EXPERIENCES IN DESIGNING THE HOHENHEIM CATeam ROOM

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ABSTRACT

While developing alternatives for the design of the Hohenheim CATeam Room, offering a computer supported meeting environment, a round room and conference table design were found to be most useful for the given facility layout and the requirements for the room at issue. The paper describes the design process and the experiences gained thereby by describing the evolution of the different design alternatives and specific fundamental issues concerning seating for teamwork and the arrangement of public screens, media usage flexibility and conference room workspace ergonomics.

1 Introduction

Little has been written about the process, isssues and problems of designing a meeting room for computer aided teamwork. This paper describes the experiences in designing such a facility, named the Computer Aided Team Room (CATeam Room), at the University of Hohenheim/West Germany. CATeam is viewed as a collection of concepts and computer supported tools to improve the productivity of group work through the use of information and communication technology.[1] The room is intended to provide a laboratory to research CATeam tools for the meeting phase of the teamwork process. In a joint research study interior and furniture design architects of the State Academy of the Arts in Stuttgart and information systems (IS) researchers at the University of Hohenheim cooperated to develop the CATeam Room.

2 Design Process

Steps of the CATeam design process conducted so far were to survey the facility layout, to determine the general CATeam Room and the conference table requirements, to generate design alternatives, and finally to test the favored alternative with a mock-up.

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[1] Krcmar, CATeam Framework 1989, chapter 3.1.

2.1 The Facility Layout

Often the exterior design of facilities that can be remodelled into a computer aided teamwork environment are given, thus constraining the design. It would be an even more interesting task to design such an environment, if the exterior design of the facility was variable, however, in the present case the CATeam Room's exterior design is a given factor.

The facility available for remodelling is located in the basement of a wing of the baroque-style Hohenheim palace. The room needs complete remodelling since it was not furnished at all but used for storage. Figure 1 presents a schematic drawing of the facility layout.

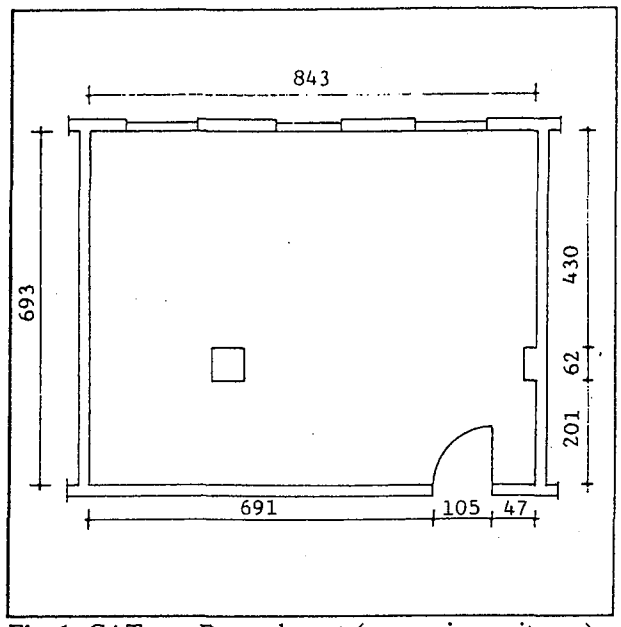

Fig. 1: CATeam Room layout (measuring unit: cm)

The room is 6.93m deep and 8.43m wide. Its total height is 3.52m, however, there are only 3.20m from floor to several suspended pipes which cannot be removed. There are windows on one side of the room which lead to light shafts. An unremovable pillar, 0.62m wide on each side, is located in the middle of the room. The existing entrance door can be relocated and widened. Even a second access from the corridor could be built, if deemed necessary.

2.2 CATeam Room Requirements

In addition to the physical restrictions of the given exterior design of the CATeam room presented above, further requirements for the interior design choices must be considered. These interior design details affect the performance of teams using a meeting room supported by information technology as their interface. Thus room design has to be considered as a controlled variable of later research into meetings and their dynamics.[2]

Design choices for the room were limited by:

(1) the requirements of the IS researchers concerning
- the basic assumptions of the research study,[3]
- the desired scope of computer support for teamwork,
- the physical characteristics of the room and its equipment,
- budgetary constraints and

(2) the desire of the design architects to create a unique room, easy to use, with a clear concept incorporating the IS researchers' requirements.

Particularly the following requirements of the IS researchers guided the design process:

(1) The room must provide an observation and a meeting facility.
(2) The observation facility must be accessible and functional and when not utilized not disturb meetings in progress. It can also be used to store equipment not necessary inside the meeting room.
(3) The observation facility must allow complete and unbiassed capturing of the meeting processes.
(4) The meeting room should accommodate a maximum of 10-12 participants.
(5) The meeting room must be functional for computer supported teamwork as well as for conventional meetings.

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[2] Mantei, Computer Supported Meeting 1989, p. 1 and Krcmar, CATeam Framework 1989, chapter 3.1.
[3] For details of the assumptions see Krcmar, CATeam Framework 1989, chapter 4.2.

(6) Each meeting participant should have immediate access to a personal computer. All personal computers are linked by a local area network providing communication capabilities and a video network, managing access to large public screen displays.

(7) Use of the personal computer should be optional. Each participant should be able to individually decide whether to use a personal computer or not.

(8) The monitor of the personal computer should not obstruct view and communication. Also, the personal screen should be occluded from "peeping" by other participants, thus providing privacy.

(9) Various conference situations (democratic, hierarchical), forms of teamwork (debate, presentation or parliamentary form of teamwork) and team sizes should be supported by room and conference table flexibility.

(10) Large public screens can serve as a focus point capturing the attention of the teams.

(11) Modern conference room equipment and technology such as a scanner writeboard, a document video camera, etc. need to be integrated.

(12) Two emergency exits are recommended for each room unit. Doors and light shafts with integrated stairs can be used for escape.

(13) The basement access corridor to the CATeam Room should be included into the design scheme.

Of high priority to the design architects were the following requirements:

(14) The meeting room and its conference table should be integrated into a homogeneous design.

(15) The concept of CATeam should be evident by the room's design.

(16) The meeting room should be designed as spacious as possible.

(17) Technical devices should be concealed, but not to the extent of generating a cozy atmosphere or boring neutrality.

It was intended to create a friendly atmosphere for teamwork in the meeting room by its design, offering smooth transition from non-information technology aided to information technology aided teamwork thus allowing an evolutionary approach of improving groupwork. Social interaction and communication among meeting participants should be maintained or even invigorated. The target user population of the CATeam Room are natural teams with members of the middle and upper management level of business organizations and university-affiliated groups (students, etc.).[4]

Preparatory work for the design included visits to group decision support systems (GDSS) research laboratories in the United States, visits to conventional conference rooms of major companies in the Stuttgart area [e.g. Bosch, Landesgirokasse (a bank) or Standard Electric Lorenz (SEL, a division of ALCATEL)], and a review of literature and videos about GDSS laboratories. Professors for psychology and ergonomics were consulted concerning issues in teamwork, the relationship between technology and humans and other factors relevant for the design.[5]

2.3 Conference Table Requirements

The conference table had to be integrated into the CATeam room's design. Each of the maximal 12 workspaces of the table has to accommodate a desktop personal computer with a 12 inch monitor, a keyboard and a "mouse". This equipment must be easily accessible and, when not in use, removing it should be simple thereby allowing computer supported as well as non-computer supported conferences and research into media usage of computer aided teams. Each participant should be able to view only his or her monitor and the monitors should not obstruct communication between participants. Arrangement of the monitors on the conference table should allow for glare reduction.[6]

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[4] In general, natural groups should be used for tool evaluation and student groups for feature evaluation. Krcmar, CATeam Framework 1989, chapter 4.2.

[5] For a report of the visit of the research laboratories in the United States see Krcmar, Besuchsbericht 1989. Acknowledgements are found at the end of this paper. For an introduction to issues in designing a computer supported meeting environment see Mantei, Computer Supported Meeting 1989.

[6] Analogous to Mantei, Computer Supported Meeting 1989, p. 10.

2.4 Design Alternatives

Starting with first sketches of ideas about conference table designs, several CATeam Room design alternatives were generated. For each of these alternatives the major characteristics and a short evaluation are presented in regard to the fullfilment of the requirements mentioned above.

Alternative 0: "Initial Conference Table Sketches"

Figure 2 shows some two- and three-dimensional illustrations of conference table designs. The round shape of the conference table evolved from metamorphosis of the popular trapezoid table segment design which is common in conventional meeting rooms.

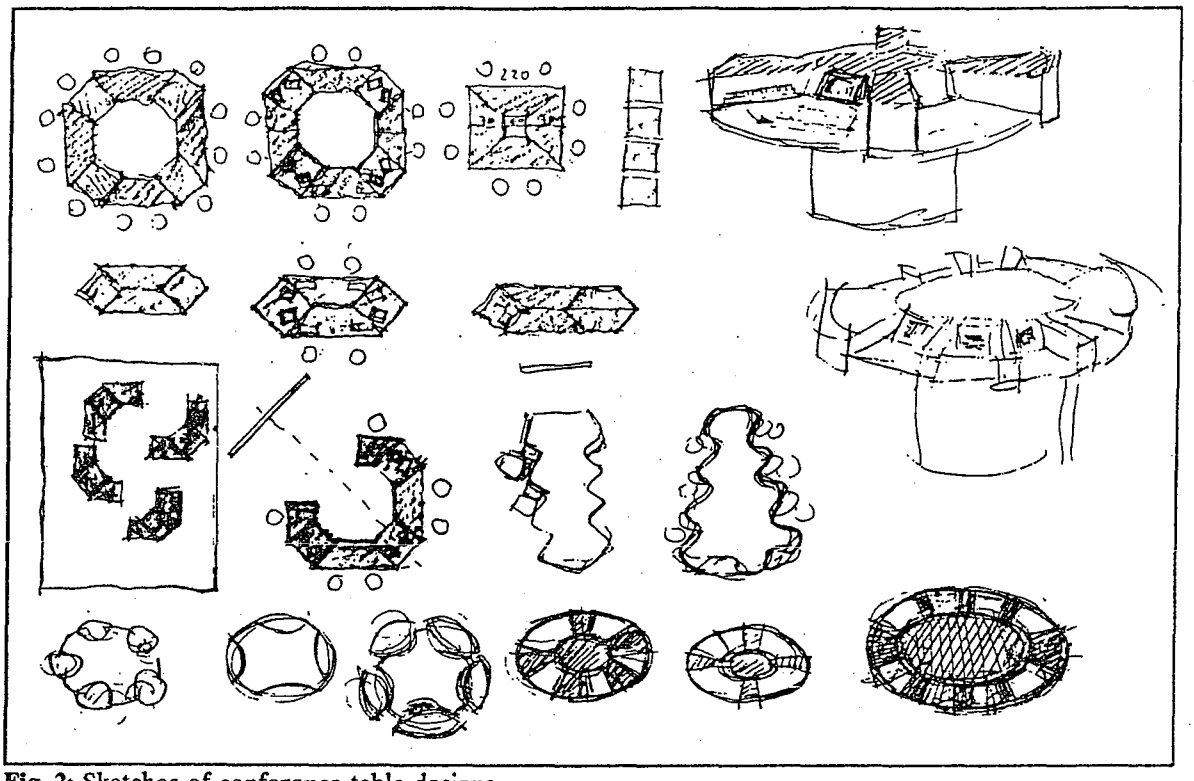

Fig. 2: Sketches of conference table designs

Alternative A: "Roman Church"

Characteristics: The cross-shaped layout of this meeting room design alternative, which is shown in Figure 3, resembles the layout of a Roman church. The impression of a comfortably large room is produced by the cross-shape and the pillar is not an irritating nuisance inside the meeting room. The conference table seating arrangement has a U-shape with an opening to the large public screen in the front. Observation is possible from one side and from the front in a sound-insulated partition of the facility which has its own access through a small entrance hallway. The hallway also serves as an access to the meeting room. The meeting room is elevated two steps from the ground on a double bottom designed for lifting up the participants physically and mentally when entering the room as well as to provide space for cabling.

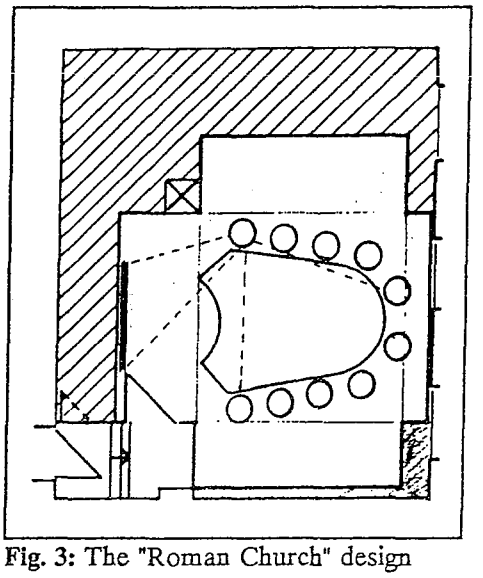

Fig. 3: The "Roman Church" design

Evaluation: Architecture, table design and seating arrangement support meetings with presentations and debates. The narrowness of the room is positively enlarged by "apses" on both sides. However, the U-shaped conference table design causes an implicit hierarchical structure in conference teams since the seating positions do not offer equal chances for drawing attention (and therefore power) to a participant's location nor do they offer equal meeting control and visual meeting room overview.[7]

Alternative B: "Hexagon"

Characteristics: The pillar is placed inside a hexagon shaped room as depicted in Figure 4.

Evaluation: The narrowness of the room only allows a maximum of 8 persons at the table. It is difficult to observe the meeting participants in the room from all sides and to make good use of its corners.

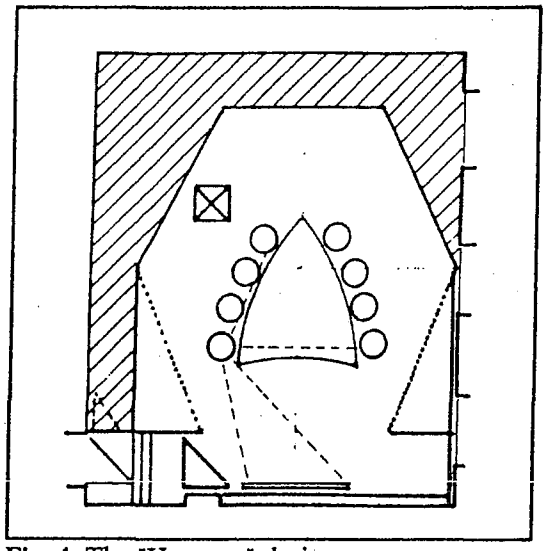

Fig. 4: The "Hexagon" design

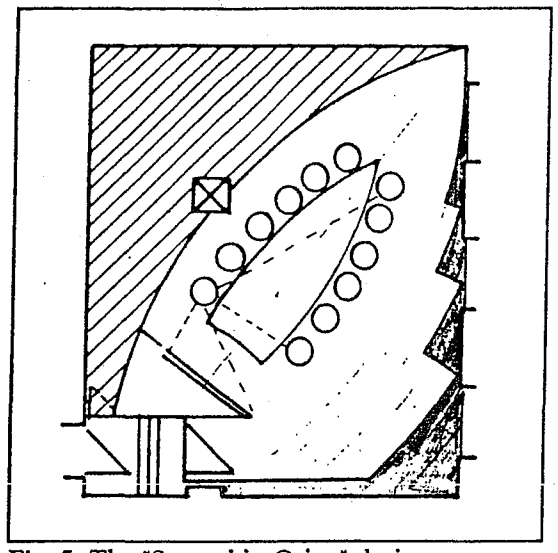

Fig. 5: The "Spaceship Orion" design

Alternative C: "Spaceship Orion"[8]

Characteristics: This interesting design shown in Figure 5 should demonstrate generosity by an elegant room layout with a swinging wall. The futurism of the V-shaped conference table, which is open to the large public front screen, adapts to the room layout.

Evaluation: The generosity of this design is hard to transform into reality due to limited available space along one side of the table and on the conference table desktop. Since there is no gradual evolution from conventional conference room layout, the abruptness of change of this futuristic design can enforce the use of personal computers. This potential of enforced information technology is not acceptable as it could adversely bias later research into computer and media usage.

Alternative D: "Bistro"

Characteristics: The design depicted in Figure 6 offers the impression of a "Bistro" atmosphere. Round, movable and self-contained conference table units on rollers are positioned in a U-shape around a cable-connection-hydrant in the center of a round meeting room.

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[7] Mantei, Computer Supported Meeting 1989, p. 13.

[8] "Spaceship Orion" is the title of a German television series of the 60ies, similar to "Star Trek".

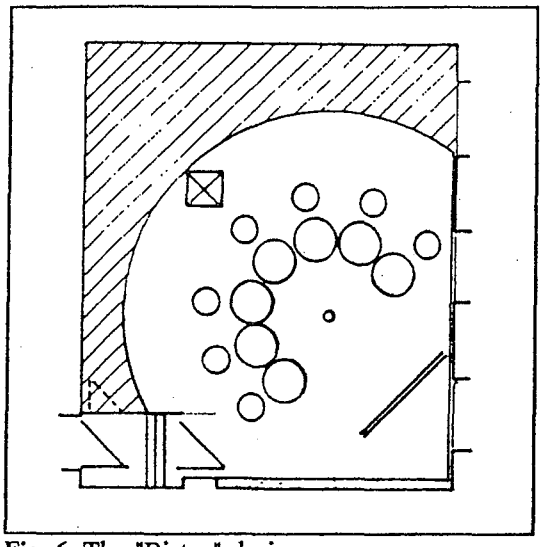


Fig. 6: The "Bistro" design

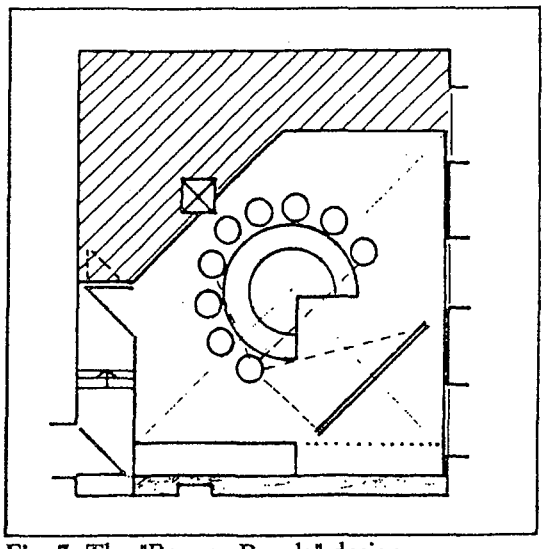


Fig. 7: The "Bonner Runde" design

Evaluation: The "Bistro" design offers a nice, "informal" working atmosphere. It seems to provide flexibility in adapting the CATeam Room to different group sizes since the units can quickly be moved in and out of the room and connected or disconnected from the supply-hydrant for one session. The seating arrangement also has greater flexibility and the formation of several small sub-groups can be supported. But the flexibility gained by movable units can create a sense of a provisional arrangement which can lessen the participants' motivation to work in this room. Furthermore, the movement of the units could require so much effort that the units will hardly ever be moved. Therefore, a stable table design is preferred. This alternative is rejected for further consideration, although the principle idea of movable workspace units on rollers connected to a supply-hydrant could be applied to improvements of regular office table design.

Alternative E: "Bonner Runde"[9]

Characteristics: An almost round conference table is placed in a hexagon room similar to the "Hexagon" alternative. The round table design should provide a more equal status of the meeting participants.

Evaluation: This alternative, shown in Figure 7, offers an acceptable design with a focus to the front screen. The front screen focus can cause an implicit hierarchical structure because of the same reasons explained in the "Roman Church" alternative.

Alternative F: "Classic Double"

Characteristics: As an improvement of the "Bonner Runde" alternative, this room is equipped with a classic oval conference table and two public screens on each wall of the longer table side. The layout is depicted in Figure 8. Visual access to the public screen is not obstructed as the screens are placed on the wall well above the heads of seated participants. As shown in Figure 9 there are three levels of viewing (monitor level, face-to-face contact with other participants and public screen level). In conventional meeting-discussions especially the desktop level and the participant-to-participant level are relevant. The addition of a third viewing level and the computer support creates a situation to which people quickly can adjust without irritation. According to a professor of perception science and semiotics and a professor for ergonomics we both consulted concerning this issue interlocking of all teamwork interaction is enhanced thereby.

[9] The "Bonner Runde" is a popular German television talk-show with prominent politicians and reporters to analyze results of elections.

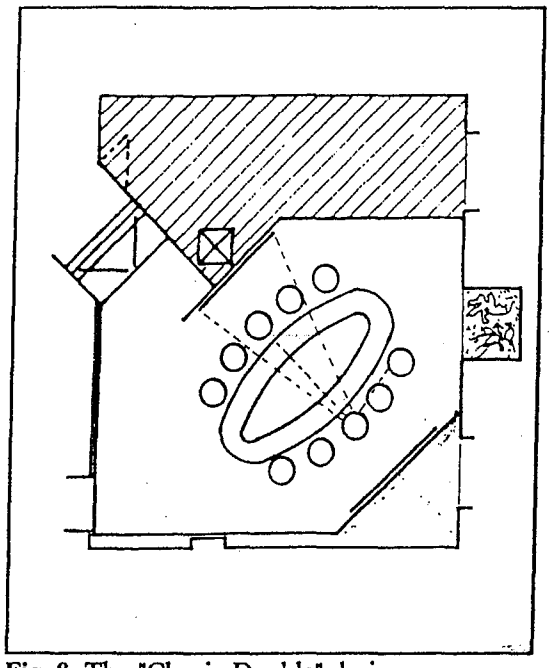


Fig. 8: The "Classic Double" design

The table shape is comparable with the design which was found to be useful for the Capture Lab, the computer supported meeting environment at the Center for Machine Intelligence, Ann Arbor.[10] However, the combination of the oval conference table design and the single public screen in the Capture Lab make a certain seating arrangement and personal monitor orientation necessary. Also, the Capture Lab design caused a hierarchy of the meeting participants because some seating positions at the table are more "powerful" than other positions.[11] The "Classic Double" alternative tries to avoid this effect with the two coupled public screens.

The computer equipment is incorporated and concealed in the table. When needed, the tipped personal monitors can be used after a cover has been pushed away. When not needed, the cover can be closed. In traditional, non-computer supported meetings in the CATeam Room, the computer equipment can be hidden from sight. The remaining small elevation in the center of the table is hardly obstrusive to eye contacts, non-verbal exchanges and verbal interaction among meeting participants.

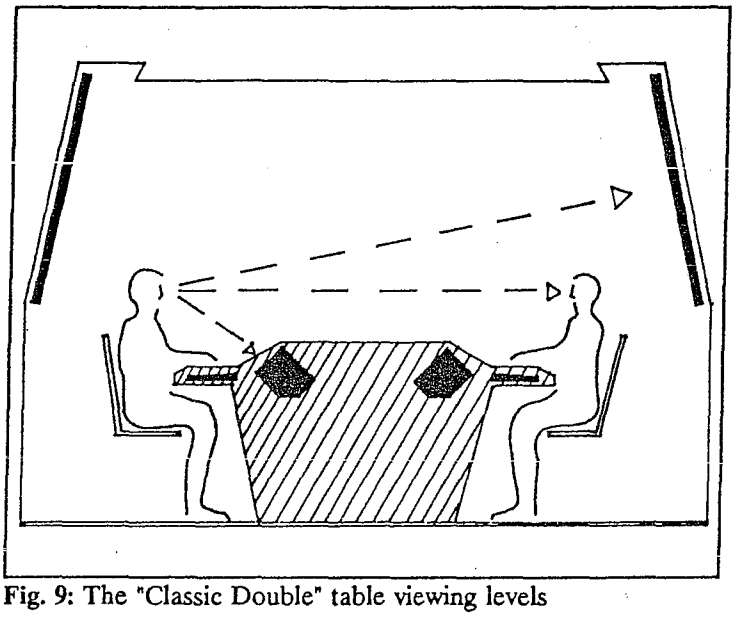


Fig. 9: The "Classic Double" table viewing levels

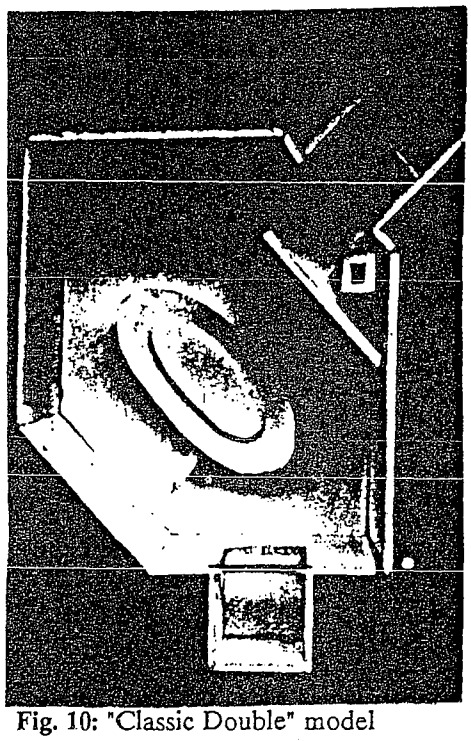


Fig. 10: "Classic Double" model

The room size is enlarged by using one of the lightshafts for a Chinese garden and the supply of some day-light. The main room entrance has been relocated and now offers a larger entrance hall useful for coffee breaks. A picture of a model of the "Classic Double" alternative is shown in Figure 10.

Evaluation: This room design makes good use of the available space. It is well suited for cooperation and debates since from each seat there is almost equal opportunity to view the public screen and actions in the room. The room entrance is separated so that no one is seated with their back to the entrance giving equal control of the entrance. However, the oval form of the conference table and the two opposite public screens

[10] Mantei, Computer Supported Meeting 1989.

[11] Mantei, Computer Supported Meeting 1989, p. 7-8 and p. 12-13.

could foster the creation of two opponent parties in meetings. This formation of coalitions could have a systematic adulteration effect on later CATeam research results. Meetings including presentations or training situations are not well supported by this design.

Alternative G: "Winging It"

Characteristics: Improvements of the "Classic Double" alternative intend to include support for presentations and training situations and to reduce the team polarisation effect of the opponent seating arrangement. A possible solution is to make one of the two wings of the conference table movable. The debate conference situation is supported when the two table wings are closed as shown in Figure 11. Both public screens are used and the center of the table is a focus point. When the two segments of one wing of the table are opened, as shown in Figure 12, presentations and training situations are possible. Team members are facing the speaker, who uses the remaining center segment of the former wing and the board with the public screen.

Evaluation: The movable conference table supports debates as well as presentation and training situations in the same room without additional equipment necessary. But the movement of parts of the table would interrupt conversation making it necessary to decide for one of the forms of teamwork before the meeting begins. Disadvantages are similar to those of the "Bistro" alternative.

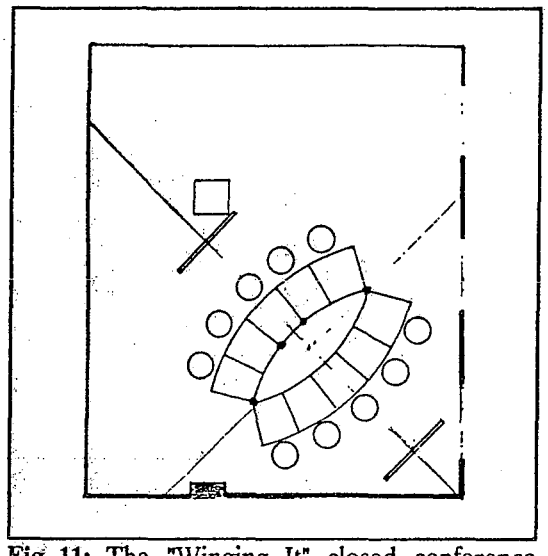


Fig. 11: The "Winging It" closed conference table version for debates

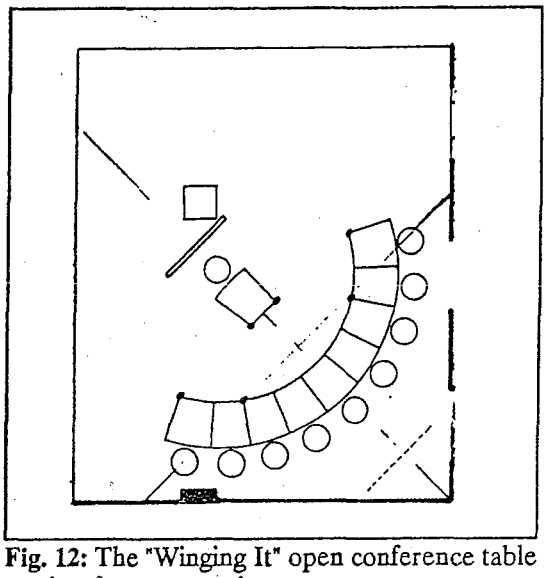


Fig. 12: The "Winging It" open conference table version for presentations

Alternative H: "Roundabout"

Characteristics: In our tests of workspace ergonomics, we found that the roundness of the conference table can be variable as long as the resulting outer diameter of the table does not exceed an acceptable distance from which people can be seated from one another. In small experiments with up to 10 team members, we could demonstrate that intense converations across the table can be sustained up to a distance of 4-6 meters if there is no interfering visual obstruction. The minimum distance at which we seated people next to each other around the table was about 1 meter. This amount of personal space was acceptable to the subjects in our tests and is consistent with results reported by Mantei.[12] Our study results suggest to modify the oval-shaped table design of the "Winging It" alternative to a ring-shaped table design with 10 unmovable segments depicted in Figure 13.

The shape of the conference table is reflected by the round layout of the meeting room with the axis "entrance-pillar-conference table". This room layout was already introduced in the "Bistro" alternative. By

[12] Mantei, Electronic Meeting Environment 1989, p. 10.

inscribing the greatest circle possible, a spacious design for the meeting room was achieved. The pillar is integrated into the meeting room with round panels which also reflect the shape of the conference table. The idea and advantages of two opposite public screens of the "Classic Double" alternative are picked up in this design alternative.

Evaluation: This alternative offers a homogenous room design and a "democratic" seating arrangement providing equal status to the participants by the ring-shaped table. From each seat there is a good view to one of the two public screens, face-to-face contact is enhanced, and personal monitors can be viewed only by the closest neighbor, if at all. A picture of a model of this alternative is presented in Figure 14.

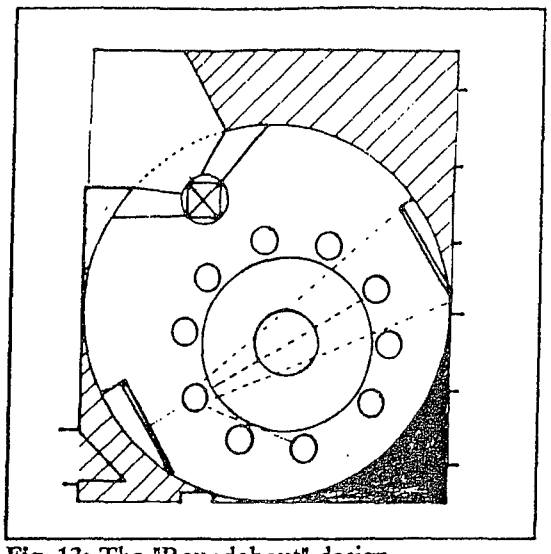


Fig. 13: The "Roundabout" design

2.5 Selection, Visualization and Testing

The proposed "Roundabout" design was selected as best alternative. For visualization and testing a 1:1 scaled mock-up of this alternative was built. Thus an impression of the future CATeam room was created. Figure 15 shows pictures of the CATeam Room metamorphosis from the cutting of paper webs to the mock-up.

During meetings in the CATeam Room mock-up, participants felt comfortable except for those sitting with their backs to the pillar and those facing the round wall. They complained about the lack of orientation possibilities. As an improvement, a recess of the wall was proposed, accentuating the diagonal room axsis. The participants had no problems with the distances to other participants across the conference table and to their neighbors.

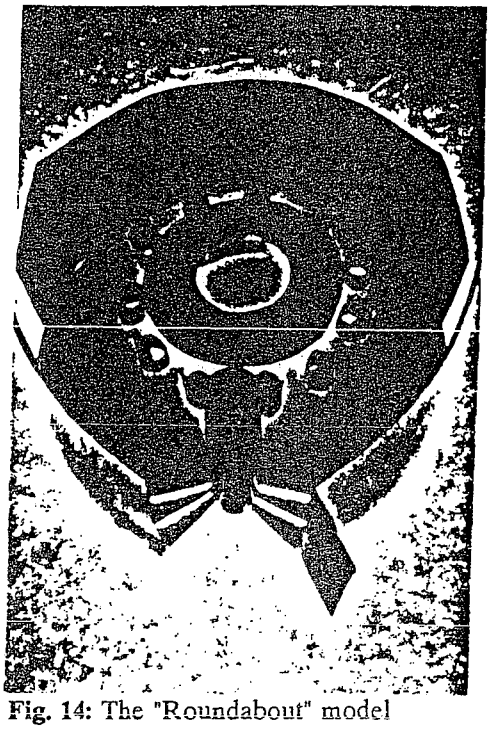


Fig. 14: The "Roundabout" model

3 Specific Issues

3.1 Overview

The discussion of the design alternatives showed that the most important issues and problems occuring during the design of a computer supported meeting environment are:

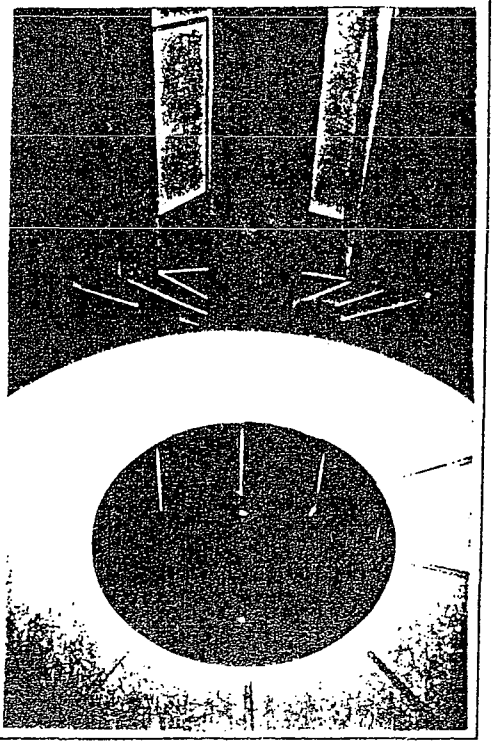
- the facility layout,
- the room aesthetics,
- the seating for teamwork,
- the arrangement of public screens,
- the observation requirements for non-participants,
- the flexibility of media usage for conventional and computer supported teamwork,
- the specific ergonomics of conference room work spaces and
- the flexibility of research designs.

The paper now discusses selected isssues that can aid the development of future rooms used for computer supported collaborative work.

Paper webs are cut in the corridor leading to the CATeam room.

Paper webs are suspended from the top of the room giving an impression of its height and showing the observation windows.

The conference table and a view to the entrance hallway.



The CATeam Room mock-up viewed from the entrance hallway.

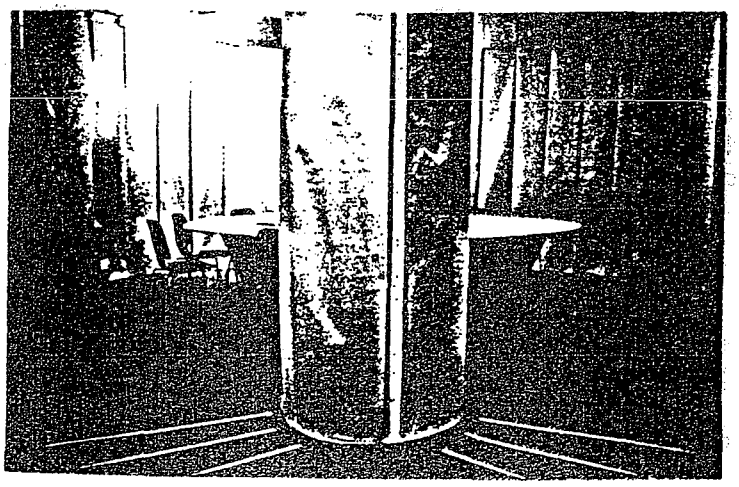


Fig. 15: CATeam Room metamorphosis

3.2 Seating for Teamwork and the Arrangement of Public Screens

Three forms of teamwork interaction in conferences have evolved from the design phase for the CATeam Room. When selected participants are the primary focus point for the conference-team, the form of teamwork can be characterized as "presentation" or sometimes "training". If all participants are actively engaged in a conference, small teams usually use a form of teamwork which can be named "debate". In a debate of small teams it is hardly necessary to sequence team member participation in advance. Debates can become more fluent by a process facilitator (moderator) and a technical facilitator (chauffeur or assistant). On the contrary, large groups often need to negotiate or implicitly agree on a protocol of member contribution to a debate in advance, designated facilitators are needed and speakers turn to "present" their teamwork input. This behavior is known from parliamentary forms of government and is therefore called the "parliamentary" form of teamwork.

Seating for teamwork has to be configured so that the various roles people play in the intended form of teamwork are supported by the physical arrangement of their workspaces and the public screens. Figure 16 shows the suitability of the different seating designs and the recommended number of large public screens for the different forms of teamwork.

Seating arrangement / Form of teamwork	Round-Shaped	Oval-Shaped	U-Shaped
Parliamentary-type	-	o	+
Presentation	o	o	+
Debate	+	o	-
Recommended number of large public screens	2	2 - 3	1

Legend: + = excellent suitability
o = reduced suitability
- = hardly suitable

Fig. 16: Form of teamwork and seating arrangement

The round-shaped seating arrangement is very suitable for debates.[13] Two large public screens on opposite sides of the room should be provided. The arrangement is then democratic because all positions on the table are of almost equal status. A single public screen leads to a focus of the team on this screen, just as it is forced in a non-debate-promoting U-shaped seating arrangement. Nevertheless, this arrangement can also be used for presentations if the speaker stands up, moves a little backwards (maybe to the public screen next to him) and the neighbors of the speaker turn towards the speaker. Suitability is limited to situations in which this behavior is acceptable. Parliamentary-type meetings, however, are not very well supported as there is no easy way to achieve moderator space. A higher number of participants quickly leads to large round tables disrupting cross-table conversations.

An oval-shaped seating arrangement, as it is used for example in the Capture Lab, can be used for debates but suitability is reduced because of the danger of coalition formation. At least two public screens on opposite sides are required to give equal ease of visual access to the public screens.[14] Presentations and parliamentary-type meetings can be performed with an oval-shaped seating arrangement, but an outstanding position of a speaker is difficult to provide. A speaker position on one of the two smaller sides of the oval can be used but suitability is limited because some participants have to move their chairs away from the table in order to face the speaker.[15] Also, a third public screen behind the speaker should be provided for his or her use. In presentations the team can focus on this third public screen, in debates they focus on the two others. Expenses for this solution are high because it is unadvisable to turn around one of the unused projectors of the two other screens and use it for display on the third screen. With every projector movement, a difficult callibration process of the optics and an interruption of the teamwork process is necessary.

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[13] See the "Roundabout" alternative description for details.

[14] See the "Classic Double" alternative description for details.

[15] Mantei, Computer Supported Meeting 1989, p. 8.

U-shaped seating arrangements support parliamentary-type meetings of large groups and presentations because a dedicated speaker position in front of the U-shape is available. One public screen will usually suffice. A debate can be enforced in this seating arrangement, but unequal status of the seating positions is implied. Because of the resulting hierarchical power structure, a U-shaped seating arrangement does not suit democratic debates.

At the Enterprise Room (the decision room for larger groups) and at the PlexCenter of the University of Arizona, Xerox Parc, the University of Minnesota, and the SMU (Southern Methodist University) decision room the typical U-shaped seating arrangement is used.[16] Although only one large public screen is provided, Mantei preferred the oval-shaped seating arrangement because it still allows parliamentary-type meetings and presentations to occur while at the same time it offers improved debate conference situations over the U-shaped arrangement.[17] For the CATeam Room, which is layed out for small teams usually engaged in groupwork processes using a hybrid of presentation and debate, the round-shaped seating arrangement with two public screens is of greatest value.

3.3 Media Usage Flexibility

Comparisons of conventional and computer-aided teamwork and hybrids of these to research productivity gains of information technology employment require flexibility in media usage and supply in the CATeam Room. The decision which media to use when in a meeting should be left in the hands of each individual participating or in the hands of the total group. Thus an evolutionary transition from conventional to computer-aided teamwork according to the need of a particular group and even of each individual, and according to the specific team-tasks is possible.

Flexibility of media usage can be achieved by giving immediate individual access to the desired information technology while at the same time devices not in use are concealed. However, nothing should be provisionally mounted or only temporarily available. This is inadequate as the percepted ease of media usage is not high enough. There is probably energy necessary and a threshold to overcome to switch to and between media. Some energy is necessary to prefer a change of media usage and even more energy is necessary to really use different media. It is thereby possible to distinguish between transitions to and from the absence of media support, single conventional media support, single electronic media support, and multimedia support.

In the CATeam Room teams should be offered a wide range of media support choices to enhance their media usage flexibility. Therefore many public information display areas must be integrated into the room's design. For the "Roundabout" alternative two large coupled public computer data, graphics and video information displays, an electronic write-board, regular white-boards, flip-charts and the personal monitors are considered. For the large public display a rear-projection system was preferred over the use of front-projection beamers, large TV-data-monitors, LCD displays mounted on overhead projectors, or public screen areas on each personal monitor, due to its in all superior image quality, applicability in bright environments, ease of implementation and maintenance. However, because of room size restrictions, front-projection as second best alternative was chosen since rear-projection systems consume too much space which we could not provide at present.

The arrangement of the different public information display areas could be one on top of the other or one beside the other if permitted by the available wall area and by room aesthetics. The second alternative is better to provide ease of media usage and simultaneous access to public information. A problem of both arrangements could be a person moving his or her body into the line of sight of team-mates or of the front-projected light-beam, especially when public screen information is used by some team members. A laser pointer or a software pointer for highlighting public screen areas can help and reduce interruptions of an on-going team conversation.

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[16] Dennis et al., Electronic Meeting 1988, p. 623-624; Stefik et al., Beyond the Chalkboard 1987, p. 33; Gallupe, DeSanctis, Dickson, Computer-Based Support 1988, p. 286; Gray, Technology 1987, Fig. 12; Krcmar, Besuchsbericht 1989.

[17] Mantei, Computer Supported Meeting 1989, p. 7-14.

3.4 Ergonomics of Conference Room Workspaces

During the design process of the Hohenheim CATeam Room we observed people working in a computer supported environment to acertain typical arrangement patterns of their workspaces and devices they use. Conference table workspace design in the CATeam Room should be adapted to these typical patterns and provide all the necessary devices.

Typically, workspaces can be empty when people communicate or think, used for keyboard input while reading monitor output, or used for hand-writing. While hand-writing people preferred to write with their paper in a straight, not in sloped position, in our tests. The optimal arrangement pattern at each individual workspace can differ during a teamwork process. Therefore all these arrangement patterns should be supported on the conference tables and switching between them should be easy.

We found that the desktop of work spaces in conference rooms offering computer and other information technology support needs to be large enough to accommodate at least a monitor, a keyboard, and a ring-binder or a stack of papers. Complementary are a "mouse", a personal disk-drive and switches or infra-red remote control units for direct control of electronic conference room devices such as the large public screens, video equipment, or light adjustments. One central console for these switches is less desirable in "democratic" meetings in which participants should be equally equipped. Otherwise someone has to take over the operator job thus forcing the team to commit itself to a power structure in this respect. Also, the movement of one person to the switching console forces an interruption of debates. A solution for this problem, which is easy to customize, is to have a networked software front-end (even in multiple languages) of the central console with context sensitive switch- and presetting-selection-menues allowing keyboard or touch-screen input at each workstation.

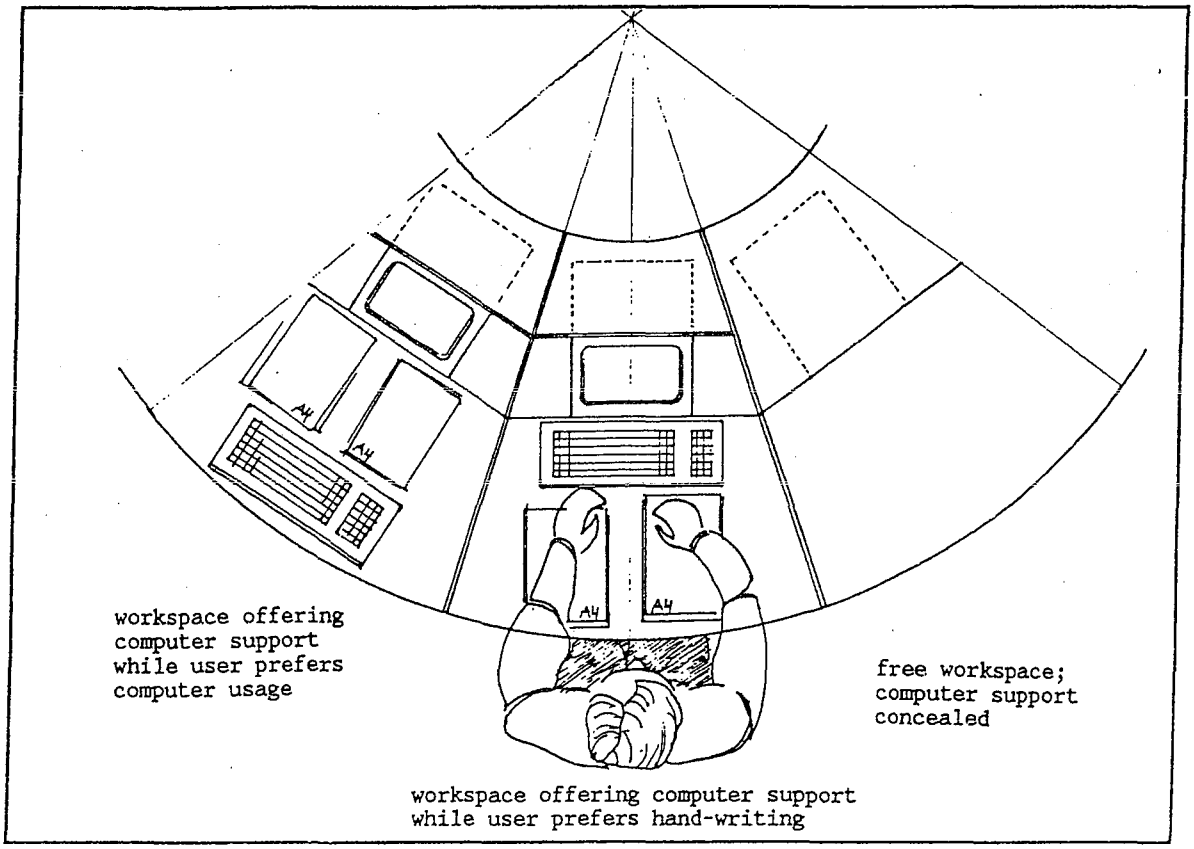

Fig. 17: Conference table workspace ergonomics

Our solution for the desktop of the conference table workspace segments, regarding the findings presented above, is shown in Figure 17. An empty desktop as it is usually provided for conventional meetings, is available when the personal monitor, the keyboard and "mouse" are moved into the table body and covered by a flap. When computer support is available, the monitor usually is furthest away from the meeting

participant. His paper documents and keyboard can be switched back and forth depending on whether computer usage and keyboard input or handwriting is predominant. Each workspace needs to be 95 cm deep to provide sufficient space for papers, the keyboard, the monitor and perhaps even a coffee cup. Each workspace can be distinguished from its neighbor by a small strip of different color.

The profile of the conference table design shown in Figure 18 demonstrates that the table leg is retreated to reduce the mass of workspace unit and to increase the available legroom.

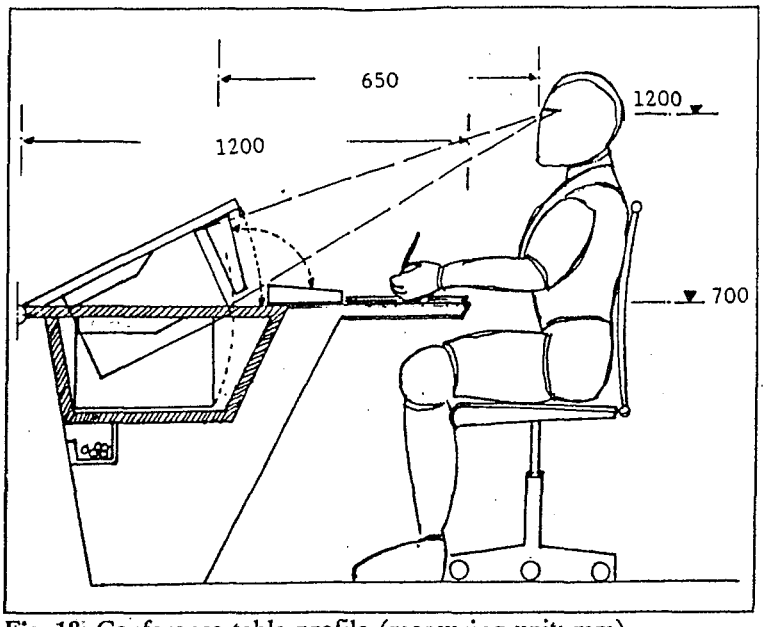

Fig. 18: Conference table profile (measuring unit: mm)

4 Possible Research in the CATeam Room

The Hohenheim CATeam Room will be used to answer the following research questions:[18]

1) How can work in teams be supported, coordinated and improved by the use of information and communication technology (ICT)?
   How could these changes, especially productivity gains, be measured and evaluated?
2) Which changes in (classic) meetings are possible through ICT use?
   Which changes in (classic) meetings are necessary for ICT use?
   Which changes in (classic) meetings result from ICT use?
3) How do certain tools work and are they acceptable to the users?
4) To what extent can results of empirical studies performed in the US be applied to Europe, especially West Germany ?
   Do studies need to be replicated due to cultural differences?

We expect to provide new tools to the knowledge worker and to develop an understanding of group work and how it can be supported with the use of information and communication technology.

5 Conclusion

The development of computer aided teamwork environments requires careful design considerations. The "Roundabout" design for the Hohenheim CATeam Room presented in this paper evolved gradually from first design sketches oriented toward traditional conference room settings while encorporating more and more requirements of such an environment. This required a joint effort of IS researchers and interior design architects to create an innovative design which tries to tempt teams to prefer working in a computer aided team environment rather than a prerequisite for more efficient and cooperative teamwork.

During the design process it has been necessary to consider that different seating and public screen arrangements favor different teamsizes and forms of teamwork, that flexible media usage has to be provided by the reduction of the amount of energy necessary to switch between media, that ergonomics of conference room workspaces should be oriented on user needs and that research questions guide the development effort.

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[18] Krcmar, CATeam Framework 1989, chapter 4.2.

6 References

Dennis, Alan; George, Joey; Jessup, Len; Nunamaker, Jay; Vogel, Douglas: (Electronic Meetings 1988)
Information Technology to Support Electronic Meetings.
In: MIS Quarterly, vol. 12 (December 1988) no. 4, p. 591-624.

Gray, Paul: (Technology 1987)
Using Technology for Strategic Group Decision Making.
Working Paper of the Claremont Graduate School, Claremont 09-10-87.

Gallupe, R. Brent; DeSanctis, Gerardine; Dickson, Gary W.: (Computer-Based Support 1988)
Computer-Based Support for Group Problem-Finding: An Experimental Investigation.
In: MIS Quarterly, vol. 12 (June 1988) no. 2, p. 277-296.

Krcmar, Helmut: (Besuchsbericht 1989)
Besuchsbericht Sommer 1988: Labors für Computer-Supported Cooperative Work Forschung in den USA. Internal working paper of the IS Department University of Hohenheim (West Germany) 1989.

Krcmar, Helmut: (CATeam Framework 1989)
Considerations for a Framework for CATeam Research. Paper submitted to the EC-CSCW '89. University of Hohenheim (West Germany) 1989.

Mantei, Marilyn: (Computer Supported Meeting 1989)
A Study of Executives Using a Computer Supported Meeting Environment. Center for Machine Intelligence, Electronic Data Systems Corporation, and Computer Science Department, University of Toronto. To be published in DSS 1989.

Stefik, Mark; Foster, Gregg; Bobrow, Daniel G.; Kahn, Kenneth; Lanning, Stan; Suchman, Lucy: (Beyond the chalkboard 1987)
Beyond the Chalkboard, Computer Support for Collaboration and Problem Solving in Meetings.
In: CACM, vol. 30 (1987) no. 1, p. 32-47.

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