

# Distributed and Constructed Knowledge in Design Education

Michael Cumming

*Delft University of Technology, Faculty of Architecture*

*Abstract. One aspect of design education to impart design information and theory, which from the students' viewpoint may appear to be a static body of knowledge. This knowledge is imparted to them by parties with expertise in particular topics. This type of information could be called 'received knowledge': teachers teach it and students receive it. There is also a 'constructive' aspect to design education, in which students are expected to build their own personal knowledge bases, and to present a progression of design proposals that build from this personal knowledge. This kind of knowledge is much more difficult to share with others because it relies on require personal interpretation. If teachers and their students are considered to form a 'knowledge hierarchy', in which those at the top know more about a particular topic than those further down the hierarchy, then centralized information and knowledge systems appear appropriate. However, in design education, students can sometimes know more specialized knowledge about certain design situations than their teachers, and can also learn and construct things of value from their fellow students. In such situations, decentralized or peer-to-peer technologies become more attractive. This paper discussed some philosophical and technical aspects to the centralizing and sharing of design knowledge, with respect to emerging peer-to-peer (P2P) communication technologies.*

*Keywords. Knowledge hierarchies; knowledge decentralization; constructivism.*

## Introduction

One of the most important topics in design research is the question of how design knowledge should be created, and shared. The underlying assumption is that if designers, and design students could have access to greater quantities of design information and knowledge, they would be able to be better designers (Dym & Levitt, 1991).

In the context of education, there is usually the presumption that students fill a role placed on the receiving end of design knowledge, which is distributed to them in various degrees of success, by their teachers. In many subjects, students' knowledge can be expected to be less developed and more naive compared to their teachers' knowledge. For instance, in building physics, or

construction technologies, professionals with experiences in these subjects can be expected not only to know more facts and information, but also more importantly have a wide integrated conceptual overview of the field in which relative relevance of topics and approaches can be made clear. As Simon proposed, expertise and mastery in most professional fields can only be expected after ten years of practice (Simon, 1984).

However, in some subjects such as design, it is not always obvious that the teacher necessarily knows more about all aspects of a topic than do her students. This seems particularly true of design teaching, where students' and teachers' interpretations of design contexts are important. Architectural design requires integrating elements from place and time-specific design programs,

creation and studying of plausible design alternatives, and visiting sites that change over time. These contextually influenced factors consist of particular sets of circumstances that may co-mingle only for a limited period.

In design education, when students are given such activities to perform, they require a lot of work on the part of the students that their teachers may not have the time to do themselves. Therefore, students may acquire within the process of their design education, a level of expertise in a confined subject that is actually more informed and considered, than that of their teachers.

The author has noticed this phenomenon while assisting with a masters level course in the faculty of Architecture at TU Delft entitled Intelligent Support for Urban Design. Here, students proposed design alternatives for a section of downtown Rotterdam called the Wijnhaven and in the process acquired a deeper understanding of this part of Rotterdam, than did their teachers (Tuncer, Ciftcioglu, Hoeven, & Cumming, 2003).

Students, also often work together in groups, and trade ideas and information between themselves. This process of sharing is good training for later design practice. Actual design practice, as opposed to much design training, is based much less on individual inspiration and private problem solving, and more on decision-making situated within groups. This collective cognitive activity involves making sense between informed parties, of specific situations (Baerentzen & Talukdar, 1997) (Schön, 1983).

Another factor that influences how much knowledge a student brings to her studies is the fact that students increasingly return to their studies as mature adults, and therefore may bring to their studies knowledge acquired in previous job or life experiences.



Figure 1: Design knowledge according to a 'trickle-down' knowledge hierarchy vs. a distributed knowledge-sharing approach.

Therefore, the assumption that all design knowledge 'trickles down' from teachers or institutions, to students, is not always appropriate. Knowledge should be allowed to move in all directions, since useful information and knowledge may be located anywhere within a design team social hierarchy. This paper proposes the use of peer-to-peer technologies to address knowledge sharing using a distributed, rather than hierarchical approach. This approach starts with the notion that the student's role should allow for the possibility of knowledge production, as well as knowledge consumption. Without an assumption of a rigid knowledge hierarchy, then a distributed approach to knowledge sharing, using technological media such as P2P systems, become more attractive.

## Background

### Design constructivism

Constructivism refers to an educational approach that proposes that learners each must form personalized knowledge structures that suit their particular conceptual approach to the world (REF). Therefore, instead of seeing knowledge as a tangible substance that can be transported easily between agents, constructivism treats knowledge transfer as a mechanism that inherently requires personalization of knowledge, in order to make it relevant and meaningful for agents performing specific tasks (Spivey, 1997).

If all knowledge requires customization by each agent before it becomes useful, then seeing knowledge as a product that can be shared with-

out consideration of what a designer knows already, or how he sees the world in general, becomes problematic.

Design constructivism views knowledge as a process, rather than a thing that can be conveniently stored in centralized databases. The writings of Bucciarelli (Bucciarelli, 1994) (Bucciarelli, 2003) and Schön (Schön, 1983) are perhaps the best known in the design research community, that promote the design constructivist approach.

Viewing design as a process of knowledge construction and reorganization, rather than one involving access to generalized, 'one size fits all' knowledge bases, can greatly influence the design of design information systems. With constructivism the idea is that each thinking agent must create, at sometimes great effort, their own personal 'databases' within their own heads. Without such personal knowledge, having meaningful interactions with the world would be impossible. This is not the same as saying that all centralized databases, for example, those that are found on the Internet, are useless. Obviously, when shared within communities that understand the meaning of the data schemas that organize such databases, they can be of great value (Bowker & Star, 1999) (Bijker, Hughes, & Pinch., 1987).

#### **Peer-to-peer systems**

Peer-to-peer (P2P) involves having computers on a network --peers-- acting as both suppliers, as well as consumers of information. The idea behind P2P technology is to enable the sharing of information between distributed peers, without first setting up a centralized system to do this. One promising approach to the P2P is the JXTA initiative by Sun Microsystems (Sun Microsystems, 2002). This standardized, open-source initiative provides a protocol, with language bindings for several languages, that allows for the easy design and implementation of secure

P2P applications.

JXTA (a term meaning 'juxtapose') is a standardized, open-source initiative that provides a protocol, with language bindings for several languages, that allows for the design and implementation of secure P2P applications. JXTA is based on open-source, standards-based protocol specification, and can be implemented in Java and in other languages. JXTA also provides a generic infrastructure to deploy P2P services and applications (Gong, 2001). JXTA is built out of five abstractions: uniform peer ID addressing, peer-groups, advertisements, resolvers, and pipes (Oaks, Traversat, & Gong, 2002).

#### **Peers and peergroups**

Peers are the basic unit of JXTA. Peers can be both the consumers as well as producers of information found on a JXTA network. As defined in the JXTA specification, a peer is a device that implements one or more of the JXTA protocols. One approach in conceptualizing what role a peer could perform is to consider them as 'roles' of a single person. For example, in collaborative design teams individuals could have multiple roles, such as designer, employee, citizen, colleague, friend, etc., in a design process. Terms such as 'stake', 'interest', or 'alias' could be considered synonyms to the term 'role'.

In the JXTA system, peers must be members of the same peergroup in order to share information. By default, all peers become members of a 'world' peergroup when they first join the P2P network. One of the primary purposes of peer-groups is to partition the set of possible users into definable groups that provide a limiting scope for search and discovery of resources. This increases the efficiency of the distributed interactions considerably. Any peer can set up any peergroup it wishes, and any peer can be a member of multiple peergroups.

## Conclusion

Design management and organizational theory recognize that organizational hierarchies, and the roles that people fulfil within them, are important in structuring collaborative activity. However, such hierarchies if they are too rigidly adhered to, may inhibit the effective flow of information in collaborative design. Centralized information systems and knowledge bases often assume that it possible, in theory, to store, and to distribute knowledge in a useful way to designers. Although such an approach can be quite useful, especially within the confines of knowledge communities that share specialized understandings of data suited to their purposes. This approach however lacks generality, since it tends to ignore the fact that designers and design students must also be involved in processes of knowledge customization and construction that depend on personalized and context-dependent factors. For this type of knowledge sharing, P2P systems that do not assume a priori knowledge hierarchies that reflect existing social hierarchies, are also useful.

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