Collaborative Computing Environments for HEP

Julian J. Bunn

Information Technology Division, CERN, Geneva, Switzerland

This paper describes the diverse software tools that facilitate the work of groups of people. The focus is on tools that exploit the Internet or intranets, and on those which appear to be useful to the HEP community. A brief history of Computer Supported Collaborative Work (CSCW) is presented, followed by a description of some CSCW tools that are currently available, and some which are used in HEP. Finally, predictions are made on what HEP might expect to be using in this domain in future years.

Key words: CSCW; groupware; conferencing; communications;

1 Introduction

There has long been interest in how computers should best aid people in their work and everyday lives. Individuals working on their own on a computer-based task are already richly served by a wealth of software tools. This is hardly surprising, as it is those individuals' needs which drive the desktop computing market. On the other hand, the computer support of work engaged in by a group of people has been much less well covered until recently. This is because it is an area that imposes special software and network requirements, not commonly dealt with in single user systems. Few tools designed for single users also support group work. The explosion in the use of the Internet, and the uptake of Web technology, has caused developers and users to rethink how computer-based tools should support groups of people. This has heightened interest in Computer Supported Collaborative Work (CSCW), and there is now a plethora of support tools to choose from, most of which use the Web and Internet as core data transports.

So how is the HEP community profitting from this situation? On the face of it, since the community can be characterised by its geographical dispersion, its multi-nationality, its reliance on networks, and its embrace of computers as everyday tools for all manner of tasks, it is a model customer for CSCW tools. Somewhat surprisingly, the majority of people in HEP make very little use of CSCW. Perhaps this is because any tools chosen by a HEP subgroup usually need to be widely available, cheap (or cost-free), and agreed upon by all those involved in using them.

This provokes the question to what extent can the support needs for groups of physicists geographically separated but all working on the same paper, who need to meet, to exchange and review documents, to modify project plans, to view events together, be satisfied now, or in the future, by CSCW? The rest of this paper reviews what is currently available, already being used in HEP, and which looks promising for the future.

2 Office Automation - The Birth of CSCW

In the mid 1970's, single user applications such as spreadsheets and word processors ran amok on mincomputers. Office automation was an attempt to integrate those applications, but without any real idea of the user requirements or of the sociology of sharing the source documents. CSCW then began as an attempt by software engineers to incorporate into new software tools knowledge on how people work in groups. This knowledge was obtained from practitioners in the fields of, for example, social psychology and organisational theory.

One of the first, and most successful, groupware applications to arise out of this work was Lotus Notes, in 1988. Notes was designed to handle document exchange between networked and mobile systems, over low bandwidth connections. The success of Notes prompted other companies to develop competitive tools, and the market for CSCW (often called Groupware in the industry) took off.

3 The diversity of available CSCW tools

To date, the technology can be broken down into several areas. By examining the functionality of the available tools in each area, it becomes apparent that the distinction between each is blurring towards a few hypothetical, homogeneous "super tools". The "super tools" would cover E-mail/Messaging, Groupware, Conferencing, Software Development and Virtual Rooms. The common theme in what is available is the underlying use of the Internet, and in particular the Web, as an inter-personal computer connection transport.

The following table shows the diversity of CSCW categories as they appear today. For each category there is an estimate of how widely it is used by the

HEP community, and some example tool names given.

Category	Used in HEP?	Example Projects and Tools
Bulletin Boards	No	WebLines
Chat	No (?)	WebChat, NetMeeting
Collaborative Design	No	n-dim
Collaborative Drawing and Writing	Unknown	GroupSketch, Conversation Board, Emacs with DistEdit, Netmeeting
Collaborative Software Management	Widely	CVS, RCS, SCCS
Collaborative Learning	No	MUNIN
Email	Yes, ubiquitous	numerous
Groupware toolkits	Little	Lotus Notes, Microsoft Exchange, Netscape SuiteSpot, EDMS/CEDAR, GroupKit, ProcessWeaver
MUDs	No	XMX, XTV
Newsgroups	Yes, widely	Navigator, Internet Explorer, rn,news
Virtual Labs and Rooms	Very little	TeamWave Workplace, UARC, AAEM
Shared Windows	Unknown	NCSA Xcollage (defunct)
Videoconferencing	Increasingly	vic,vat,rat,nv,CU,NetMeeting, WebPhone,VidCall,FreeVue, Vfone,etc.
Virtual Reality	Marginal	VENUS, CAVE,DIVE,MASSIVE
Web-based conferencing	Increasingly	CMSDOC, WebCrossing, WebNotes,WebBoard, NetMeeting
Web-based calendars	Very little	WebCal

4 CSCW Market and R&D

What is driving the market for the tools shown above? As PCs become more and more networked, small groups of workers become potential new customers for groupware tools. Mature single user applications can be embellished with groupware features. Telecom companies seek to increase demand for networks by promoting multimedia tools that make use of them. In these halcyon days of "free" (often as far as the end user is concerned) networks, the interest in Internet-based communications packages is at fever pitch. Commercially, the platform being targetted is the PC, and Microsoft in particular has recently announced and made available for free download, an impressive set of groupware applications that, almost overnight, have obsoleted more mature products.

Apart from commercial factors, there is considerable interest in the academic community in wide area project collaboration, and this is spawning R&D effort in leading edge applications such as virtual collaborative worlds, and so on.

5 Conferencing

This category is broken down into four sub-categories: Pure videoconferencing, Meetingware, Web conferencing and MUDs.

5.1 Pure Videoconferencing

This is technology that allows two or more users to interact using audio, video or both. It is covered by a set of standards relating to CODEC, ISDN and packet-based conferencing, which are more or less supported by the available tools. For HEP, the importance of adherence to available standards in this area is recognised. The following are of particular significance: T.120 (data), H.320 (ISDN video), H.323 (LAN audio/video) and H.324 (MODEM audio/video): all ITU standards for multimedia teleconferencing. Moreover, the focus in the industry is now on inter-operability between tools and systems, which is reassuring.

Traditionally, HEP has used the packet-based MBONE tools, originally from LBL, but now also from UCL and elsewhere. These include vic, vat, sdr, rat and so on [9], and they can be used on most platforms (including the Windows PC).

The MBONE tools are targetted for use with multicast. Very recently, Microsoft announced its NetShow product [12], which is compatible with IP multicast. NetShow is a networked multimedia tool, and comes with clients to view material and tools to source it. It delivers live and on-demand material and uses the latest bandwidth-conserving and streaming software technology to do so. It comes as part of the Microsoft Information Server 3.0, although clients exist for Windows '95, and will shortly be available for Unix and the PowerPC Macintosh. HEP might make good use of such a tool for providing tutorial material (a good candidate might be the Paul Kunz's C++ course ... filmed and made available on a NetShow server at each LHC institute).

For point-to-point telephone conversations across the Internet, there are many tools available. Their proliferation is probably temporary, since they are rapidly being obsoleted by audio/video phones.

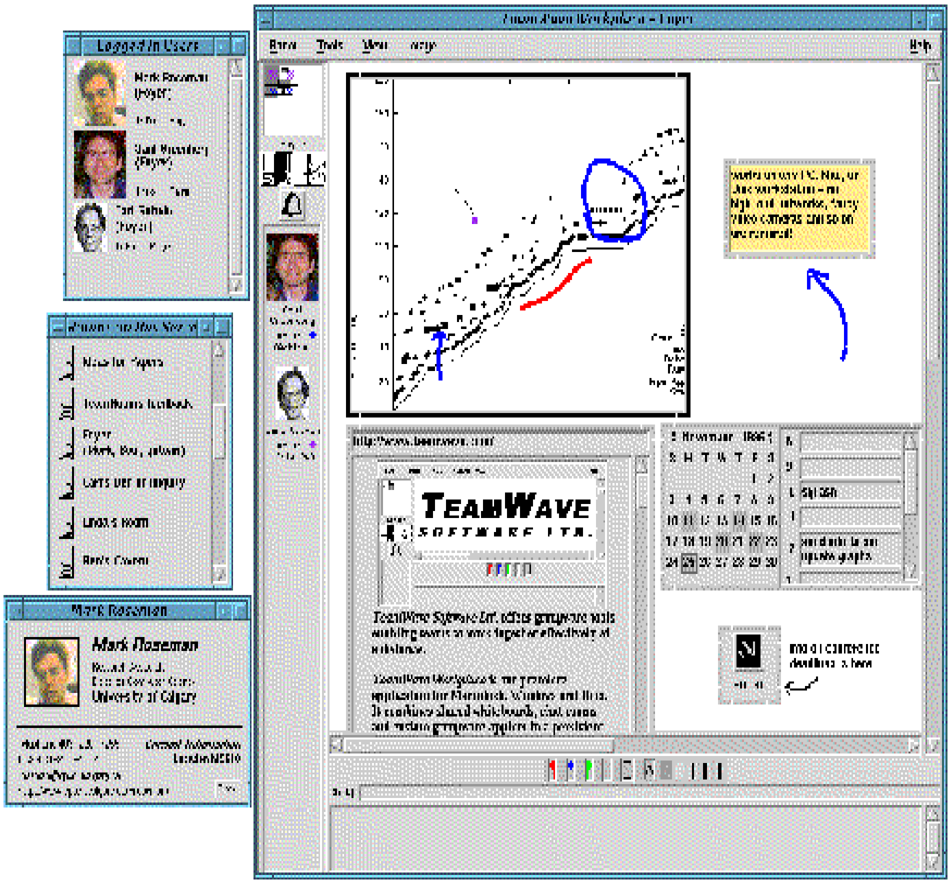
5.2 Meetingware

This category is for tools which integrate videoconferencing as part of a suite of subtools to support meetings. The latest generation of Internet-based meetingware available for the Windows platform offers integrated Email, FAX, video and audio conferencing, together with shared files, whiteboards, and clipboards. The current leader is Microsoft NetMeeting [11]. The platform for which the most tools exist (by far) is the PC.

NetMeeting offers support for the ITU standards, built in audio and video, shared whiteboard, shared clipboard, and a chat window. It is integrated in Microsoft's Web browser, Internet Explorer 3.0. With NetMeeting, one can share just about all information on the PC with another person. There is full desktop integration. For example, copying a piece of a local document into the shared clipboard causes it to appear in the other conference participants' clipboards too. Chat online is supported either by typing or by talking. The whiteboard can be used to discuss, modify and annotate diagrams together.

In addition, shared applications are supported. For example, one can allow other people to watch the build progress of an application being worked on in Developer Studio ... or one can allow them to take over Developer Studio and make their own edits to the code.

Glancing aside at tools available on Unix, we note TeamWave Workplace [16], an example of use of which is shown below. This tool was originally developed at the University of Calgary, but is now commercialised. It runs on Unix, Windows and Macintosh platforms, and provides shared whiteboards, chat rooms, and customizable groupware applets with a persistent work environment.



5.3 Web Conferencing

This is group discussion using text messages. It has its origins in vintage 70's systems such as "Confer", which ran on mainframes. The first Web based tool was called WIT [10], developed at CERN in '94 as a "quick hack" by Ari Luotonen. It featured discussion threads which took the form of a continuously expanding hierarchical tree. There followed HyperNews, a much simpler tool, but with the grandiose intent of obsoleting Usenet news and of storing all discussion or conference material indefinitely. Since then, there has been a considerable number of tools come to market, most of which offer the following features:

- Separate conferences for broad subject areas
- Threaded discussion
- Informative topic lists
- Support for frequent, and infrequent, participation
- Search and filter tools
- Access control
- Archiving

Currently available systems include WebCrossing, WebNotes and WebBoard (see [19] for a complete list). In HEP, the CMS experiment for example, has developed its own Web-based conferencing service called CMSDOC [13].

5.4 Multi-User Dungeons (MUDs)

These applications are also referred to as Multi-User Dimensions. The basic idea is that, using a text-based system, the user enters an environment that contains objects and other users, and then interacts with the environment by typing commands. The main use of MUDs is in game playing coupled with social intercourse between the participants. So what role do these have to play as collaborative work tools? An interesting application of a MUD was made by Rmy Evard at Northeastern University, where an attempt was made to create a replica of the work environment. Quoting from [6]

"The original environment that we built was a replica of the building that we work in. Everyone built their office, we implemented a network that one could travel through, and we constructed a central meeting place. But we found that having one real-life version of our urban university was enough. Instead, we created a virtual space that is different and somewhat more pleasant, and this has seemed to change the mood of the MUD for the better.

..

We have found that the MUD is an effective way to hold pre-arranged meetings for people who can't be in the same physical location. We have had virtual systems meetings three or four times, each about various topics. We save a transcript of the meeting and email it to people who weren't present, and refer to it when trying to remember exactly what issues had been raised. Using a MUD in this way is not as time-effective as meeting in reality, but is at least as useful as having a conference telephone call.

We use the MUD as a coordination mechanism. People tend to announce on the MUD what they are doing in real life. Phrases like "Jim heads into the machine room to check the tapes", "Ivan is about to reboot amber", or "I'm hungry, who's interested in lunch?" are commonly seen. We have found this to be so useful that we have encouraged it by writing utilities that people can use to indicate why they are "idling" in the MUD. A character is called "idle" when they do not respond to activities within the MUD. This normally happens because the user has quit paying attention to the MUD for some reason. When a character is idling "for office visitors" or "to drive home", the other participants in the MUD can look at that character and see why it idled. In this way, we use the text-based virtual reality to reflect what is happening in real life. Before the MUD, we saw each other only at meetings, or after running all over the building trying to locate each other."

The users of such a MUD would appear to be limited to those people who spend the vast majority of their time in front of their workstation screens. However, its use as a user support tool can be imagined, particularly if the MUD contained "bots" (expert systems who appear in the MUD as other users). Imagine the following interaction in a CERN Computer Centre MUD:

```
<New User> enters the User Consultancy Room
There are rows of shelves with manuals
An eerie light enters through a window giving onto the machine room to the West
There are five other people in the room
<New User> says: "Where is the CERN Phone book?"
<Bill> says: "I want to check in some 3480 cartridges"
<Helper> says: "<New User> look at http://consult.cern.ch/xwho"
<Helper> says: "<Bill> go to the tape vault in Building 513"
<New User> says: "Thanks Helper"
```

In the above, "Helper" is a bot, trained to answer common UCO questions. New User and Bill are MUD users, perhaps physically located at other ends of the site.

6 Groupware

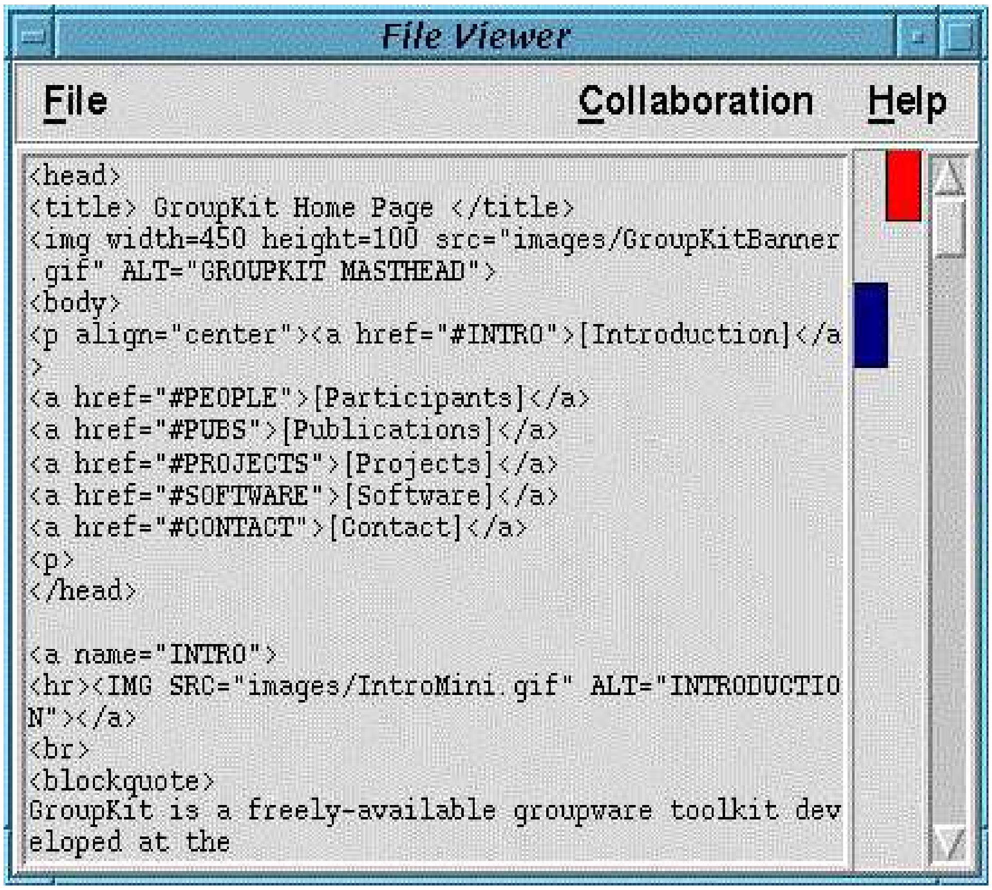
The tools that belong to this category are designed to alleviate paperwork, and help in the management of projects involving several people.

6.1 Toolkits

Some of the members of this category are offered as toolkits that allow programmers to develop groupware applications. One such is GroupKit [14] from the University of Calgary. This is based on Tk/Tcl and supported on Unix, Windows and the Macintosh. It comes with example applications such as the FileViewer (seen below), which allows a document to be examined and edited by several users at a time.

6.2 Workflow Tools

Workflow tools help in the management of project schedules. They allow the sending, reception and annotation of electronic documents, and the triggering

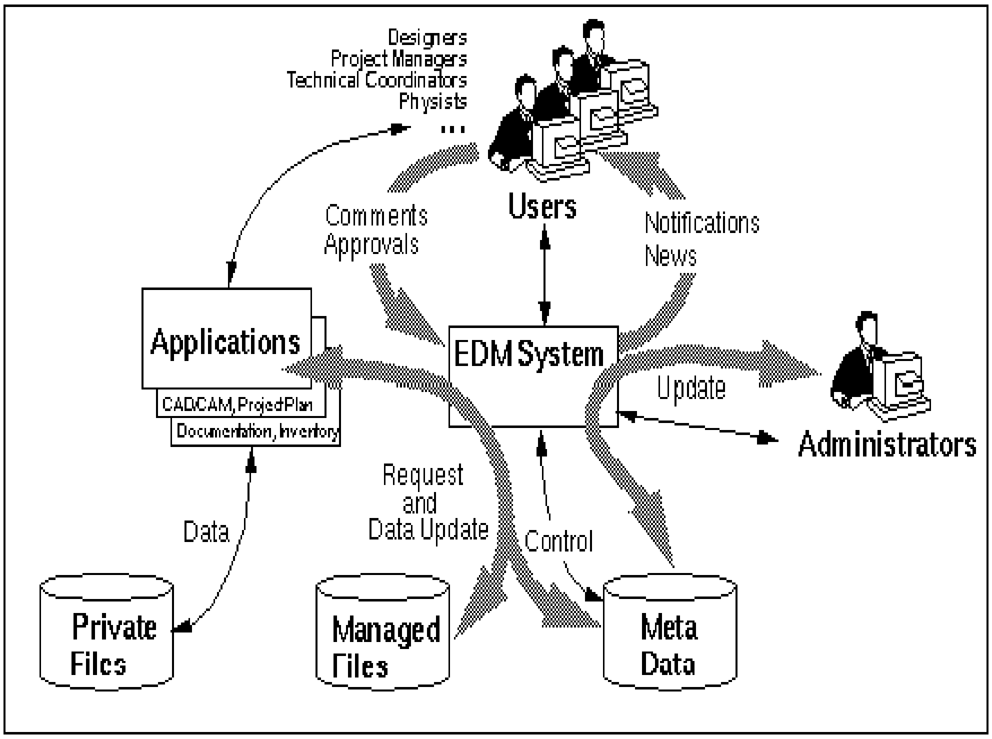


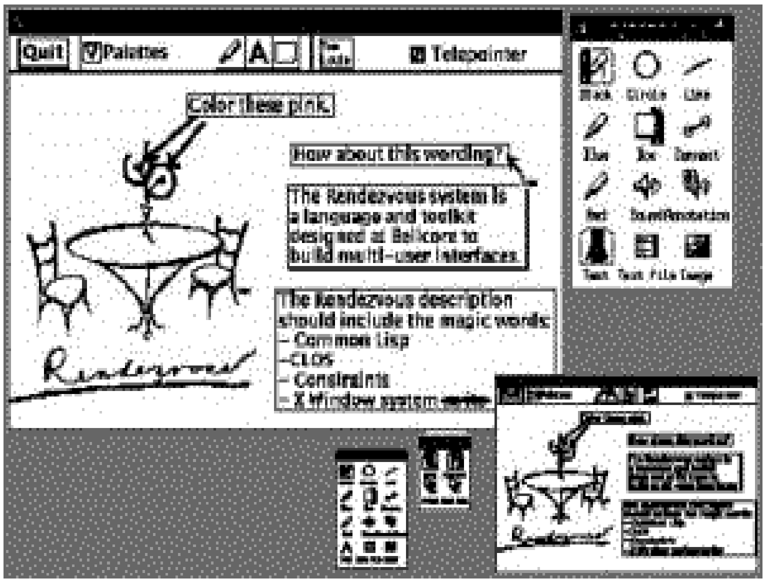
of messages to be sent when certain conditions have been met.

The basic building block is an Electronic Data Management System (EDMS), which provides a structure in which all types of information used to define, manufacture, and support products are stored, managed, and controlled. Typically, it is used to work with electronic files and database records, including the project schedule plan and the project resource documents. The functional view of CERN's CEDAR project [15], an EDMS for detectors and accelerators is shown below as an example of how such a tool operates.

6.3 Drawing and Writing

Drawing and Writing tools are just that: they allow a group of people to draw or write in a document concurrently. An example of a typical tool, the "Conversation Board" [2], is shown below. The important requirement in this category is WYSIWIS (What You See Is What I See). Other examples of such tools include XMX [1] and XTV[17], which essentially multiplex X displays between several user workstations.





7 Email and Messaging

7.1 Email

Electronic mail is the most widely used and platform-independent groupware system. It is the lowest common denominator collaborative computer tool.

HEP has made heavy use of Email for aeons, and it is not further treated here.

7.2 Usenet News

This is also widely used in HEP. Most Web browsers have built in News readers. It is interesting to note that the thriving market for dedicated Web conferencing products shows that News-capable browsers are not sufficient for Web-based conferencing. The conclusion is that the best interface for a news reader is given by a dedicated tool.

7.3 Bulletin Board Systems

These were mainly designed in the late '70s as dial-up systems dedicated to the exchange of files between people. There are Web-based BBS systems, such as WebLines [18], available. In general, BBS systems are not used by HEP, and their functionality is, in any case, completely duplicated by other CSCW tools.

8 Virtual Labs and Rooms

This category contains tools that allow users to enter virtual spaces, manipulate objects within them, and interact with other users "present" in the space. Typically, users are embodied as humanoid shapes called "avatars". Of course, the games market has been driving technology advances in this area. However, more serious applications are available, notably those which allow remote use of laboratory equipment (these are sometimes called "collaboratories"). The Distributed Collaboratory Experiment Environments (DCEE) Programme [8] is an initiative funded by the U.S. Department of Energy, whose goal is to allow remote manipulation of expensive and sophisticated laboratory equipment. Several projects make up the program. One good example is the AAEM/TPM project [20] which is an on-going R&D effort at Argonne National Laboratory to provide live video imaging and remote control of an electron microscope facility. Another is the remote control of the Advanced Light Source (ALS) at LBL for SpectroMicroscopy, a project which is also making use of electronic notebooks.

Apparently separate from the DCEE programme, UARC [4], the Upper Atmosphere Research Collaboratory, from the University of Michigan, is an application that provides access to real-time instrument data and provides support for a shared working environment among researchs that are conducting a weather experiment. The interfaces for this application have recently been re-written in Java, and allow multi-user Web access to view data on space weather.

Closer to home, the VENUS [5] project allows HEP physicist and engineers to navigate around 3D models of detectors and experimental areas. This is a powerful simulation which can be of invaluable use at the design stage, not to mention its power as a publicity tool.

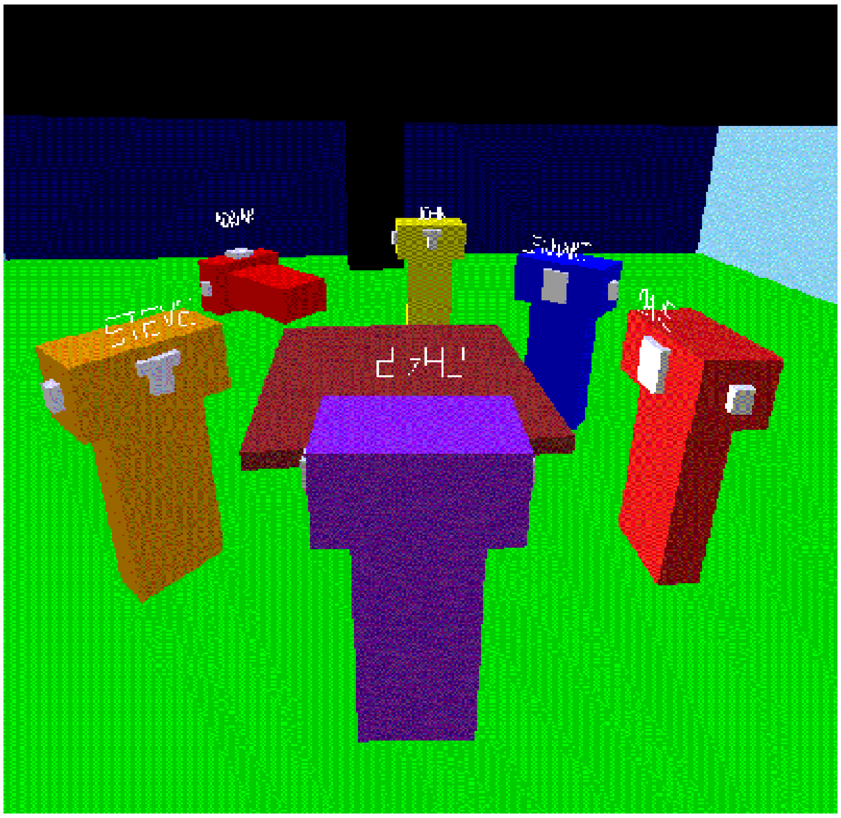
Why are virtual environments so compelling for CSCW? Because they provide the ability to present a large amount of information in a naturally navigable space, and they provide a context in which it is "natural" to observe several other people. Additionally, the interaction between the people and objects in the virtual space is easily understood and controlled.

One example of a multi-user virtual reality system is DIVE [3], the Distributed Interactive Virtual Environment, where participants navigate in 3D space and see, meet and interact with other users and applications. Another is the MASSIVE [7] system, whose features include networking based on IP multicasting; support for a new extended spatial model of interaction, including third parties, regions and abstractions, support for multiple users communicating via a combination of 3D graphics, real-time packet audio and text and an extensible Object Oriented (class-based) developers API.

The picture below shows an environment built with MASSIVE, where six conference participants have gathered around a table. Embodiments with ears indicate users with audio capability, those with "T"s embossed on their faces are running a text-only client. The "owner" of the supine embodiment has probably left his workstation in the real world and indicated this by lying down. (Such behaviour is unusual in real-world meetings.)

9 CSCW Futures for HEP

It is expected that CSCW tools will be increasingly adopted by HEP over the coming years. The need for tools that support collaborative work at a distance is evident when considering the size of new generation HEP collaborations and their geographical spread. Some areas of HEP work appear to be particularly amenable to the use of CSCW, such as meetingware and shared applications. By using already existing CSCW toolkits that support wide area collaboration, we can envisage the construction of multi-user event displays. Such displays could be operated by physicists located around the globe, all examining and analysing the same events concurrently. On a similar theme, the use of VR techniques and equipment should allow us to create systems



that enable physicists to meet around a real table, and view the events in a virtual detector that hovers above the table top. As the technology becomes more mature, flexible and commonplace, new possibilities for putting it to work for HEP will become apparent. The momentum of the industry in the direction of Web-based multi-party applications and games is going to make this sooner, rather than later!

References

[1] Bazik, John. "XMX - An X Protocol Multiplexor". Online at http://www.cs.brown.edu/software/xmx/home.html

[2] Brinck,T. and Hill,R.D. (1993). "Building Shared Graphical Editors in the Abstraction-Link-View Architecture". Proceedings of ECSCW'93 (European Conference on Computer-Supported Cooperative Work), Milan, Italy, Sep. 1993

[3] Carlsson and Hagsand, "DIVE - A Multi User Virtual Reality System", IEEE VRAIS, Sept, 1993

[4] Clauer, C. R. et al. "A Prototype Upper Atmospheric Research Collaboratory (UARC)," Visualization Techniques in Space and Atmospheric Science, E. P. Szuszczewicz and J. H. Bredekamp (eds.), pp. 105-112, NASA SP-519, Washington, D.C. 1995.

[5] De Gennaro, Silvano. "VENUS - A Virtual Prototyping Project at CERN". Online at http://www-venus.cern.ch/VENUS/vr_project.html

[6] Evard, Remy. "Collaborative Networked Communication: MUDs as Systems Tools", Proceedings of the Seventh Systems Administration Conference (LISA VII), pages 1-8, November 1993, Monterey, CA

[7] Greenhalgh, C., and Benford, S., "MASSIVE: a Distributed Virtual Reality System Incorporating Spatial Trading," in Proc. IEEE 15th International Conference on Distributed Computing Systems (DCS'95), Vancouver, Canada, May 30 - June 2, 1995, IEEE Computer Society.

[8] Johnston, W.E. and Sachs, S. "Distributed, Collaboratory Experiment Environments (DCEE) Program: Overview and Final Report, February 1997". Online at http://www-itg.lbl.gov/DCEE/

[9] Kumar, Vinay. "The MBONE Information Web". Online at http://www.best.com/~prince/techinfo/mbone.html

[10] Luotonen,A. and Berners-Lee, T. "W3 Interactive Talk". Online at http://wwwlab.cern.ch/WebOffice/wit/Overview.html

[11] Online at http://www.microsoft.com/netmeeting/

[12] Online at http://www.microsoft.com/netshow/

[13] Porte, J.P.. "CMSDOC Presentation". Online at http://cmsdoc.cern.ch/pictures/DOCtalk/TALK.html

[14] Roseman, M. and Greenberg, S.. "Building Real Time Groupware with GroupKit, A Groupware Toolkit". ACM Transactions on CHI, March 1996.

[15] Rousseau, Bertrand and Hoimyr, Niels. "CERN Engineering and Data Management System for Detectors and Accelerator". Online at http://cadd.cern.ch/cedar/Welcome.html

[16] Online at http://www.teamwave.com/

[17] "XTV - A User's Guide". Online at http://www.visc.vt.edu/succeed/xtv.html

[18] Online at http://www.pwrhouse.com/weblines./INDEX.HTM

[19] Woolley, David R.. "Conferencing on the World Wide Web". Online at http://freenet.msp.mn.us/people/drwool/webconf.html

[20] Zaluzec, Nestor J.. "Tele-Presence Microscopy & the ANL LabSpace (eLab) Project". Online at http://146.139.72.10/docs/anl/tpm/tpmexecsumm.html