Commercial Meeting Solutions: Where we are and where we are headed

Christine Perey
President, Perey Research and Consulting
c/o IDIAP
Rue du Simplon 4
Case Postale 592
CH-1920 Martigny, Switzerland
+41 (0) 79 436 68 69
cperey@perey.com

Charles H. House
Director, Research Collaboratory
c/o IR5 Office Building
Intel Ireland Ltd.
Collinstown, Leixlip IRL
001-702-360-6926
charles.h.house@intel.com

ABSTRACT

This paper describes products and technologies that enterprise customers can purchase and deploy to enhance the non-verbal and verbal human communications of employees during their meetings with remote participants. After descriptions of specific solutions, the authors focus on frequent bottlenecks that hinder natural interaction, and then outline some approaches being taken by researchers and manufacturers to address the issues.

Three broad categories of end user products are available to enhance realtime, on-line human-human visual communications:

→ hardware-intensive room/group video communication systems for bringing together groups of people in two or more locations. This large category includes telepresence systems at the high end, high definition room systems, standard group conference room systems, interactive white boards, and small video-conferencing appliances for meeting rooms and individual desks

→ specialized software running on industry-standard computing platforms with general purpose audio and video capture for use by individuals or groups. This category includes an array of "webconferencing" solutions which integrate voice and video into a personalized virtual meeting experience

→ personal mobile handsets with all appropriate hardware and software for visual communications by individuals integrated into a single system. These systems are multimodal in the sense that they transmit and receive voice and video.

In addition to devices directly in contact with end users, assorted network hardware and software which support special features in the previously mentioned categories represent a complex and essential piece of the puzzle. These digital networks are crucial to the successful system operation.

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When not sharing the same physical space, people fail to receive many non-verbal cues which are essential for instantaneous transmission of important information such as attention and emotional state. Some people have adapted their behavior to compensate for gaps in context or experiences which are inconsistent with face-to-face communications. The authors describe a number of human needs and compensatory behaviors during remote meetings, and suggest directions for new technologies to overcome them.

Categories and Subject Descriptors

H.4.1 [**Office Automation**]: Collaboration Systems

General Terms

Management, Performance, Design, Experimentation, Human Factors

Keywords

Collaboration, video-conferencing, presence, meetings.

1. INTRODUCTION

Improvements in information technology processors, architectures, devices, machines, networks, peripherals, applications and software for both computing and communications capabilities have transformed not only personal, business and entertainment morés, but much of the work flow and structure of societal infrastructures – in governments, institutions, and organizations. Individuals, groups, institutions, event nations once quite removed from the loci of creativity, intellectual contribution, and economic power can now participate. Outsourcing, offshoring, and shifting of work centers are more practical than ever imagined – many strategic shifts are happening in industries as well as societies around the globe with lightning speed. Thus, the effectiveness of ***collaboration*** becomes ever more important, often in fact the critical success factor for many of these activities [1].

A few key technologies created this remarkable transformation. Dramatic silicon advances have brought computing power within reach of both small companies and individuals. The Worldwide Web provides an extensive portion of the world's knowledge to anyone able to connect. Fiber-optic networks have radically altered the cost of connection, especially for high-

speed connection at a distance. And finally, wireless networks and inexpensive mobile telephones have solved both "the last mile" bandwidth problem and the lack of wired (whether fiber or copper backbone) infrastructure.

One problem, though, is still vexing. *S*erious tools that allow sharing of perspective, workload, application, and mood have not moved ahead at a commensurate pace. While e-mail, Instant Messaging and document sharing have improved greatly, analog teleconferencing systems from twenty years ago offered more multi-mediated capability, higher quality audio and video signals, and a better "virtual presence" than most of today's digital replacements. A simple videotape then served as a better archive of the event than most digital alternatives available today. Most conferencing systems today make key assumptions about the structure of the groups who seek to collaborate – and those key assumptions are still primitive and increasingly mis-aligned to the realities of much current work. Fortunately, the research community and the product marketplace are active, and new capabilities are unfolding. This paper will describe current products for collaboration, and then assess areas of high potential contribution where researchers and developers might best focus their efforts.

2. Current Products

2.1 Hardware in the room

Specially-designed, hardware-intensive room/group video communications systems bring together groups of people in two or more locations with the highest visual and audio accuracy available to date. The systems range from custom designed, immersive "telepresence" systems at the high end, to high definition or standard definition conference room systems, usually with interactive white boards, and at the other extreme, small videoconferencing appliances for meeting rooms. Experiences with these systems vary with the applications for which they are used and the expectations of the users.

In general, the customer's selection of the solution has less to do with how the people in the room interact than with the dimensions of the room and the budget available for the purchase. Telepresence systems costing over $100,000 per location include liquid plasma, displays from table top to ceiling, special compression and decompression hardware, and software that requires a specialist to operate. These are considered appropriate for only the most elite of board rooms, strategic emergency response or military "war" rooms and some time-critical medical applications. Although they tend to be delivered and managed as technology "silos" within an enterprise or institution, several dozen of these rooms are equipped by highly trained audio/ video engineers every year.

In contrast with the "studio quality" experiences, systems which manufacturers refer to as "business quality" are available for approximately $5,000 to $20,000 per unit. These systems, provided by companies such as Polycom, TANDBERG and Sony feature modular architectures, standard "television" quality cameras, easy to use interfaces with remote controls, and support for introduction of documents or presentations. Despite early problems with interoperability, usability and reliability, group videoconferencing systems continue to be popular among distributed teams with the need to see remote meeting participants between face to face meetings. The systems are easily integrated into an existing information technology department's management systems and typically are managed remotely with relatively low overhead. Several thousand group videoconferencing systems are sold to businesses around the world each month.

In addition to group videoconferencing systems, networked digital white boards are also commonly seen in business meeting rooms where videoconferencing systems are deployed. SMART Technologies, fore example, supplies a turnkey unit that allows remote sites to see and make modifications to information introduced manually or by computer on the surfaces of the white boards. The educational and learning segment was the first to adopt electronic whiteboards widely; however, large enterprises are increasingly including the hardware as meeting participants request support for shared "spaces" during their collaborative sessions. Advances in design, manufacturing and software are reducing the purchase price and making such systems affordable to even medium sized businesses.

2.2 Software at the desk

A second important category of collaborative tools is provided to meeting participants in the form of desktop software installed on business computer platforms, most commonly Windows-based PCs. This category of collaborative technology is also very diverse, ranging from simple "point to point" solutions with just document viewing capabilities to systems supporting unlimited number of participants in peer to peer networks with full duplex audio, video and interactive document sharing.

Most frequently, technologies implemented on the business users' desktop computer are managed by a central information technology (IT) department and is used exclusively with others in the same company. A variety of security measures and addressing issues prevent people in different networks, even when connected to one another by the Internet, to exchange audio and video or documents with one another in real time. Examples of software designed for use in enterprise for desktop collaboration include Microsoft Office Communicator with Microsoft Live Communications Server, and RADVISION's Click to Meet platform with web clients and servers. Other products often in use are Webex for multi-mediated conferences, or NetMeeting to share PC desktops with all meeting attendees. SharePoint is one of several products that provide a Document Repository for a group to post files, documents, and work assignments.

The virtual participants in meetings connected by desktop collaboration platforms frequently must adapt their behavior to meet the limitations of the technology. User studies have shown that the video window is frequently hidden (covered up by other open applications, taking up bandwidth in the network without benefit to the participants. In addition, audio quality in some cases is insufficient to support real time collaboration. Users commonly "fall back" to audio conference bridges for important discussions or negotiation.

3.0 Future Products – the Problem Statement

Global expansion, outsourcing, competitive pressure to do complex projects more efficiently, and increased focus on work-life balance drive the need to collaborate more effectively. In today's turbulent economic and political environment, robust methodologies are vital to support company functions and activities, especially the effectiveness of the teamed knowledge worker across time and space.

While Collaboration Tools have become *de rigueur* for virtual team performance in multi-national companies, their design metaphors, functionalities, and capabilities were designed for much simpler tasks. Today's team collaboration products do not seamlessly support enterprise scale multi-teaming, or business process and application integration. Under serious usage, they are limiting for enhancing true team productivity, because of a number of design presumptions: single-team long-term membership "inside the firewall" is assumed; shared toolsets, time zones, and calendar are presumed; while important friction points such as language and cultural barriers, not to mention organizational barriers, are usually unaddressed. Fluidity between asynchronous and synchronous collaboration modes within a single environment is especially difficult.

3.1 Potential Breakthrough Areas

Focused contributions could really help vis-à-vis:

1. *"presence"* – for either physical attendees of a virtual meeting, or for asynchronous *"meetings"*
2. coordinating and managing either a succession of meetings for one team, or a steady stream of parallel collaborative teams, or both
3. sharing applications rather than just documents
4. automated archival / retrieval / analysis capabilities

Each of these areas has a set of criteria regarding the essential elements of contribution. Research on many individual aspects has proceeded with some enthusiasm over many years, but systems that exhibit significant clusters of capability have been remarkably absent, either in experimental test-bed form or in commercial offerings. We will examine current efforts for each.

3.1.1 Presence

3.1.1.1 Presence for virtual meeting attendees

As noted above, most virtual meetings today use an audio bridge, shared documents via *Webex* or *NetMeeting*, and occasionally something such as *SharePoint* services [2]. Voice is incredibly rich and nuanced; people can easily detect and appreciate either enthusiasm or ennui in a speaker's tonality even as the same words are spoken – high-quality audio bridges serve this requirement well. On the other hand, everyone has experienced the disarming situation where the spoken word and even voice intonation is contradicted by the person's facial or body language. Many expressions have emerged in most cultures that bespeak the value of the close physical presence with its multiple visual, auditory and tactile cues to supplement the words being said – *"seeing is believing", "look 'em in the eye", "he has a firm handshake"* . . . Visual presence even offers a partial answer to the question of different tongues – smiles can do wonders to help build confidence and trust, even as spoken and written words must go through a translator. Thus it is not surprising that the *picture phone* has been the holy grail for those seeking to *"be there while still being here"*.

Video conferencing systems, though, for all of the enthusiasm and desire, have repeatedly fallen short of the promise. *Latency* is a major issue; the *"lip sync"* problem, where the sound track is delayed by a different amount of time than the visual image, is more subtle but no less distracting. Off-axis camera placement on many systems meant that you could only see the other person's eyelid, never their eye – building unperceived distrust into every meeting. Low-bandwidth connections ensure that image quality is primitive, while sudden movements frequently cause pixel breakup. Tools in this space have been sporadically deployed; even broad installations have been seldom utilized. Some angrily rue their purchase, and vow never to try again [3].

Fortunately, the new systems offer significant progress. Broadly speaking, they can be categorized under four headings:

1. Better *meeting presence* – *e.g.* Hewlett-Packard's *Project HALO* [4] or France Telecom's *Equant "Real Meeting"*.[5]
2. Better *immersion* into a scene – *e.g. 3D Caves* [6] or UCSD's *Reality Flythrough* [7]
3. Better *3D environmental* presence – *e.g. heads-up* displays or *Elumens* workstation [8]
4. Better *meeting participant awareness* – *e.g.* Microsoft's *Ring Cam* [9]

Hewlett-Packard's system, in beta release, has drawn rave reviews from initial users, primarily for its lifesize, realtime, photographic quality imaging of the virtual attendees. Latency and lip sync loss are virtually undetectable for meetings held even half-way around the globe. One normally critical observer noted:

> *"The bar has been raised on high-end videoconferencing. This setup was exceptional, and especially notable for its natural feel. Our Intel genes tell us to focus on the meat, but the HP folks have clearly spent a great deal of time on the trimmings…many subtle details in room setup, lighting, etc that contribute to a very human-friendly experience* [10].

Each of these systems affords much greater image quality, much more *realism*, and significantly enhanced near-realtime interaction compared to predecessor systems. Just as costs are plummeting for high-definition plasma and LCD display technology for television, teleconferencing costs will lower greatly as users adopt these newer metaphors. While most of the approaches on this list are relatively expensive *in situ* solutions, some – *e.g.* the Microsoft solution – are aimed at quasi-mobile meeting structures. Thus, these high-end systems seem to offer much for a select audience, even if they aren't the panacea for most situations. It is easy to postulate every facility having one or a few rooms equipped with this capability for those important negotiations or high-priority problem solving situations. For the bulk of meetings, however, other solutions are demanded.

3.1.1.2 Presence for Asynchronous Virtual Meetings

Most collaboration systems, including nearly all of those mentioned above, are constructed around the assumption that two teams of people, geographically separated, need to meet periodically to synchronize their views and co-ordinate their work. But as companies have shifted to offshored, outsourced organizations, the *"teams"* in question have morphed considerably. And with the sizable increase in mobility, plus working from home, the notion of "sited" capability becomes more and more limiting.

This state of affairs has led researchers down a different path – trying to discern the most troubling issues with meeting effectiveness. Frequently the first problem encountered is "can the meeting be scheduled?".

The toughest meetings to schedule are not necessarily those with the most people, or even those with great distances between two sites – but rather, meetings where four, five or more geographic sites are involved. Three major factors are at work here:

1. People are increasingly mobile; as laptops and cellphones and Blackberrys have proliferated, they can work virtually from anywhere – and they do.
2. The team has fragmented, and members may be in five or six locales. It is harder to find a "common time" to meet as the number of different team members increase; harder still as the number of local time zones increase. The hardest is when the team is spread "around the world" – and cultural norms and languages add their own level of hindrance.
3. The team may not have sole allegiance to the company – some are suppliers, some are suppliers to the suppliers, and some are partners, but all are involved in "the project". Another truism in an outsourced world – tomorrow many of the "team members" may be working with a competitor as well.

Recent research in several arenas has been focusing on questions pertaining to these new team definitions, and issues that arise as a result. One study found a surprising shift: more than two-thirds of the company's employees are participants on teams that cross multiple sites. Moreover, two-thirds of those who participate on multi-site teams do so with three or more teams concurrently, making the scheduling problems exceedingly complex [11].

Several studies have documented the increasing scheduling difficulty encountered as a function of the number of different sites. This is particularly hard to schedule when the teams are separated by large latitudes rather than longitudes (*e.g.* Canada to Brazil is further than New York to London – time zones, not distance, is the issue)[12].

These findings suggest that more emphasis on effective asynchronous meetings might be well placed. While such a suggestion might sound like an oxymoron, it is intended as a serious quest. For example, most meetings have a series of routine occurrences – a. status reports; b. issues; c. action requests; and d. voting – as well as a series of unstructured deviations, such as reaction to a new discovery, problem, or a serendipitous connection between hitherto unrelated thoughts.

It might be quite possible to design asynchronous supporting tools that automatically aggregate – by team – the routine elements ahead of time (and during the meeting) so that someone coming into the meeting late, or not even joining until tomorrow, can find all of the relevant information re the routine material. Threaded notes or *persistent IM's* could be generated by those at the virtual meeting that flag the critical input for the asynchronous member who "join" several hours later. Answers from that member would be fed back to the thread creators, and all who chimed in along the way. While analogous to email or Notes threads, the critical difference is that it is done automatically, in the team workflow context, with full supporting documentation. Thus, itt is akin to process workflow software, but it is designed for malleable, open-ended discursive situations rather than constrained operational procedures [13].

Another area of study for asynchronous meetings is the role of camcorders and camphones and voicemail to leave a "current message" complete with context – *"here's where I am, and what I'm doing"* – which we might postulate can help to build trust, perspective, and empathy, all qualities that are hard to do historically even for virtual meetings which everyone attends. Several companies have deployed software that helps people to create their own *ePersona*, in effect a short-form personal Blog. For team members who may never meet face-to-face, these are surprisingly helpful in initial phases of a team formation, to help build camaraderie and spirit [14].

3.1.2 Co-ordination of multiple meetings and groups

Designing an environment for a person who is a member of multiple teams – most of which are wholly inside the corporate firewall, but some of which are not – is the major requirement for this new metaphor of the distributed team worker. First of all, the environment has to present its user with a contextual perspective of all of his or her workload. This *contextual view of a person's entire workload* means that the environment must be aware of all of the conflicting action items for which the worker is responsible, and it helps define and design prioritized timelines that enable meeting the multiple, incessant needs of the various teams.

A key ingredient of this *personal environment* is the individual's personal profile – showing the interplay of multiple meetings, calls, assignments, but also offering access to personal goals, needs, and interests. The design intent is that the total environment has to be both comfortable for the user and embracing for his or her full range of needs – otherwise, the environment will likely be *visited* rather than *lived in*. Experience shows that this leads to less and less utilization. Enticement is the goal, for a satisfying experience over time.

Secondly, whenever a specific team environment is invoked, it has to present a fully contextualized representation of that team – all the way from *"Who is on the team"*, to the *Action Items* and *Time-Line* of the project, along with a rich corpus of automatically indexed and searchable materials that have been accumulated by the group. The value of the richness of this team space cannot be understated – custom design environments are dramatically more utilized in Intel's experience than "out-of-

the-box" solutions today; the difficulty is that no company can really afford to perpetuate a full set of "custom capability".
Another problem under-represented in current systems, that begs to be addressed, is the fact that most professionals multi-task; more than half of Intel's workforce are involved with half a dozen major teams weekly. How this actually happens is that interactions happen with three or four different groups daily, sometimes even hourly. While many studies suggest that such context switching is a significant detriment to productivity, the fact remains that this has become both habitual and necessary for many employees – they seemingly have no choice. So the question really must be: "can tools be designed for truly easy multi-tasking? Fortunately, initial evidence is positive [15].

Finally, as the amount of materials accumulate, it is important that the environment be able automatically to merge, fold, update, and index the suite of materials that exist amongst all of the projects underway, including useful materials held by other team members that have not necessarily yet been shared.

Seeking to address some of these daunting issues, Intel's Research Collaboratory is experimenting with a *3-D Collaboration Environment*, modeled on the Intel *Miramar* and *VCRT Concept Car* metaphors. *Miramar* is an extension of *Grand Canyon* developed at MIT's Media Laboratory, whereby any individual serving on multiple teams with multiple projects has a highly interactive and gracefully supported environment for each project, either in parallel or sequentially.

Documented modestly when first developed, *Miramar's* key attribute is the provisioning of a 3-D work environment, with attendant near-far zoom capability to bring work of interest – files, documents, images – close for inspection or iteration, or send them to a miniaturized background, still visible in a contextual setting, but out of the way for the moment [16]. This work has been piloted with various flat-screen metaphors, all the way from a handheld PDA device to a 6-screen "wall", plus the Elumens shell. Preliminary results have been published [17].

The VCRT team designed a Flash Demo *"environment"* as a *Concept Car*. Figure A illustrates the opening screen for the resultant demo. Note the member icons, with name, home nation and organizational association. The timeline shown is for project deliverables, along with assigned roles of each member. The cluster of spheres in the upper right corner is the total projects for one member of the team.

Fig. A – Top Screen for VCRT demo
The Flash Demo was then built into two DVD streams, one playing for 10 minutes with full narration, and the other a brief 3 minute excerpt. The longer version was shown to the IT Staff just before the annual planning cycle began; the response was electric. People were captivated; requests to have their own copy of the DVD multiplied, and the CIO showed it widely, both inside the company and externally. Focus groups arose, and interest in Collaboration requirements peaked as a result. The goal is to stimulate the vendor community to address these topics with product introductions that more clearly meet the needs of these widely distributed "teams".

3.1.3 Application sharing
Napster and Grokster did more than cause a legal stir with the music industry. The notion once prevalent in computing circles of a parallel Peer Network Operating System has become a dream once again for researchers and developers alike. This peer network system would provide the backbone "shared services" layer for a uniquely powerful interactive model for collaborators to share applications rather than just documents.

Project Croquet investigations going on at the University of Wisconsin, University of California at Berkeley, and the University of Minnesota in conjunction with Alan Kay's Viewpoints Research Institute are one experimental approach to this goal [18]; the *Grid Computing* challenge put forth by Ian Foster and others in Europe is another compelling avenue [19].

One major goal of peer network sharing is to embed a deeper understanding and utilization of computationally rich data into the skill base and decision-making process of collaborators. Quantitative analytical visualization techniques could be taught and utilized much more widely, particularly in the social sciences and in medicine.

Edward Tufte's first book on visualizing data is nearly 25 years old – yet computing equipment that allows social scientists, physical scientists, and medical practitioners ready access to such analytical tools are virtually absent except for a few home-brew systems [20]. So, one piece of the vision for better collaboration would be to stimulate much more experimenting with and sharing of graphical analytical techniques. Seymour Papert posed an apt question forty years ago: *"What if there were a Math-land, like there is a France-land?"* Every one except French children, he noted, *knows* that French is hard to learn, but French children master it well [21].

How might such a goal be pursued? Since such a *Math-land* today has few masters, effective outreach and stimulation is a paramount requirement. In environments with scarce talent, the question always has been how to leverage that rare commodity. Sharing applications rather than simply sharing PowerPoint slides or Word documents seems a powerful place to start.

3.1.4 Better than Being There
Most collaboration-system users view the tools as useful for a meeting, with little thought about enhanced services. This is

truly unfortunate, but it is a natural legacy from much of what people have learned from school and business for years.
Many vendors are beginning to use a phrase *"better than being there"*, and it is in fact a bit of a double entendre. Certainly there are those who try to convey the notion that if you can see the person nearly as well as if you traveled to meet them face-to-face, you've saved the cost and the hassle of traveling, not to mention the time that can be devoted to other work (including other virtual meetings). This point of view has considerable merit, as well as marketing appeal. But we believe that there is a more profound manner in which this can be viewed. That view is the notion that truly more effective work can be accomplished – better answers will result, more quickly, more easily, cheaper.

Three examples might help to demonstrate this:

1. Stanford Distance Instructional TV for engineers
2. Hewlett-Packard's beta test group for CAE software
3. Dialogic Corporation executive team decision-making

3.1.4.1 Stanford Distance Learning

Today many distance learning environments are built around the premise that self-paced study is effective enough to be considered an adequate solution. Few are built around the notion that it can be truly *"better than being there"*. Yet the clear finding of Stanford's Honors Co-operative program with the Distance Learning TV Network was just that – students got consistently better grades in courses of great complexity when they never attended class, but used the off-campus tools and approach. Lots of analysis followed this surprising finding, with the main conclusion being that access to archived, retrievable course lectures, coupled with a colleague who could help interpret the material, was a key determinant [22]. To put this in context, the *experiment* was with 15,000 students over 30 years – primitive tools yielded lower grade point averages about 0.7 grade points lower than on-campus students for five years; the best tools produced higher grades by nearly 0.7 grade points over a fifteen year period. Not only statistically compelling, this says the *off-campus students really learned the material.*

3.1.4.2 Hewlett-Packard CAE Beta Test

HP built an early wide-area beta test group – essentially inviting all of the company's design engineers to wring out new CAE offerings before they were offered to the market. The first time this was done was nearly catastrophic – the group collectively voted "NO" on the products. The Group Vice President was incensed, pronouncing the use of a company-wide Internet (in 1985) for such a purpose to be the most seditious act he'd ever seen. He first tried to have the network disassembled; he then ordered the products released to market. The marketplace, over a much more protracted period, gave substantially the same answer as had the internal "team". Correlation later of the two groups of feedback was stunningly consistent. As one might hope, the company kept the network, and the executive left [23].

3.1.4.3 Dialogic Executive Staff Decision Making

The third example was a two-year study of one hundred weekly staff meetings with the executive team for Dialogic Corporation, a NASDAQ 100 company headquartered in New Jersey. Over the two years, records were kept of the involvement of each staff member (15 people) as a function of their presentations and their questions, comments, and critique during the typical three hour meeting. Half of the staff was "off-campus", at some seven total locations on four continents. For the first year, collaboration tools to support the staff meeting were minimal. The second year added an early version of Webex, full-duplex Polycom telephones, whiteboarding, and aperiodic videoconferencing.

Involvement from non-local members more than doubled on average with the better tools. The most surprising number when the data was compiled was the percentage increase in "NO" votes – nearly 600% more often. Analogously to the HP CAE example, this wasn't greeted with uniform enthusiasm – the vote often was in conflict with the goals and desires of the CEO. The CEO, a bombastic hard-charging individual, had little history of reliance on a staff for corrective input. Interestingly, however, the company's decision-making, especially with respect to sales in world markets, seemed to strengthen when "locals" were able to "have their say". But until the tools, they had been unable to "have that say" with any degree of confidence that they could be heard. Once they felt empowered, they seized the opportunity. The collective opinion of a seasoned team was that it mattered, in fact it mattered a lot [24].

3.1.5 Automated archival / retrieval / analysis

"Better than Being There" effectiveness is enhanced greatly by both the quality of the attained and the retained knowledge. Most collaboration tools try to fulfill the attainment goal; very few focus on the retainment. To a degree, Knowledge Management tools have been created with the expectation of helping to retain community knowledge. But the knowledge needed by the team is often ephemeral, nuanced by the interactions of the team members in a very situational way. It is this knowledge – somewhat implicit, usually transitory in nature, that has enormous if somewhat opaque value. A good example of this kind of knowledge might be the knowledge that can be gleaned from software enhanced analysis of a photographed sporting competition, in virtually any sport.

Dartfish, a Fribourg, Switzerland company; has redefined the use of analytical video comparison. It builds a set of kinesthetic analyzer capabilities and tools which are quite interesting. Originally developed for sports video analysis, the company has expanded its application focus into the Arts. A remarkable statistic from the 2004 Summer Olympics – 85 of America's 103 Medal winners used the Dartfish Training software, providing endorsements as strong as the following:

> *"If a picture is worth a thousand words then Dartfish is worth a thousand pictures! I believe that The Dartfish Motion Analysis Software Program has completely redefined the future of all athletic training environments. It decreased the time required for our skiers to internalize their skill levels and move rapidly forward toward enhancing them. The time spent with their coaches has become significantly more productive and efficient. In comparison, simply placing athletes in front of a television for 'video' could be compared to coaching in the stone age* [25].

Observing the value that Dartfish brought to the sports competitor seeking to improve skills, several research teams have pondered the value of doing similar archival recording of meetings. Two groups that have built extensive experimental test kits are Stanford and IDIAP.

3.1.5.1 Stanford DIVER project

Better multi-mediated "comparative analysis" was the goal of Stanford's DIVER project. Conceived by Roy Pea, developed over a three year period, this ambitious project originally aimed to figure out how to repurpose video for classroom learning environments. The value for corporation collaboration, though, is that the techniques developed are rich in capability for meeting dynamics post-review – *e.g. why didn't you support me, as you had agreed to do before the meeting?* As many as five multi-media streams are captured for a meeting, after which they can be compared, snipped, and collated into a new "event master" focused on one or a few elements in the meeting [26].

Obviously, in order to be effective for a virtual team, such an experimental toolset would have to be developed with an automatic archival / retrieval capability for multi-media annotations and analysis. Storage, perhaps ephemeral over a week's period, would allow any synchronous or asynchronous participant to retrieve any segment, or more importantly, to compare the reaction of any two participants to time-synced sequences. Coupled with voice-to-text extraction and auto-indexing files, this could provide sharp focus and much better insight into participant involvement and interaction. It is expected that such capability could be instructive in terms of helping to organize and run more effective meetings and teams.

3.1.5.2 Augmented Multi-Party Interaction (AMI)

The AMI project, jointly managed through IDIAP (aligned with the Swiss Federal R&D laboratory) in Martigny, Switzerland, and the University of Edinburgh, offers just such an integrated approach. Five digitized cameras with 72^{o} field of vision capture the meeting participants, along with time-coded directional speech tracks. Film editing tools then allow correlation and juxtaposition of faces so that the facial and bodily reaction of any participant to the comments of any speaker can be compared. Preliminary experimental results with the system reveal that greatly enhanced event analysis is obtainable from the system [27].

It is not a natural act to record meetings in business. In many ways, it is antithetical to the instincts of business leadership. Concern about possible litigation, invasion of privacy, or just discovery of ineffective styles and methods are typical emotional responses. And yet, the gains from understanding more about the process of effective and ineffective meeting morés seems well worth the time and effort, particularly if the effort could be minimized through automated tools. Why would meetings where arcane issues and elusive information is trying to be imparted be considered more likely to work than a lecture hall on a campus with a prescribed script and procedural approach to the problems being presented?

Obviously more work is needed for automated capture and digitization; better extraction tools are sorely lacking. But the most important conclusion perhaps is to realize that research along these lines could well be the most important incremental step that can be taken toward providing "better than being there" capability for the hosts of folk now getting immersed in the collaboration world in order to get their jobs accomplished.

4. CONCLUSION

The Collaboration world is undergoing change, in response to very compelling and different requirements than were imagined but a few years ago by the designers of the current set of tools available to companies with groups who must meet at a distance.

New morés are being codified, and new metaphors of effective collaboration are being established. Toolsets are evolving to serve those needs, and much current research is experimenting with new modalities of decision making and context awareness.

The result can only be positive for those who seek to develop computing enhanced capabilities that help to fulfill one of mankind's most cherished dreams – "better than being there".

5. ACKNOWLEDGMENTS

Our thanks to the various vendors cited in this report. No specific endorsement of products is intended or implied; many other vendors offer equivalent capability, and anyone seeking to purchase and deploy systems of this type should do their own independent evaluations and assessments.

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