Supporting Cooperative Working Using Shared Notebooks

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This paper discusses the use of a shared cooperative notebook by a group of software engineers and support staff distributed over two sites The design of the notebook is described and results of the pilot trial reported It was found that the system was an effective means of sharing information for the non-technical staff but required much greater integration with other information systems and the actual rather than perceived working practices of users Issues which appeared to influence the results were the distinction between formal and informal information and the parallel rather than genuinely cooperative work patterns of the technical staff.

Introduction

This paper discusses some of the work of the DUCK project in supporting co-working between members of a distributed group. DUCK aimed to provide, in the first instance, a cooperative toolset for the practice and management of engineering design. The development of the toolset was driven by detailed requirements engineering and by longitudinal pilots situated in the actual working environments of the users.

J. Hughes et al. (eds.), Proceedings of the Fifth European Conference on Computer Supported Cooperative Work, 281-295.

The DUCK project's user company was a large supplier of engineering and software services and consultancy with many sites distributed across the length and breadth of the United Kingdom, and a significant number of cross-site teams. In the second phase of the project the particular focus was the creation and evaluation of tools to support distributed, cooperative software design, build and testing. This work forms the subject of this paper[1].

Resources for mutual awareness

From early requirements elicitation work with the teams involved in software development, it emerged that a potential function for technological support would be to keep team members aware of what their colleagues were doing, particularly those located at a different site. The technology should support such mutual awareness as appropriate. Where members of workgroups share a physical workplace, they are continually aware of what their colleagues are doing through the everyday processes and cues of co-presence. It is easy to pass on information in an *ad hoc* way when the situation demands it, and to glean information useful to oneself. For example, a designer passing a colleague's desk may recognise part of a prototype, recall that problems had been found with a similar module in an earlier project, and suggest an alternative. A further piece of information afforded by the encounter is that work on this part of the project is far from finished, and therefore the first designer's task on an interfacing module can be postponed for a while. In a more active exploitation of co-presence, a code fragment which 'just doesn't look right' can be passed across the desk for someone else to check. The key points about these types of interaction is that they are unscheduled, informal and demand very little extra effort beyond that required for the main task in hand.

Similar low key exploitations of co-presence have been described by researchers working with, for example, air traffic controllers (Bentley *et al*, 1992) and London Underground staff (Heath and Luff, 1991). Such cooperation usually relies on the affordances of common artefacts such as screen displays (Underground control rooms), flight strips (air traffic control rooms) and whiteboards (engineering design office - Rogers, 1993). We were interested to know if a shared technical notebook could provide similar affordances for software teams.

Uses of technical notebooks

One of the main loci for the work of designers, managers and others in technical domains is the notebook, daybook, logbook, journal or laboratory book. In its prototypical form, this is of A4 size with hard covers. The notebook is used for a wide range of activities - for engineering designers, for example, these include

[1] For more details of DUCK see Turner and Turner 1994; and Turner, Turner, Green and Mayne, 1997

recording and exploring ideas in words and sketches, notes of discussions, calculations, records of trials, keeping lists of tasks and so on. Notebook contents comprise not just the book's original pages, but frequently other items are attached or simply interleaved. Our own anecdotal knowledge of notebook use is supported by two surveys conducted as part of the early requirements work in the DUCK project. These consisted of (i) a questionnaire survey of 200 engineers, managers and support staff at the DUCK user company and (ii) a smaller scale analysis of the use of notebooks at a software house. Of the 200 people surveyed 103 responded and of these 90 were engineers or (technical) managers. It was found that the major uses to which the notebooks were put were for notes of discussions (34%), 'to do lists' (28%), and calculations (22%). Of the software house survey 25 software engineers, designers, and software project managers were interviewed and it was found that the notebooks were used for 'technical purposes' (52%), 'to do lists' (30%), and as a diary (11%). The major findings were that although the profiles of usage from the two studies do vary, there remain a number of key commonalities. Notebooks are not used exclusively for technical matters; and they are used for both formal and informal information. Notebooks thus provide the repository for much of the stream of work which is the subject of informal interactions of the sort discussed above. Consideration of the notebook as a resource for work-in-progress suggested that sharable on-line notebooks could support cooperation where opportunities for mutual awareness and the casual exchange of information are restricted.

The Collaborative Notebook System

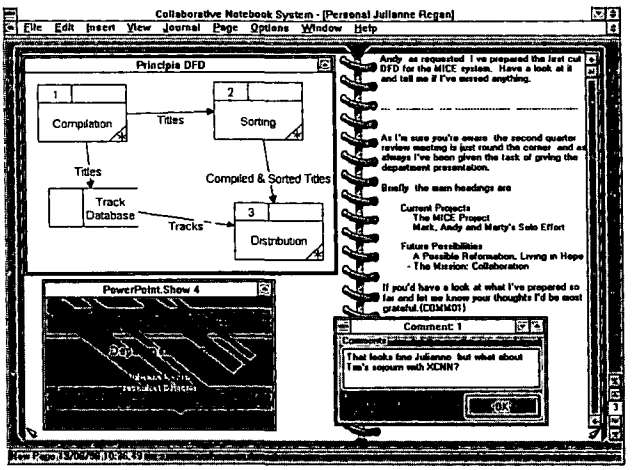

Figure 1 - A pair of notebook pages

The collaborative notebook system (CNS) is the software implementation of a shared notebook. The CNS is built on a LOTUS NOTES™ platform thus giving it all the necessary facilities to support both group and distributed working. The CNS presents the user with pairs of pages separated by a 'binder'.

The right-hand page

supports simple note taking, and the ability to add comments, identified by a marker and between and within notebook 'hyper-links'. The left-hand page is a OLE-enabled page into which any OLE capable document can be embedded. Figure 1 is a screenshot of a typical pair of notebook pages.

New (empty) notebooks or ready populated notebooks created from user-specified keywords are easily created. For example, a user could ask for a new notebook to be created from all notebook pages to which he or she has access containing the words 'bug report' or 'management meeting' and so forth. The on-line notebook also supports full text searching (using the LOTUS NOTES search engine), printing, a contents page and page *publication*. Publication is the mechanism whereby a page from one notebook is made available to a second notebook. Figure 2 illustrates the mechanism of publication as implemented in the CNS. As can be seen from this figure, notebook A consists of five pages while notebook B consists of four pages. There is one common page (the shaded figure) which can be thought of as being published from notebook A to notebook B.

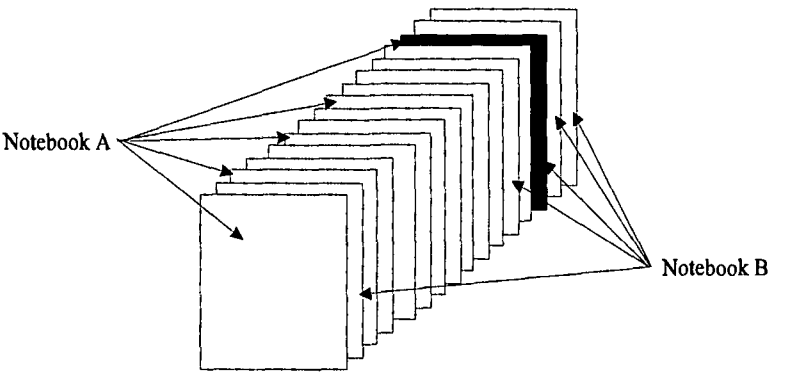

Figure 2 - The mechanism of publication

The dialogue whereby a page may be published from a notebook to one or more other notebooks is illustrated in figure 3 (overleaf). Published pages are then rendered read-only but comments may be added. Access control also allow users to specify who has access to their notebooks and the nature of the access, e.g. reader or writer. The recipient of a published page is notified by an automatically generated email message.

The final CNS as described above was developed in close conjunction with the potential users prior to its first release, and then in response to change requests and the evaluation exercises described below. Comments made in response to pre-pilot demonstrations resulted in the original, fairly crude approximation of notebook appearance being replaced by something that looked much more like the real-world object. Hyperlinks were also introduced at this stage. After the one-month evaluation the original functionality embodied in the left hand page, a simple

sketching tool, was replaced by the OLE-enabled page described above and the final phase of enhancements, after the three-month evaluation, provided integrated email and publication notification (described above).

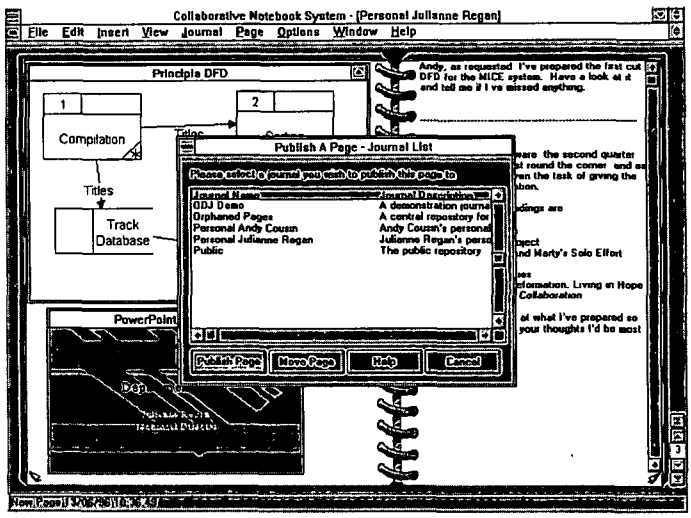

Figure 3 - Page publication in action

The pilot trial of the CNS

The context

To validate the CNS an extended pilot was set up across a pair of test sites selected from the DUCK project's user company's offices. These test sites were geographically remote being located in London and Glasgow (some 400 miles apart) but shared responsibility for the user company's software product range. The design of the pilot followed the recommendations of Opper and Fersko-Weiss (1992) who have argued that the pilot introduction of CSCW technology should be divided into two phases - an experimental and then an expanded pilot. In the former, which is the case under report, the group itself is heavily involved in the evaluation of the system and actively observe changes in their own behaviour and working practices. It should be noted that this was not intended to be a formal experimental trial of the software: indeed the pilot was run to address a real-world business problem.

The users at both sites were groups of software designers, developers, support staff, sales staff, and a management team, all of whom were very IT literate. In all there were eight users in London and three in Glasgow. Most took part in the initial pre-release demonstration and discussions and were supported by hands-on training in the CNS. Once the software was installed on individual machines, they were asked to experiment with the system and to use it in any way they found useful in support of their normal activities,

As a group they were initially very enthusiastic about the CNS and its potential to resolve a number of information sharing issues that existed between the two sites. Overall, these groups were responsible for the continued software development of their product range of CASE tools. The development drive came from a number of sources but most immediately from customer feedback. This feedback took a variety of forms but centred around change requests and bug reports.

However the information sharing issues faced by these groups were much broader than that, as in addition to change requests and bug reports, requests for support, sale enquiries, training enquiries and so forth for the full product range frequently arrived at either site. This happened despite the fact that the support of these products is explicitly demarcated between sites. It was therefore envisaged that the CNS would play an informal role in supporting a range of such activities.

Evaluation objectives, methods and schedule

In parallel with the pilot was an evaluation activity, the purpose of which was to produce a measure of the usefulness of the CNS. To this end the three key dimensions along which the CNS was evaluated were identified. These were (in brief):

1. Is the CNS a better technological solution to information storage and management than a paper notebook?
2. Does using the CNS make the individual user more productive / effective in their day-to-day work?
3. Does using the CNS make the group using it more productive / effective in their day-to-day work?

Each dimension was then further divided into sub-issues and questions generated. The users of the CNS were interviewed at four points: immediately before the start of the pilot as to their expectations of the CNS; after one month and after three months, using semi-structured interviews and administered questionnaires; and finally after six months using semi-structured group discussion.

Results

This section first reports quantitative data obtained from users' ratings of the software then amplifies this material with the less structured material obtained from user interviews.

Ratings of the CNS

What follows are the core results from the rating scales which formed part of the administered questionnaires.

Technological effectiveness

Eight of the original 11 users[2] were interviewed after the pilot had been running for one 1 month. The items to be scored (on a scale of -3 to +3) were:

1. How reliable did you find the CNS?
2. How responsive did you find the CNS?
3. How well integrated with other applications did you find the CNS?
4. How effective is the analogy between the CNS and an A4 notebook?
5. Would pen-based technology make the CNS easier to use?
6. How useful did you find publication?
7. How secure did you find your (i) pages, (ii) your journals.

The first three items were repeated at the three months stage; it was considered that data on the remaining four items would be less meaningful at this point. Figure 4 (overleaf) illustrates the mean scores for the technology component of the evaluation of the CNS.

As figure 4 shows, after one month (i) the technology was performing quite well in terms of its reliability and responsiveness, although (ii) the CNS did not particularly look, feel and behave like an A4 notebook. The main reasons for this were two-fold: firstly portability - as the CNS was only installed on desktop PCs it was not portable. Secondly, a number of users pointed out that a real notebook may be opened in the middle, towards the end and so forth. The CNS always opened at the first page, although comprehensive page navigation facilities were available thereafter. Next, (iii) pen computing was not perceived as a useful addition to the CNS largely on the grounds that it was another operating system to learn; (iv) publication, that is, the primary means by which information is shared using the CNS, was seen to be useful but not overwhelmingly so. This may be due to the relatively short period of time the CNS had been in use. Finally, (v)

[2] The other users continued to participate in the pilot, but were unavoidably not available for interview,

integration. The CNS did not offer integration with other Windows™ application except at the most simple level (i.e. cut and paste using the clipboard). It will be recalled that the requirement for integration was realised in the final version of the CNS.

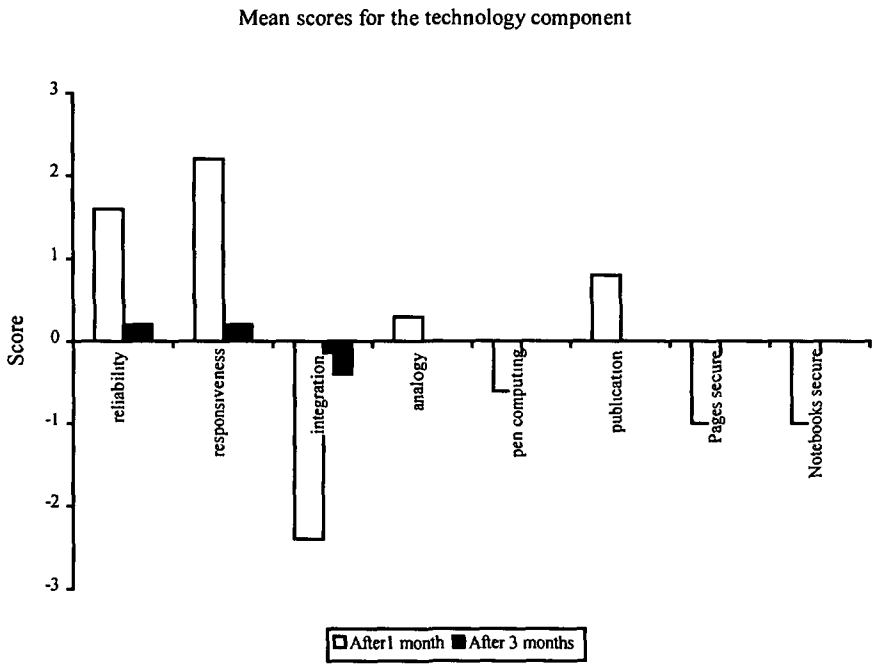

Figure 4 - mean scores for the technology component of the CNS at one and three months.

After three months, while integration problems had been ameliorated, there had been a corresponding drop in perceived responsiveness and reliability. Responsiveness and reliability were however no longer identified as problems in the group discussion session at six months.

Individual and group working using the CNS

Users were similarly asked to score the CNS (on a scale of -3 to +3) along dimensions designed to elicit perceptions of overall usefulness for individual and group working. (The underlining corresponds to labels on the graph overleaf.)

1. How would you score the usefulness of the CNS for individual work?
2. Has using the CNS improved your productivity when working alone?
3. Has using the CNS made your job easier?

4. In the context of group working, how would you score the usefulness of the CNS for keeping in touch with other people's work in the office?
5. In the context of group working, how would you score the usefulness of the CNS for sharing information?
6. In the context of group working, is the flow of information better or worse?
7. In the context of group working, does the CNS provide the features which allow you to work with others?
8. Has using the CNS improved your productivity as a member of a group?
9. Has using the CNS improved the productivity of the group as a whole?

From figure 5 (below), it is clear that after one month using the CNS had made individual work a little more productive. Turning to the groupworking measures, there was a more positive assessment of the CNS as a means of supporting collaborative working. For both conditions there was a small negative response to 'Has using the CNS made your job easier?', but this may be an effect of the overhead of learning to use the system. The major change from the one month evaluation point to three months point is the perception that the CNS had improved the productivity of the group and the individual while the support for individual and groupworking *per se* remained approximately constant.

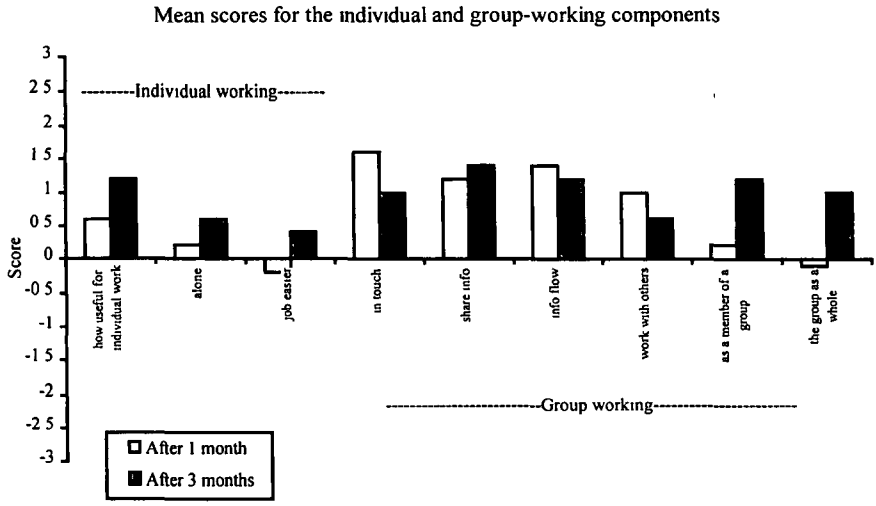

Figure 5 - Mean scores for the individual and group-working components

Supplementary material from semi-structured interviews

Pre-pilot findings

Each of the sub-groups within the pilot sites (i.e. technical staff, salespersons, managers and support staff) foresaw a clear role for the CNS in their range of day-to-day duties. For the technical staff this was product support activities; and for the sales staff, marketing activities and so forth. For the managers it would be used for all of these.

After 1 month of use

The software engineers uniformly failed to use the CNS. In contrast, other staff at the test sites used the CNS extensively, particularly those individuals supporting their software products. Further analysis of the evaluation data revealed that there appeared to be an antagonism between the clarity and ease of information sharing that the CNS offers - no more *Chinese whispers*, as one individual put it, with the apparent transformation of informal to formal information when committed to an electronic medium. Informal information exists without a written record or time and date stamped, while information within the CNS is necessarily written and time and date stamped. Yet, users did find the CNS useful for jotting down ideas and for managing unstructured information. In all the software engineers appeared to resist using a means of communication perceived as formal for information which they considered informal. In contrast the managers and sales staff were using the CNS as they had indicated at the pre-pilot stage.

After 3 months of use

Four major issues emerged after this extended period of use, (i) all groups of users reported greatly improved information sharing between the two sites, but (ii) the transition from their current working practices to CNS was proving to be very slow, which was being hampered by (iii) software reliability problems. The users finally noted (iv) that there was a clear need to integrate the CNS with other information sharing tools such as MSMAIL and MICROSOFT SCHEDULE+.

After 6 months of use

The users after six months believed that they had fully explored the CNS's potential and uniformly found it useful if not 'too powerful' for their immediate needs. The CNS was variously described as 'only' an information sharing tool; as a tool for supporting cooperative working; and as a medium for sharing formal information while 'feeling' like an informal system (this dichotomy was attributed to the *situated* nature of the PCs on which the CNS ran which were perceived as

group resource located at the users' place of work whereas notebooks are personal and owned by an individual). Use of the CNS was seen to have greatly improved cross-site communication where email (and fax, and telephone) had proved to be insufficient. Finally, a small number of users said that they would not return to their paper notebooks after the pilot.

Overall many of features of the CNS were not used, which is not in itself surprising except to note that this includes the publication mechanism. Users shared information by creating public notebooks to which all had access. In the main private notebooks were created, experimented with and then discarded in favour of the public notebooks. On being asked why this was so, users, excepting the overall manager, described themselves as having a peer relationship with respect to technical information.

Discussion and conclusions

Technology push

That the transition from current working practice to the CNS was very slow is understandable and is a well-known problem faced by many if not all CSCW projects - the reports by Orlikowski (1992) and Bowers (1994) are two of numerous examples. In our case existing working practice at the pilot sites was proven, well understood and familiar and the need to migrate to a new system in this instance was due to technology push rather than an identified set of problems. Moreover, take-up may have been adversely affected by performance problems during the middle phase of the trial.

Our experience may be compared to the major example of a 'shared notebook' used in real-world contexts, the VIRTUAL NOTEBOOK SYSTEM (VNS), (Brunet *et al*, 1991; Fowler *et al*, 1994). The VNS is a much heavier-weight instantiation of the notebook concept, supporting large repositories of information in several media. The system has been found to be most valuable where its introduction is hand-in-glove with process re-engineering, thus facilitating adoption of information sharing resources. This supports our observation that the adoption of the CNS may have been limited by the attempt to infiltrate the notebooks into existing work patterns.

Technical and non-technical staff

Prior to the pilot users were asked to estimate how much of their work normally fell into each of the following categories: independent[3], sequential[4], reciprocal[5] and team working[6] (Categories drawn from Van de Ven and Delbecq, 1976). The mean percentages of work allocated to the four categories were:

	independent	sequential	reciprocal	team
Technical	70%	0%	13%	17%
Managers/sales/support	37%	15%	28%	20%

If these data are graphed (summing sequential, reciprocal and team percentages to arrive at an overall percentage for cooperative work):

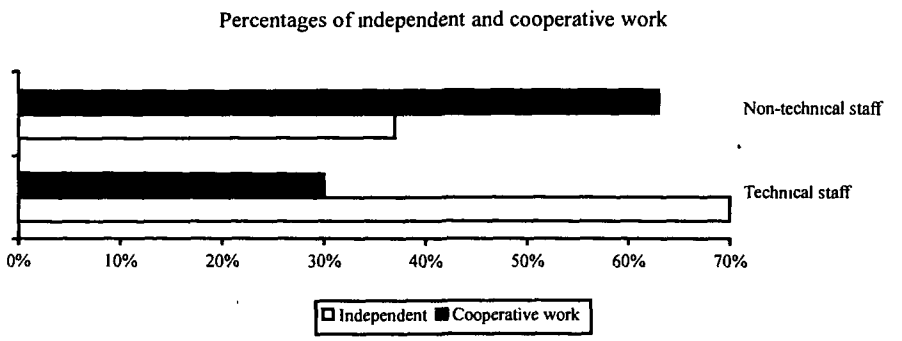

Figure 6 - Percentages of independent and cooperative work

From the above data and very clearly from figure 6, it can be seen that the relative proportions of independent and cooperative work are virtually mirror images of each other. The style of work between technical and non-technical staff may be assumed to differ. Moreover, as Reder and Schwab (1990) note:

> " ..we observe that some occupational groups, such as artists, architects and mechanical engineers (designers of physical objects whose development is shared in posted drawings or sketches) tend to prefer open workspaces through which colleagues are encouraged to browse. Other occupational groups (e g. software engineers, academics, writers) tend to prefer more enclosed and private workspaces which offer fewer intrusions and interruptions "

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[3] Independent working work is performed by you independently and does not involve anyone else in the team

[4] Sequential working work flows between you and one or more other members of the team, but only in one direction

[5] Reciprocal working work flows between you and one or more other members of the team in a reciprocal 'back and forth' manner

[6] Team working you and one or more other members of the team problem solve and collaborate as a group at the same time to deal with the work

While Reder and Schwab refer to the physical workplace, this observation appears very pertinent to our findings. Technical work of the type under discussion may simply offer less of an opportunity for collaboration technologies than managerial or support activities.

Premature information sharing

The pilots teams' preference for the use of group journals rather than the publication mechanism may be partly explained by the relative ease of doing this, but more interesting factors may be at work here. As we have observed elsewhere (Turner and Turner, 1995) technical staff are frequently reluctant to commit partially formulated information (i.e. informal information) to publicly available media in case it is used prematurely and attributed to its originator. A similar observation has been made by Citera *et al.* (1995), in their study of creating databases to record design rationale. One might speculate that that information contributed to a *group* notebook is perceived to have a weaker link to its originator than information on a page published from an *individual* notebook. The moral here is perhaps that considerations of privacy, responsibility and ownership remain very important in implementations of this type even when information sharing is discretionary. Indeed the whole issue of responsibility for the integrity of information once electronically available is one that warrants further study.

Not another box on my desk

A key observation to be made lies with the dichotomy between personal and shared (or business) information systems The identified need to integrate the CNS with other tools was not unexpected. This is consistent with our experience elsewhere, in the context of real-time, multi-media information sharing (Turner and Turner, 1992) that users prefer integration with existing tools to standalone innovations, a point of view put succinctly by one potential user as 'not another box on my desk'. The existing personal information system we sought to replace here was the A4 notebook which may be characterised as being (i) easy to use; (ii) portable; and (iii) secure or easily secured. In contrast the corresponding characteristics on a shared and / or business information system are: (i) integration with (other) information systems; (ii) integration with messaging systems / calendaring / scheduling (iii) integration with business applications; and (iv) that it is secure. The CNS attempted to bridge this dichotomy but only partially succeeded as it matched some of the former characteristics but few of the latter. The evidence therefore suggests that CSCW applications must bridge the gap between personal and shared (or business) information systems.

Were the users actually cooperating?

We suspect that there may be a difference between the users' perceptions of their patterns of work compared with the actual patterns. Our informal observation of the technical users suggests parallel but linked working. While it will be recalled that the technical staff reported that they spent around 30% of their time in team work, this may be an over-estimate of the true situation and/or much of this work may actually consist of co-ordinated, but relatively independent activities. The team members are working towards a common goal, but this is at a higher level of organisational activity: for example, to get the next release of the software out on schedule. Individual goals may not be shared, and the object of apparently 'cooperative' work may be so subdivided as to be no longer a common artefact in any meaningful sense. Comments elicited from individuals at the six-month evaluation illustrate this: *"We work individually" and "We work as individuals not as a team."*. In such circumstances the information sharing supported by the CNS may be to some extent an irrelevance at this level, and the lesson for designers of similar technologies may be that information only needs to be shared at the boundaries of individual tasks.

Postscript

This note is based on a series of informal observations made of the use of the CNS outside the DUCK project. At the first author's place of work a software development project was being conducted at two of the company's sites which were separated by a distance of 10 miles or so, two developers at one site and a developer and a manager at the other. Until the CNS became available to the team, co-ordination was achieved by means of frequent meetings (twice weekly as a minimum) as email (and phone and fax) had proved to be insufficient.

The team decided to adopt the CNS as a means of bridging this gap. What emerged over a period of six to eight weeks was strikingly familiar: the publication mechanism was not used. Instead public notebooks were used to shared information which largely consisted on site reports, meeting minutes and 'to do lists'. The CNS was described as being useful for 'braindumps' and for storing information which did not neatly fit elsewhere.

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