models.

Therefore, the analysis and interpretation of parametric models in a collaborative fashion are neither efficient nor practical within interoperability. They require extraordinary collaborative effort in order to interpret the model by different actors who participate in the project. They involve interpreting the shared visualization and the learning and building of consensus over a common goal with the purpose of initiating individual or collective actions. These consensuses are superficial agreements on particular meanings of the representation. These agreements do not follow a formal methodology to define and represent semantics. These non-formal agreements hide the representation complexities in defining construction concepts. The collaborative sessions demand mapping elements of the visualization or representation to perform analytical operations within other applications. A simulation of a construction process is an example of the analytical action.

In contrast, the proposed social network approach for sharing, exchanging, and integrating information immerses to some extent the efforts of the actors who participate in the collaborative sessions. In the social network approach, the representations explicitly engage the role of the actors or interpreters and the nature of the relationship among them. The social network approach will overcome the resulting inefficiencies and costly sessions of collaboration involved in the collaborative approach, as these sessions require significant human resource time and other resources to conduct, for example, face-to-face collaborative meetings. Even if these collaborative sessions are not organized at the same time and place, coordination efforts are required to conduct them. Coordination efforts use time resources and require expertise regarding the information processing activity, knowledge of the organization for resolution problems, among others. Also, one of the assumptions of the collaborative session is that the actors can access the resources and availability to conduct the sessions. This assumption is questionable when multiple actors from multiple organizations participate in significant extensive projects. Figure 2 illustrates a contrast of the collaborative approach and the social network approach in exchanging and sharing information. Multiple actors participate in sessions where they perform interpretations of a representation or visualization of a construction product.

As shown in Figure 2(b), these actors share the same physical space at the same time in order to interpret, compare, learn, and create a consensus regarding the representation in order to initiate particular actions. Figure 2(a) illustrates a social network where actors are connected to share and exchange information

(a) Social network (b) Collaborative meeting

Figure 2. Approaches for sharing and exchanging information modalities.

4 SEMANTIC TAGS DESCRIPTION

4.1 *Theoretical foundations*

The rationale of semantic tags is based on the semiotic framework developed by the logician and philosopher Charles Pierce, compiled in multiple documents (Eco 1976; Eco 1984; Hoopes 1991; Chandler 2002; Danesi 2004). The fundamentals of this theory have recently been articulated to the construction domain (Mutis and Issa 2008). Semantic tags recognize the role of signs as the main representation to hold semantics, based on three fundamental elements (Sowa 2006): the (1) entity that the sign represents; (2) the relationships to another entity; and (3) the actor or interpreter. Semantic tags embrace these elements to represent concepts within the social network of a construction project. The semantic tags proposition has the ability to (1) represent a construction concept, (2) describe the relationships from the actor's source and actor's destination, and (3) give an account of the representation with the purpose of interpreting the construction concept. An elemental assumption of this proposed effort is that any form of representation generated by the source can be annotated in order to enrich it semantically. The interpretations of the representation, therefore, are streamlined through the semantic annotations.

Semantic tags embrace the assumption of being semantically annotated. Social network theory is a proposition that will articulate the annotations' ability to (1) represent a construction concept, (2) describe the relationships from the actor's source and actor's destination, and (3) give an account of the representation with the purpose of interpreting the construction concepts. Social network theory is the basis that underlies the central principles regarding the social networks approach of construction projects. This research is not concerned with the artificial construct of social networks' structures. The focus is on the analysis of the natural formation of the networks within construction projects. The starting points are: (1) the *actors' social roles* and their formal definitions, and (2) the *linkages* associated with one another actor.

The description of *actors' social roles* is expressed as patterns of relations, which are obtained between actors. This concept differs from the one of *actors' social position.* The *actors' social position* refers to a collection of actors who are similarly embedded in social activities, ties, or interactions with respect to other actors in their positions (Wasserman and Faust 1994). For example, the role of an actor, a contractor, can be defined as a combination of several relations, such as contractor-electrical subcontractor, contractor MEP subcontractor in simple linguistic labels.

4.2 *Signs and annotations*

Tags are annotations *per se*. However, semantic tags are different from other methods used to annotate data and to define semantics. Semantic tags cannot be defined as one or two fractions of the aforementioned abilities, as they act as a trichotomy. Semantic tags are not for markups such as those defined by the Extensible Mark Up Language (XML). Semantic tags are defined by a set of ontological categories that define metadata. They are not data-models that can be defined by a Resource Description Frameworks (RDF) (Brickley and Guha 2004), as their categories are defined by an ontological approach. For a better understanding of the trichotomy of this semantic tags proposition, the definitions of each one of these abilities are discussed below.

4.3 *Concept representation*

The characterization of construction concepts with symbols and other more elaborate forms of representations, such as conceptual models, is performed to share construction concepts through representations within the social network. A 3D representation of the connection of a truss is the characterization of a truss concept, which takes form through the 3D model representation. Concepts can be characterized by employing symbolic approaches based on formal forms. Symbolic formal forms reify concepts through the use of languages. Figure 3 illustrates a 3D representation of a metal-truss connection shown by modeling software. Figure 3 shows a visual representation of the truss concept, the context with other objects, as well as truss-connection details expressed by syntactic representations through the use of natural language. These two forms of representation are used to characterize the metal-truss concepts. As shown in Figure 3, the two forms are necessary to interpret the truss connection concept.

Formal logic adopts symbols, constraints, and rules of containment to characterize concepts. However, it does not fully express the characterization of a concept. The expressed set of sufficient conditions in formal languages, a formal form of representation, does not guarantee other actors' understanding of a concept. The represented concept in a 3D model annotated with descriptions in natural language in Figure 3 represents the modeler's semantics. However in interpreting the intended representation's semantics, other actors can gather other interpretations from such representations; as such, explicit and direct correspondences from one actor's concept to another actor's concept, and then in turn, from concepts to the world, cannot possibly be established with certainty. Semantic tags define a representation of concepts through symbols and annotations. They are complemented with other elements in response to their limitations to expressing semantics.

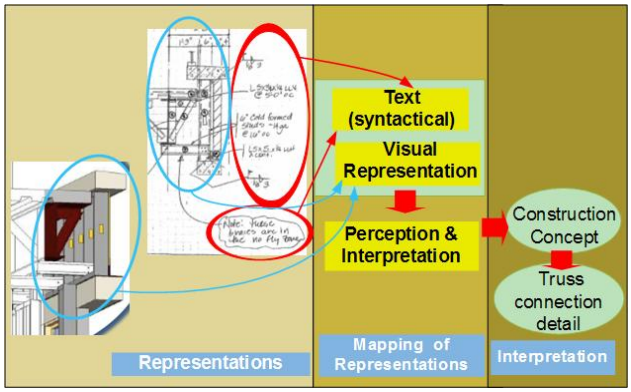


Figure 3. Construction concept interpretation through two forms of representation

4.4 *Categorizations as a schema that structures annotations*

The annotations that hold semantics are organized in a schema, structured by ontological categories. Any annotation, then, is ontologically defined. The annotations of the representations are instances of the ontology that define the nature of the social network where such representation is shared, exchanged, and interpreted by the social network actors. The assumption is that when the representation is shared with other actors in the network, a set of instances of the schema has to be generated. These instances correspond to the semantic annotations or semantic tags. As was mentioned, the annotations have the ability to describe the relationships from the actor's source and actor's destination and give an account of the representation with the purpose of interpreting the construction concepts.

Figure 4 shows the core elements of semantic tags proposition. In the figure, for example, the categorization describes the relation of the actor to the social network, the actors' roles, and a narrative of the purpose of sharing a representation.

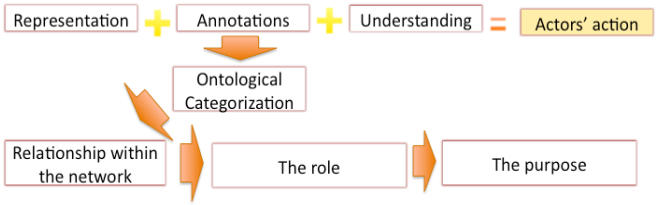
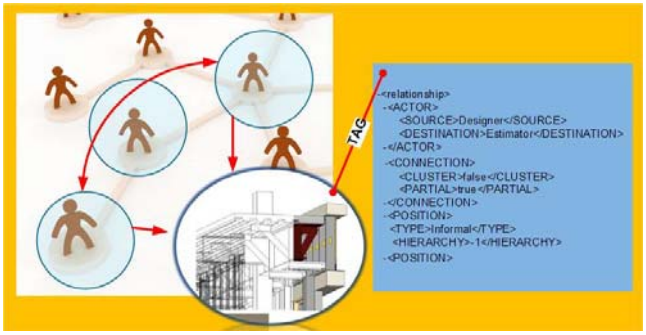


Figure 4. Elements to perform interpretations using annotations

4.5 *Actors' relationships*

The descriptions of the actors' relationships are semantic annotations of the nature of the relationships along the path from the representation source to its destination along the social network. A schema based on selected postulates of the social network theory defines the semantic annotations. The complexity of the connections among actors (Freeman 2000), the strength of the connections (Granovetter 1982), the "interpersonal environment" often used, and the multiplicity that presents the possibility of having a different role in a given relationship and different flows between two actors (Lazega and Pattison 1999; Bottazzi and Ferrario 2005) are the selected tenets of the social network theory used to define the schema.

The basic functionality of the schema is described by categories that define the relationships among the actors within the network. The schema provides the semantics to tag with the data representations that are shared between the actors about their defined relationship. For example, a designer provides a 3D visualization of a truss connection, as shown in Figure 5. This visualization is a representation that is going to be shared with other actors within the network. The source is the designer and the destination, an estimator. As the representation is generated, planned, and shared with the estimator, the semantics are annotated on the 3D visualization of the truss representation. The semantic annotations define the source and the representation's destination and aspects of the relationship, such as the hierarchy levels. A schema that characterizes the relationship between the source and destination defines the structure of the annotations. The schema is the metadata



that is tagged to the representation.

Figure 5. Semantic tag of a visual representation.

The actors' relationships are also associated with the actors' roles and the articulation function they perform within the network. This research studies frameworks that categorize actors' roles in articulation within the network. An example is the Gould and Fernandez (1989) typology that suggests an idealization of grouping actors according to a given role. In this typology, *Liaisons* connect actors from different groups while they belong to their own group, *Representatives* belong to the same group while they articulate other actors from different groups, and *Coordinators* are unsettled articulators who act like brokers but who belong to the same group (Degenne and Forsé 1999). An illustration of

these categorizations to define actors' roles is shown in Figure 6.

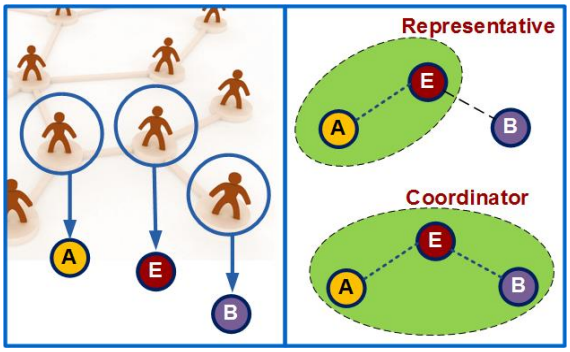


Figure 6. Actors' articulation roles

In the figure, two roles of actor E to communicate with actors A and B are shown in the network. In the first role, E, the representative, will play a representative role for A for any interaction with B. In the second role, E coordinates the interactions between A and B, but E's role is conducted within the same organization of A and B.

4.6 *Description of the purposes*

Semantic tags give an account of the representation with the purpose of interpreting the construction concept. This account is based on the identification of the actor-representation relationship and, in turn, representation-physical world relationship. These relationships between (1) actor-representation and (2) representation-physical world play a significant role in the actors' interpretation of the representations. Actors in the physical world take materials and objects and perform some action according to their interpretations. Therefore, the actors perform actions that are prescribed within the representations.

It is important to note the distinction between two actions: interpretation and information processing, or handling, or its computation. Actors' interpretations are semantic operations and the manipulations of the actors' representations are "computations" of the symbolic composition of the representations. This study focuses on the first part of this distinction: the relationship between the actor and the representation.

The purposes are defined through an ontology that holds expertly defined concepts of sharing a representation through a social network. The purposes of sharing a representation are the ones that the source wants to interpret by the destination within the social network. They are the ones that the source requires from the interpreter regarding the shared concept. These purposes are prescribed by the required actions from the interpreter. The description of the required actors' action corresponds to the social consensus amongst the source and destination for the shared concept. These required actions should describe actor-representation and representation-physical world relationships. Roughly, the aspects required to prescribe purposes with regards to the social network are: (1) actors, the source, and destination; (2) the actions as a consequence of the representation, (3) situations that describe the actor's interaction resulting from the representation.

Consider the following semantic annotation of a representation that is shared by two actors within a social network. Consider (1) two actors, a source (electrical engineering), and a destination (electrical subcontractor) that share the layout of a Porcelain-enameled reflector with 30°CW x 30°LW shielding representation; (2) the action – verify the intensity distribution in lumens of 30°CW x 30°LW shielding fixture; and (3) the situation – general maximum and minimum illumination is specified, but not minimum local illuminations, as light reflected from walls, size of the room, and ceilings changes. Therefore, from the ontology, the three required aspects prescribe the purposes of sharing the 30°CW x 30°LW shielding representation, described by a syntactical form, within the social network.

5 CONCLUSIONS AND FUTURE WORK

Currently the construction industry employs approaches to interoperate by transforming concepts into models, schemas, or conceptual models. These approaches address methods of mapping, harmonizing, integrating, and aligning formal representations between the interpreter and other information sources. However, these efforts do not address (1) the fundamental problem of understanding the information that is generated by different sources nor (2) information processing from a social network perspective.

This research explores the detriment of the actor's communication within the social network, which stems from the lack of characterization of the actor's relationships of the social network itself, and of the actors that influence the definition of the network for construction projects.

This investigation directs attention toward the process of interpreting a concept from a representation and of interpreting a concept according to the interpreter's role. An alternative to the collaborative approach to overcome the inefficiencies derived from the understanding of the representation of construction concepts is proposed. This research assumption is that the correct model to represent the concepts is not that one created by one designer that must be understood by all actors through the network in construction project. Rather, the correct representation is the one that holds the semantics required by other actors in a social network. The information in the network is defined by the required sequence and actors' interactions in sharing and ex-

changing information in a project. Social networks is the proposed framework for understanding the actors' relationships within a construction project, as the actors share and exchange the representations within the construction project network. This research proposes to semantically tag the representations that are shared and exchanged by actors within the social network. It is anticipated that exceptions of actors' routine activities in understanding representations will be reduced, as this research proposition is the definition of the actors' relationships through categories that are specified by the semantic tags.

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