Crossing the research fields

In this two-part article, Steven MacGregor, Design, Manufacture & Engineering Management, University of Strathclyde, provides a joint perspectives approach to literature reviews.
Here, in Part 1, he looks at how computer supported co-operative work can be useful for a study of distributed design.

Literature reviews are crucial to any research as they identify current gaps which may aid in the development of a valid contribution. We can also review related fields and use existing models and frameworks on which to base new design models and frameworks.

This article includes a joint perspective view of engineering design literature, examining research fields believed to be useful for a study of distributed design. These fields, Computer Supported Co-operative Work (CSCW) and Knowledge Management (to be discussed in Part 2 in the next issue of *Engineering Designer*) were investigated partly through a five-month research tour of North America.

This is a short review of CSCW and Knowledge Management within the context of engineering design, and is part of the overall research approach (Figure 1).

Work proceeded within these fields for a variety of reasons. Firstly, they lend themselves easily to a study of distributed design. CSCW investigates communication within a computing context with a particular focus on distributed work, while Knowledge Management aims to share knowledge more readily within an organisation by improved capture and re-use – a potential avenue of support for distributed design.

These fields may also include past and present research which may be of use to supporting distributed engineering design. Design, in being a highly diverse activity, overlaps with many other fields of study. To focus only within engineering design literature would mean missing an opportunity to benefit from research in other fields which tackle similar problems.

Indeed, the fields of CSCW and Knowledge Management are closely related with many overlapping concepts (Figure 2, over the page).

Within CSCW, any co-operative work will involve the exchange of information and consequently, transfer of knowledge. This knowledge and information has to be managed effectively and efficiently and the use of computers can aid in this quest. One major parallel regards the broad nature of each of the fields and the different exponents of research within them.

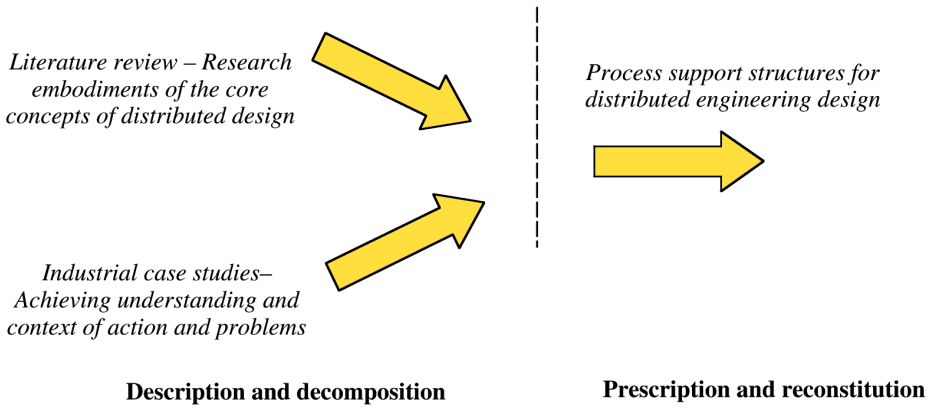

Figure 1: Overall research approach.

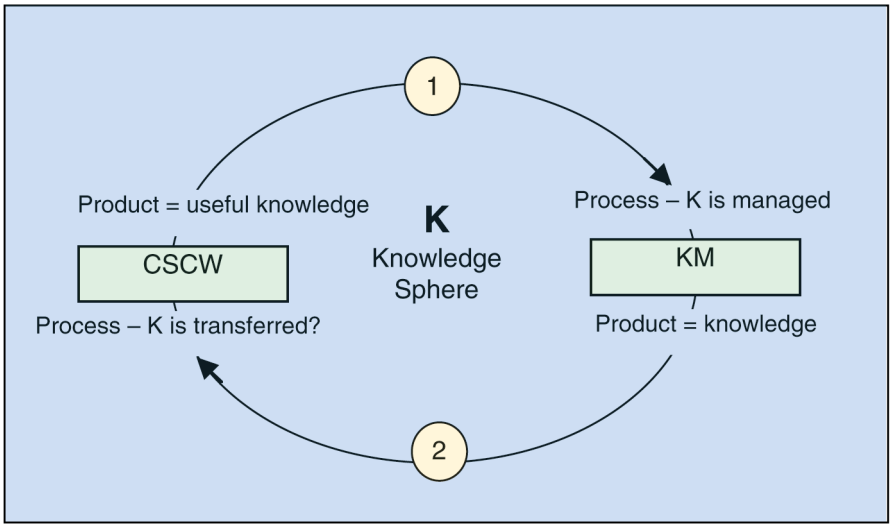

Figure 2: CSCW and Knowledge Management relationship.

It is clear that, for instance, in the design of a collaborative design studio, computer scientists may construct and implement a system, yet for any measure of success, they need to understand the nature of engineering design work.

CSCW – Definitions and nature

Put simply, CSCW is the study of how people work together using computing technology. It involves the study of people and computers, both in isolation and together. Although research proceeds along the lines of computer users in the same physical space (for example, the office), the focus of research in recent years has been on physically separated workers (for example, those on separate floors or in different buildings). In an examination of the definition and nature of CSCW, two other terms are worthy of mention.

First of all, Human Computer Interaction (HCI)[1] is the design, implementation and evaluation of interactive systems in the context of the user's task and work. The interface between human and computer and the concepts of usability and accessibility are central to the study of HCI. A more established field, formerly known as man-machine studies, HCI has a similar development process to that of design in the production of systems, and is complimentary to the field of CSCW which places more focus on understanding human needs and co-operative work.

Finally, 'groupware' is the term given to systems or software designed to facilitate the collaboration of groups.

CSCW has emerged as a research field only in the past 20 years and has helped advance computing technology as well as being facilitated by it. In particular, the growth of the internet has resulted in rapid progress. As CSCW involves the investigation of both people and computers, many different disciplines and study segments are included within its boundaries.

Behavioural and technological issues are tackled from a wide variety of disciplines, including computer science, engineering, management and psychology, with many exponents studying various research issues. Some of these research issues include computer architectures to support group activity, the development of new technologies such as wearable computers, (computing technology that can be worn, for example, internet browsers that can be viewed in a pair of glasses) and social and organisational models that describe the effects of technology. In summary, the main development areas of CSCW are as shown in Figure 3.

Studies within the engineering design field include Tang[2], who analysed the shared drawing activity of small groups. The main findings, which raise design implications for collaborative technology, include the role of hand gestures in communicating significant information, the amount of information conveyed in the process of creating and using drawings over and above the drawing itself, and the importance of the drawing space in mediating group collaboration.

Cockburn and Jones[3] investigate some of the challenges of implementation within the context of groupware. For any new groupware system to be adopted within an organisation, the users must first of all see the benefits of that system. However, in most systems, benefits do not become apparent until it has a certain amount of users – a critical mass of users. There is therefore a time lag in the uptake and visible benefits of a system.

Furthermore, there is often an imbalance in the benefit-effort axis where those who put in extra effort accrue benefits for others and not themselves. For example, an engineer who documents his experiences of a project may indeed learn on reflection, although the greatest benefit is for other engineers who may tackle similar projects in the future and want to learn from past cases. Motivation and the construction of communities with a common purpose is therefore crucial and implementation is not always straightforward. Indeed, very few

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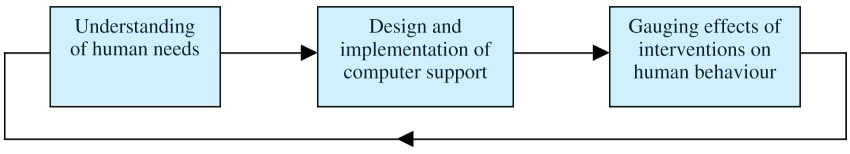

Figure 3: CSCW development process.

systems designed within the CSCW domain succeed and are used.

Ackerman[4] attributes this failure to the 'social-technical gap – the divide between what we know we must support socially and what we can support technically'. Human activity is reported as being highly flexible, nuanced and contextualised with current technology unable to replicate these traits closely enough.

Use for engineering, design and distribution

Two themes within the CSCW community which may provide useful knowledge for an investigation of distributed design, include casual interaction and awareness. These include aspects of investigating the conventional domain, where designers may be in the same physical space, then examining challenges and potential support for distributed work in light of this knowledge. Casual interaction investigates how people communicate through incidental or informal interactions when in the same physical space. For example, a chance meeting in the corridor, or at lunch, may lead to useful communication.

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These informal interactions are affected by physical separation and partly explain why groups collaborate better, or at least more often, when in the same physical space. Kraut[5] found that when collaborators are separated on different floors, they have the same likelihood of collaborating as if they were in different buildings. The question then regards how to substitute for such effects in distributed work or at least gauge the effects of their absence.

We must first examine the exact nature of physical collocation that supports greater collaboration. Kraut found that when people share the same physical workspace, they maintain a keen sense of presence, activities and availability. The aggregate of these pieces of information has been labelled informal awareness. Work within the CSCW community has attempted to augment this informal awareness in distributed scenarios through the addition of a visual channel or physical artefacts connected to the computer.

There are other types of awareness – an up to the moment understanding of a situation or fact. Appropriate types to design include change awareness, an understanding of what changes may occur in a design project or model and the propagation of those changes, and workspace awareness, an understanding of what people are doing when co-operating in a shared virtual workspace.

Finally, a note on the philosophy of CSCW is worthwhile. Much of the research concentrates on facilitating the natural way of working as opposed to actively changing it. With respect to application, much of the research regards small, sporadic teams. Few studies are evident on large collaborations and latter design phases. Presumably, large collaborations prove difficult to study while latter design phases may include more predictable and collocated work.

◆ This article continues in the next issue of *Engineering Designer* with an overview of Knowledge Management.

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About the author

Steven MacGregor has just completed his PhD in the CAD Centre, Design, Manufacture and Engineering Management at the University of Strathclyde studying distributed design.

You can email him at: steven@spmacg.com or view the project website at www.spmacg.com. His thesis on process support structures for distributed design and development will be published later in the year.

This is the second in a series of three short papers examining industrial case studies in distributed design and the wider approach adopted to tackle identified problems. A short review of distributed design within a manufacturing led adaptive and variant design environment was published in *Engineering Designer*, July/August 2001. A further review within a marketing led original design environment is coming soon.