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INTERDISCIPLINARITY: PERCEPTIONS OF THE VALUE OF COMPUTER SUPPORTED COLLABORATIVE WORK IN DESIGN FOR THE BUILT ENVIRONMENT

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Abstract. This paper presents the findings from a study into the current exploitation of CSCW in design for the built environment in the UK. The research is based on responses to a web-based questionnaire. Members of various professions including civil engineers, architects, building services engineers and quantity surveyors were invited to complete the questionnaire. The responses reveal important trends in the breadth and size of project teams at the same time as new pressures are emerging regarding team integration and efficiency. The findings suggest that while CSCW systems may improve project management (e.g. via project documentation) and the exchange of information between team members it has yet to significantly support those activities that characterize integrated collaborative working between disparate specialists. The authors conclude by combining the findings with a wider discussion of the application of CSCW to design activity – appealing for CSCW to go beyond multidisciplinary working to achieve interdisciplinary working.

1. Introduction

Design for the built environment is probably the most multidisciplinary practice in all of the design professions. Now, more than ever before, architects, civil engineers, building services engineers, quantity surveyors, construction managers, landscape architects and interior architects are required to work with a very high level of integration during the design and

development of schemes. It was clear from informal discussions with practitioners at the outset of the research that, to a greater or lesser extent, the various professions are experiencing a number of pressures. There are pressures to reduce lead time, to reduce costs, to reduce defects, to lower environmental impact and to increase client satisfaction. Also there are pressures to improve communication with colleagues, and to establish consistency in tools and procedures. Simultaneously there are pressures to adopt computer-based working - partly so as to address the above issues. The cumulative result of these pressures has been that today many professionals in this broad field display some participation in computer supported collaborative working (CSCW). It was also clear from these early discussions that CSCW did not seem to be achieving the influence that it promised. Opinion suggested that while the individual constituent parts, the team members, exchanged information their working did not display a sophisticated level of integration. It seemed to be more 'multidisciplinary' working and less 'interdisciplinary' working. Consequently, it was proposed to undertake a modest questionnaire survey that would hopefully illuminate this phenomenon and which might provide particular foci for future research.

2. Research Design

In December 2001 a questionnaire was devised, piloted and developed. It was designed to be completed in under ten minutes and presented three sections. Section One sought information about respondents' current activities. Sections Two and Three sought opinion on team working and CSCW respectively and exploited the strategy of offering statements to which respondents could state their level of agreement or disagreement via four check boxes. For example:

My work involves multidisciplinary team working
Totally agree   0   0   0   0   Totally disagree.

The use of only four categories was deliberately used to prevent respondents 'sitting on the fence'- forcing them into partial agreement or disagreement. As a research strategy it has its advantages and disadvantages. It was anticipated that respondents might overly use the second and third categories due to an unwillingness to present the strong 'total' feelings specified by the first and fourth categories. However, the feedback did not confirm this worry. The questionnaire also included six expandable boxes allowing potential respondents to add information that could inform the research. A database was compiled consisting of email addresses of people who were known to be active in one or more fields associated with design for

the built environment (architects, building services engineers, civil engineers, construction managers plus a small number of other specialist professionals). The questionnaire was uploaded to the project website:
http://tyne.open.ac.uk/~pm2976/cscw_survey_1.html
and in January 2002 150 invitations were emailed out. Potential respondents were invited to return the completed questionnaires electronically by a given deadline. By the time of the deadline 25 had replied. The low response is disappointing but it provides an indication of trends in this field. Given the low response an overly statistical approach to the presentation of the data would not be appropriate. What trends there are emerge easily from simple presentations of the data. Bar charts would have been ideal for this presentation but space did not permit. If the responses increase it may be relevant to look more closely at the data, perhaps looking at responses within particular professions. In the following section, where percentages are given, the figure is followed by the actual number of returns

3. Research Findings and Discussion

3.1 SECTION ONE
Of the 25 respondents, 11 were building services engineers, 6 were civil engineers, 4 were project managers and 2 were architects. The remaining two respondents were a landscape architect and a Director of a professional institution. The respondents would appear to be very experienced in their professions, 52%(13) stated they had more than 20 years experience in their work, 36%(9) stated they had 10-19 years experience.

Question 3 asked *'What do you use your computer(s) for?'* and offered 9 fields plus an expandable box for 'other' uses to be specified. Not unexpectedly, respondents demonstrated multipurpose use of their computers with a mean of 4.4 uses per respondent. Most popular uses were management 84%(21), communication 84%(21), document control 72%(18), researching 44%(11), detail design 40%(10), specifying 36%(9) and conceptual design 28%(7). The 'other' category revealed a number of tasks of personal relevance to the individual respondents. They concerned, for example, financial modelling, safety assessment, feasibility, sales and marketing but none of these received more than 2 mentions and are therefore not viewed as significant at this stage.

Question 4 asked *'Which forms of output are you producing from the above tasks?'* and the findings confirm the multipurpose use found above (a mean of 4.5 forms of output per respondent). The most common outputs were word processing 96%(24), spreadsheets 92%(23), administration 80%(20), databases 52%(13), drawings including animations 40%(10), CAD

models 28%(7) and bills of quantities 20%(5). The 'other' category produced 8 other headings e.g. Web publishing, presentations, sales output, and Gantt charts but no heading received more than one mention.

Question 5 asked for an estimate of the percentage of working time spent at a computer and offered 5 alternatives (100%, 75%, 50%, 25% and 0). 32%(8) spent ¼ of their working time at a computer, a further 32%(8) spent ½ of their time at a computer, 28%(7) spent at least ¾ of their working week in front of a computer and for two people (8%) all of their time was computer based.

3.2 SECTION TWO

From question 6 onwards the survey moves away from requesting descriptive data and begins to require respondents to make judgements regarding their multidisciplinary team working. It also marks a shift in question design. From question 6 onwards the respondents are confronted with statements with which they are asked to rate their level of agreement. Question 6 through to the penultimate question (Q26) was presented in this way - as a statement against which respondents had to indicate one of four levels of agreement/disagreement.

Question 6 through to question 14 was seeking to establish a foundation of current practice within which the emergence of computer supported collaborative working could be investigated. This section was titled 'Team working, multidisciplinary working and your experience of changes over the past two years'. Question 6 stated directly *'My work involves multidisciplinary team working'*. 64%(16) totally agreed, 28%(7) partially agreed and 8%(2) partially disagreed. The follow-up statement said *'I am involved in <u>more</u> multidisciplinary working than I was two years ago'*. 24%(6) totally agreed, 44%(11) partially agreed, 16%(4) partially disagreed and 16%(4) totally disagreed. Given the consistency of the questionnaire design the remaining data from each statement will be provided simply as four percentages with the actual number of respondents given in brackets. In each case the first percentage relates to 'totally agree' and the fourth percentage relates to 'totally disagree'.

Q8 *'The number of different disciplines represented in teams in which I work has increased in recent years'*.
16%(4); 60%(15); 8%(2); 12%(3) including one non-response.
Q9 *'I now send, receive or exchange more information with colleagues from other disciplines'*.
32%(8); 52%(13); 12%(3); 0% including one non-response.
Q10 *'There is an increased requirement for me to make sense of, or interpret information from other disciplines'*.
24%(6); 52%(13); 12%(3); 8%(2) including one non-response.

Q11 *'There is an increased requirement for me to make decisions regarding other disciplines'.*
   8%(2); 44%(11); 36%(9); 8%(2) including one non-response.
Q12 *'There is an increased requirement for me to integrate closely with other team members'.*
   40%(10); 48%(12); 4%(1); 4%(1) including one non-response.
Q13 *'There is an increased requirement to improve the team efficiency'.*
   44%(11); 44%(11); 4%(1); 4%(1) including one non-response.
Q14 *'There is an increased requirement to improve team output quality'.*
   60%(15); 32%(8); 4%(1); 4%(1).

Section Two of the survey confirms what many will know to be true from their own experiences – that team working is increasing and there are very real pressures to increase team efficiency and team output quality. The findings also confirm that in this field of design for the built environment teams now involve a wider range of specialists and communication between these specialists has increased. However, traditional lines of demarcation between specialist areas or professions still seem to exist. The responses are less supportive of the notion that this increased team working has lead to new responsibilities for interpreting or making decisions based on data arising from outside their area of specialism.

3.3 SECTION THREE
Section Three of the questionnaire sought to explore respondents opinions regarding their computer supported collaborative working. Given the increasing pressures towards team working it was important to begin to establish how CSCW was contributing to a strategy for addressing this pressure. Questions 15 to 26 use the same format as those in Section Two.

Q15 *'More of my team working is via computer supported collaborative working'.*
   36%(9); 36%(9); 16%(4); 12%(3).
Q16 *'CSCW has improved communication in the teams with which I have worked'.*
   28%(7); 44%(11); 12%(3); 12%(3) including one non-response.
Q17 *'CSCW has improved creativity in the teams with which I have worked'.*
   8%(2); 24%(6); 44%(11); 20%(5) including one non-response.
Q18 *'CSCW has improved problem-solving in the teams with which I have worked'.*
   4%(1); 36%(9); 40%(10); 16%(4) including one non-response.

Q19 *'CSCW has improved project management in the teams with which I have worked'*.
16%(4); 36%(9); 32%(8); 8%(2) including two non-responses.
Q20 *'CSCW has improved project documentation in the teams with which I have worked'*.
28%(7); 52%(13); 8%(2); 4%(1) including two non-responses.
Q21 *'CSCW has increased the quantity of work I get through'*.
16%(4); 52%(13); 20%(5); 4%(1) including two non-responses.
Q22 *'CSCW has increased the quality of my contribution to projects'*.
12%(3); 60%(15); 16%(4); 4%(1) including two non-responses.
Q23 *'CSCW has increased the overall quality of output from teams with which I have been associated'*.
20%(5); 56%(14); 12%(3); 4%(1) including two non-responses.
Q24 *'CSCW has increased my satisfaction with outcomes of projects'*.
4%(1); 48%(12); 36%(9); 0% including three non-responses.
Q25 *'CSCW has increased client satisfaction with outcomes of projects'*.
4%(1); 52%(13); 28%(7); 4%(1) including three non-responses.
Q26 *'CSCW has increased understanding between team members'*.
12%(3); 52%(13); 28%(7); 0% including two non-responses.

The responses to Section Three do not provide the strength of feelings that Section Two reveals. Also there were more non-responses to questions. The non-responses in Section Three involved the same three people but this group was different to those offering non-responses in Section Two.

Clearly the increase in team working identified in Section Two is translated into an increase in CSCW. 72%(18) of respondents totally or partially agreed that more of their team working over the past two years has been computer supported. Interestingly, 68%(17) totally or partially agreed with the statement that CSCW has increased the quantity of work they get through. Questions 16 to 20 focused on qualitative improvements as a result of CSCW. 72%(18) believed that communication had improved and similarly that project documentation and project management had improved with 80%(20) and 52%(13) respectively in total or partial agreement with the statement. Interestingly 64%(16) disagreed that team creativity had been improved with 56%(14) disagreeing that team problem solving has improved with CSCW. More significant are the responses to questions 22 and 23. 72%(18) of respondents totally or partially agreed with the statement *'CSCW has increased the quality of my contribution to projects'* while 76%(19) totally or partially agreed with the statement *'CSCW has increased the overall quality of output from teams with which I have been associated'*. The increase in self-satisfaction is marginal but belief that there has been an increase in client satisfaction as a result of CSCW is more marked. The purpose of question 26 was to see whether any increase in communication

was matched by a perceived increase in understanding between team members. This would seem to be the case.

4. Conclusions

As noted above, a 16% return rate to the questionnaire was disappointing. Furthermore, given that 11 of the 25 respondents were building services engineers the findings may be viewed as distorted by the particular activities or requirements of this group. The poor return may be to do with questionnaire design, pressure of work or insufficient incentive. It may also indicate that individuals feel they have nothing to offer such a study, perhaps because their use of computers for collaborative work is small or considered inexpert. However, those that have replied reveal themselves to be aware of and perhaps interested in CSCW and maybe even open to further studies of their CSCW.

The study set out to identify trends in CSCW. This experienced group of practitioners clearly consider themselves to be involved in multidisciplinary team working and they indicate that this has increased in the last two years with a simultaneous increase in the number of different disciplines represented in the teams with which they have been associated. The responses reveal the existence of pressures to achieve close integration between team members, to achieve greater efficiency and to improve the quality of the output of the team. A change in responses seemed to emerge when these pressures were addressed within the context of CSCW. While computer supported team working has increased for the respondents this seems to have manifested itself as an increase in communication without necessarily any increase in the quality of team working. When it was proposed that creativity and problem-solving have been improved by CSCW the responses indicate disagreement. At the same time project documentation and project management is believed to have been improved by CSCW.

CSCW seems to have increased the quantity of the work that the respondents get through but the rating for personal satisfaction is only marginal. Perhaps more importantly, there is a belief that CSCW has increased the quality of the respondent's contribution to projects and the overall quality of output from teams with which they have been associated. Future studies may seek to investigate whether this is a consequence of successful remote team working or due simply to computer based working with its access to computer based resources and tools. Either way, the outputs seem to have increased client satisfaction.

For these respondents CSCW has made contributions to supporting multidisciplinary group activity but potentially it can do much more. Effective

team working in design displays interchange between participants but this largely concerns the conveying of information. Design particularly requires the explicit intervention of participants whose expertise is to synthesize information and render it useable by the group. The goal for CSCW in design might be to support higher levels of 'interdisciplinary' collaborative working where participants are empowered to explore and negotiate meaning and generate conjecture. The notion of interdisciplinarity in CSCW is not new (see Bannon, 1992) but its importance has re-emerged as a result of the volume of design activity taking place by distributed participants and the particular nature of designing. Kvan (1999), for example, proposed that supporting expert design behavior via CSCW tools required a perception of design activity as more than social and situated acts. Nissani (1997) has proposed that interdisciplinary working is essential where there is a need for creativity and where there exists complex problems. Multidisciplinary working is rich in information; interdisciplinary working is also rich in interpretation and transformation. It represents greater synergistic activity and it comes closer to offering the 'shared understanding' between participants as referred to by other CSCW researchers (see for example Maher, Simoff & Cicognani, 1999). Edmonds & Candy (1999) have noted the significant influence that computer based media have on creative thinking and particularly the emergence of ideas but there is still much research to do on the potential for CSCW to support and improve creative interdisciplinary working.

The exploitation of CSCW in design for the built environment and its influence in improving interdisciplinary working has been erratic but potentially design for the built environment can provide the ideal context for valuable developments to our understanding of both design and CSCW.

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