Collaborative design: what is it?

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Abstract

Collaborative activities are an important application of computer technology now that telecommunications infrastructure has been established to support it. There are many students in schools of architecture who are undertaking collaborative projects using the Internet and many practices who work together exchanging files and interacting on shared digital models. Software vendors are developing tools to support such collaboration. But what are we doing? What is the nature of collaboration and what are the implications for tools that support this work? © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

It has become accepted practice to use the term “collaborative systems” to describe the computer systems which support distal communication between designers. In the field of design, we are beginning to see the term computer-supported collaborative design used increasingly often. Although the term normally used is computer-supported collaborative work, a similar word, “co-operation”, appears to be used interchangeably with “collaboration”, as seen in the journal name Computer-Supported Cooperative Work or the paper title Exploring communication in collaborative design: co-operative architectural modelling [19].

In discussions about computer systems for collaborative design, their behaviours, specifications and implementation, the most fundamental arguments appear to be encountered on the issues of interaction [16,23]. What is the interaction to be provided, both interaction with the systems and interactions between participants? Not only do the participants need to share data but, how are they going to communicate with one another? To illustrate the issues and confusions, look at the discussions about the role of video — how important is it, how does it contribute to the interaction between participants and how wide does bandwidth have to be to support it. These issues are raised when considering other aspects of collaborative systems — data exchange; participant interactions with digital models; audio links; among others.

Cuff [5] has observed that participants in collaborative design “did not necessarily participate equally or collaboratively.” From our own experience, we can observe that simply working together or talking about the same subjects does not make the act collaborative [25]. What specifically makes these acts of collaboration or not? Is there any importance in the name applied to this field of study (CSCW), which is sometimes rendered ‘computer-supported collaborative work’ and at others, ‘computer-supported co-operative work’?
2. What’s in a word?

What do we mean by ‘collaboration’? Let us consider a variety of situations to explore the realm of activities that fall within our understanding of collaboration. We team together in design settings to take advantage of what Steiner [24] calls process gain. Collaborative success can therefore be said to be achieved when we have accomplished something in a group which could not be accomplished by an individual. Shea and Guzzo [22] identify three facets of a task which determine the success of group effectiveness: task interdependence (how closely group members work together), outcome interdependence (whether, and how, group performance is rewarded), and potency (members’ belief that the group can be effective). To be successful, a collaborative project must establish a definition of the team, identify their outcomes, ensure there is a purpose of the collaboration and clarify the interdependencies of the members.

If this is to be possible, are there limits to collaboration, either in time, place or size? Can we collaborate if we have too many or too few participants? While Steiner’s work suggests strongly that the maximum number of participants in an effective working group is four, others have found successful collaboration extending to many more. Sudweeks and Rafaeli [26] took part in an extensive and prolonged exchange with over one hundred scientists and concluded that collaboration was possible with large numbers. As noted by Abarbanel et al. [1], the many thousands of Boeing engineers who worked on the 777 consider themselves collaborators. From these examples, it appears that there are no numerical limits to collaboration, nor physical, when taking place in computer-supported environments.

2.1. Collaboration and co-operation

Part of the problem with the term ‘collaborative act’ is that the activities that are undertaken in such acts may vary in intent and degrees of participation, yet be called the same thing. Is the crew of a ship [10] guiding it into port collaborating with the pilot who has come on board as it enters the harbour? Is their working together not one of co-operation? The pilot points out the hazards, the captain issues commands to the crew. Are they collaborating?

The roots of the words are, of course, frustratingly similar but they do carry distinctions worth pursuing. Indeed, the Oxford English Dictionary defines collaborate as “to co-operate, especially in literary, artistic or scientific work”, deriving from the Latin words *col labore*, to work along side one another. Collaboration can be thought of as joint problem solving. It means working with others with shared goals for which the team attempt to find solutions that are satisfying to all concerned.

Co-operation, as the Oxford English Dictionary tells us, is “to work together, act in conjunction (…) to co-operate for (…) mutual benefit” from the Latin *co operari*, to work with or along side. The dictionary also tells us that co-operation is an older concept (the first instance dates from 1616) while collaboration appears in the English language only in 1860, perhaps suggesting that co-operation is a simpler concept than collaboration.

The important distinction between the two words is in the creative aspect of working together. In this way, collaboration in design is a substantially different activity than the collaboration shown by ants. Design collaboration requires a higher sense of working together in order to achieve a holistic creative result. It is a far more demanding activity, more difficult to establish and sustain, than simply completing a project as a team. I suspect that we collaborate far less often than we pretend to.

From their survey of literature in collaboration, Mattessich and Monsey [15] have defined the words more thoroughly and have drawn a third distinction, that of coordination.

- **Cooperation** is characterized by informal relationships that exist without a commonly defined mission, structure or effort. Information is shared as needed and authority is retained by each organization so there is virtually no risk. Resources are separate as are rewards.

- **Coordination** is characterized by more formal relationships and understanding of compatible missions. Some planning and division of roles are required, and communication channels are established. Authority still rests with the individual organization, but there is some increased risk to all participants.
Resources are available to participants and rewards are mutually acknowledged.

- Collaboration connotes a more durable and pervasive relationship. Collaborations being . . . (a) full commitment to a common mission . . . Authority is determined by the collaborative structure. Risk is much greater . . .

As Mattessich and Monsey emphasize, collaboration requires a greater commitment to a common goal than co-operation with an attendant increase in risk. For this to occur, the level of trust must be higher.

3. Designing

The act of designing is, to many, an act that involves others. Many practitioners cannot imagine completing an architectural design and saying “That is mine, and mine alone.” For most, the process of designing includes other members of their profession and members of other professions. To some, this is an ideological position — for example, those who hold the belief that the only good design is participatory design. Work such as that by Christopher Alexander [2] has attempted to formalise this approach into a design methodology. On the other ideological side, the Howard Roark image persists [20]. The brazen hero, working in defiance of society or preconceived notions of design delivers to a client a design that should be accepted must be accepted if the client is to be saved from branded an ignominious ignoramus.

Discounting the extremes of these two positions as being positions that seldom occur and, if they do, are beyond the realm of normal collaborative process, let us ask “Is design collaborative or co-operative?” What criteria could we use to distinguish between the two? Typically, we think of design as a continuous close-coupled process (Fig. 1) in which the participants work closely to realise a design. Here, the participants work intensely with one another, observing and understanding each other’s moves, the reasoning behind them and the intentions. At any stage of the design, the observer cannot identify a discrete contribution to the design product from one participant or the other.

Experience tells us that much design is in fact loose-coupled (Fig. 2), with each participant contributing what they can in different domains of expertise at moments when they have the knowledge appropriate to the situation. The participants have been engaged to work together because each has a particular expertise that can be contributed to the solution process. In this situation, we see two or more experts operating in their own domains on a shared problem. The design moves in discrete steps, perhaps not a linearly as set out in the very simplified diagram below, but still in ways that we can see a step and identify what has happened during that step.

3.1. Some attributes of design activities

During the design process itself, what is happening? Loose-coupled or close-coupled, how are the participants working together. Design is often thought of as a process that occupies a continuous space of time. If you ask a design team what they were doing,
the participants typically will not think of a time when they are not designing. They will describe a complex series of decisions, threads which were picked up and dropped, tasks and events which occurred. Typically, they will describe intense and extended periods of time when they worked intensively together to solve the design problem. Challenged to identify discrete tasks, they may tell you about tasks that took hours, days, or weeks.

Gero and McNeill [7] have shown that design is in fact a process that consists of a series of distinct events that occupy discrete and measurable periods of time. Most significantly, they have shown that the temporal span of these design events is remarkably short. In one design analysis, they recorded the majority of events taking less than 30 s; another in which the participants were more expert in their field, most event lengths were less than 15 s (see Fig. 3). As the authors note: “These differences may reflect differences in expertise with the experts moving quickly through the design task or they may reflect differences ... between the designers.”

In their paper, Gero and McNeill have shown that design can be seen as a series of discrete activities and that the level of expertise affects the way work is done, being discernible in the temporal pattern of their work. As collaborators come together in design, we can assume that the nature of their activity does not change since collaboration still requires a designer to attend to design as an individual as well as collaborate. Collaboration is probably episodic and cyclical too. This means that design remains a series of discrete steps. Collaborators work together for moments, then divide up and go their separate ways [11]. The participants act as individual experts addressing design issues from their perspectives. Their expertise may change during a design session as their understanding is supplemented and they learn from their involvement.

This analysis is in sympathy with a model of collaborative design (Fig. 4) postulated in by this
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author elsewhere [13,27], which suggest that collaborative design consists of parallel expert actions, each of short duration, bracketed by joint activity of negotiation and evaluation. Thus the design activity itself is discrete, individual and parallel, not intimately linked. The participants act as individual experts addressing design issues from their perspectives. Their expertise may change during a design session as their understanding is supplemented and they learn from their involvement.

We suggest that the cycle time in this model is very small — probably in the realm of seconds, perhaps not even the 15 s that Gero and McNeil have found, although we are still exploring this data. In this model, we can see that the work is in fact co-operative in nature, and that collaboration occurs as negotiation and evaluation, activities observed as essential and present in computer supported collaborative design [17]. This view of the design process is supported further in the categorisation of design collaboration identified by Maher et al. [14] in their experiment in collaborative design, namely:

- Mutual collaboration, in which the participants are "busy working with the other".
- Exclusive collaboration, in which the participants "work on separate parts of the problem, negotiating occasionally by asking advice from the other".
- Dictator collaboration, where the participants decide who is "in charge" and that person leads the process.

Indeed, Maher et al. note that the 'exclusive collaboration' model is the most effective and the one in which they observed most productive results. Mutual collaboration led to no result at the end of a very busy exchange between the participants, whereas dictator collaboration came to a conclusion as soon as the leader made up her mind.

Design collaboration therefore requires a higher sense of working together in order to achieve a creative result than co-operative design. It is a far more demanding activity, more difficult to establish and sustain, than simply completing a project as a team. It should be noted that collaboration does not imply capitulation by individual members nor does it imply decisions by consensus (a common mistaken assumption, see, for example, Ref. [3]). But if we look further at collaboration, we see one more issue — compromise. Compromising suggests an expedient settlement that only partially satisfies those involved. It does not dig into underlying problems but rather goes for a superficial arrangement. This indeed is borne out by Dorst [6] with his observation that designers practice "satisficing" very often. In Cross and Cross [4] for example, collaborative designers reach design decisions which are not the best solution but which are adequate. This is not a pejorative to be dismissed, for the basis for the satisfied solution goes beyond superficiality and is often a truly innovative solution.

4. Implications for computer systems

Whether we are co-operating or collaborating, we can be designing, but our expectations for the design environment changes if we think we are doing one or the other. A loose-coupled design process requires a very much different set of tools and conditions to be successful than a close-coupled one. Collaboration requires more than machinery and systems to occur. To what extent the systems are necessary for collaboration has yet to be addressed — many working in this field have their vision clouded by the issues of collaboration itself, failing to recognise the broader and far more important issues of systems for co-operative work. This over-riding desire to support collaboration leads to high-bandwidth demands to support close visual linking in order to replicate co-location [8,9,21]. Now that we have over a decade of experiential data, it is becoming apparent that these simulations of co-location do not lead to better work product outcomes [28]. Experimental data suggests that this conclusion is true [12,18,27].

To be provocative, I suggest that most of the time when people think they are working collaboratively they are actually co-operating and, even more important, compromising. And most of the time that is exactly what they should do. Collaboration is time consuming and requires relationship building and is suited to very particular problems that require such close coupling of the design process and its participants. It would be inappropriate to collaborate to accomplish most design tasks, in the strictest meaning of the word. In short, working together, even effectively, is not necessarily collaboration, nor should it be.
From this review, we see that collaboration is a deeper, more personal synergistic process and the term should be used selectively. Perhaps we should refer to our field as "co-operative design", recognising that the design process itself is one of negotiation, agreement, compromise, satisfying in order to achieve success. We might even talk about "compromised design" at the risk it might imply the wrong thing. I suspect again that we collaborate far less often than we pretend to. We focus on collaboration, failing to distinguish that act from co-operation, diminishing the usefulness of this looser coupling. Most design projects bring teams into a relationship which fits Mattessich and Monshey’s definition of co-operation or co-ordination more closely than it fits their definition of collaboration. Computer systems which support co-operative design can be loose-coupled components which allow for different systems and are reliant on a variety of communication channels. In a pursuit of systems for collaborative work, we risk over-emphasising particular features which may not be needed. For example, synchronicity may be unnecessary for much co-operative work. In place of striving for closer coupling of systems and tasks, we should perhaps pay greater attention to work processes which are needed to create the environment for successful co-operation or collaboration. We cannot expect to create such an environment simply with hardware and software tools. An over-reliance on tools can only lead to less than cost effective use of our resources.

References

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