Virtual Workspace Technologies
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Emerging technologies enable virtual and distributed teams to communicate — and innovate — more effectively. Arvind Malhotra and Ann Majchrzak

Multinational companies increasingly rely upon the work of virtual teams to manage their global intellectual assets and encourage innovation. Spanning functional, geographical and corporate boundaries, virtual team members work together on various projects but are based in different locations nationwide or worldwide. Virtual teams allow companies to leverage their global expertise, take the pulse of diverse markets, promote broader participation in key strategic decision making, increase job flexibility, lower travel costs and pool the knowledge of experts (Majchrzak et al., 2004a). The current economic and socio-political climate has made frequent face-to-face meetings a thing of the past, and because displacing functional and regional experts from the centers of their expertise is often problematic, many executives seek technological solutions to help their virtual teams maintain and sustain essential links. E-mail and conference calls have, until recently, formed the backbone of communications support for virtual groups, but these rudimentary technologies have been found to encourage miscommunication and the loss of crucial contextual information. Can e-mail and audioconferencing adequately support virtual teams, or do they need new technologies that assure a richer communication flow between participants? Research attention has begun to focus on how technologies mediate communication among virtual team members and suggests what technological features might be best suited to different work and cognitive situations.

The Need for Context

Much of the earliest research on support for virtual teams has focused on the use of technologies such as e-mail and audioconferencing, informed by a theory referred to as “media richness” (Daft and Lengel, 1986). Media richness theory argues that some technologies allow more cues to be shared than others; according to this theory, e-mail allows few cues to be shared and is thus very constraining, while audioconferencing allows a few more cues (such as tone, pauses and recognition utterances) but constrains referential integrity (such as when the speaker points to what is being talked about for emphasis, prioritization and focus). In addition to the lack of cues, e-mail exchanges often lead to what has been referred to as information asymmetry, when members engage in a one-to-one e-mail exchange not distributed to the entire team or when someone is intentionally or unintentionally left out of the e-mail list. The use of e-mail also often leads to information overload, resulting in messages being deleted without being read. In addition, teams using e-mail and audioconferencing often fail to share critical information about the context underlying a message, such as why information needs to be shared, the reason why a person didn’t respond, the background behind decisions made or alternative viewpoints on an issue. As a result, members of virtual teams who are exclusively using e-mail and audioconferencing struggle to generate the common ground necessary for understanding each other’s communications (Clark, 1996). Misattributions about motives and behaviors frequently arise when members misinterpret what others say or don’t say, and they misconstrue silence as acceptance rather than dissonance.

Some researchers have argued that users can overcome some of the constraints imposed by e-mail and audioconferencing through the development of practices and norms of use (Markus, 1994). Nevertheless, sufficient problems in communication remain, leading researchers to conclude that for tasks requiring many cues, such as negotiation and conflict resolution, face-to-face communication is preferable to using e-mail and audioconferencing (McGrath, 1991; Maznevski and Chudoba, 2000; Hinds and Bailey, 2003; Cramton, 2001).

As long as face-to-face meetings are considered a viable backup plan when virtual team communication goes awry, however, virtual team members tend not to engage fellow members online in critical debates that spark innovation, delaying collaborative interactions for more infrequent face-to-face conversations (Majchrzak et al., 2004a). In addition, team leaders count on members to serve as remote outposts for the team. A reliance on face-to-face meetings transplants experts from their local situations, thereby impairing the very source of their expertise — their local knowledge.

Alternative Workspaces

Instead of relying on e-mail and audioconferencing, firms are increasingly employing richer media that provide more cues. Loosely described as “virtual workspaces,”

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these technologies include such features as electronic whiteboards and collaborative document editors that enable members to see where others are pointing and gesturing; instant poll capabilities to gauge member opinions on issues under discussion; instant messaging for quick, pointed personal and back-channel communication; calendars for joint scheduling; a common repository for sharing documents (which can be organized by the team’s processes and/or their task assignments to facilitate document retrieval); discussion threads for conflict identification and resolution; links within discussion threads to documents that facilitate retrieval; annotations within documents to identify the owners of particular perspectives; and version control and change tracking capability to trace the evolution of a document (Greenberg and Roseman, 2003; Bordetsky and Mark, 2000; Kraut et al., 2002). Often, videoconferencing is not integrated into the virtual workspace because many team leaders assert that the technology shifts the focus to talking heads rather than on shared artifacts (such as documents and drawings).

The advent of these virtual workspaces has only recently made it possible to examine the effect of an integrated set of support tools on the work of virtual team members. A team at Intel Corp. that we observed during our research provides an example of the effective use of virtual workspaces. The team, comprising nine members from Israel, the Philippines and the United States, crossed both human resource and information technology functions. Team members agreed to route all information through the virtual workspace rather than through e-mail. The workspace included a full range of functionalities — from links to search features to discussion threads to document annotation capabilities. In addition, the team made extensive use of synchronous tools, using an electronic whiteboard for real-time brainstorming and synchronous application sharing for collaboratively editing documents onscreen. They also used technology-based meeting aids, such as a raise-hands function when someone had questions during a virtual presentation and a silent-voting function to determine if there was consensus among meeting participants to end a discussion and progress to the next topic.

More recent research examines how the communication needs of virtual teams are facilitated by specific technological features of virtual workspaces. For example, instant messaging has been shown to help virtual team members build closer ties by helping participants engage in informal communication, thus creating a feeling of virtual co-presence (Nardi et al., 2000). Virtual team members also have begun to utilize IM in a polychronic mode — using IM while also engaging in other activities such as audioconferencing — making its use more effective. Researchers also have pointed to features of some virtual workspaces that help to organize the evolving documents of the virtual team, as well as how sophisticated search mechanisms can
be used to retrieve documents (Bordetsky and Mark, 2000).

Still others have taken a more comprehensive approach to analyzing virtual workspaces, classifying features that virtual teams need to bolster work-space effectiveness in two theory-based dimensions: support for multichannel synchronous communication, such as electronic-whiteboard application sharing, IM and audioconferencing; and support for maintaining a persistent record of knowledge over time, such as a central knowledge repository with search mechanisms, threaded electronic discussions and hyperlinked documents (Greenberg and Roseman, 2003; Majchrzak and Malhotra, 2004). Functionalities within each dimension support different communication needs in order to create common ground among team members. Multichannel synchronous communication supports the

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**Referenced Research**


Majchrzak, A., and A. Malhotra, *Virtual Workspace Technology Use and Knowledge-Sharing Effectiveness in Distributed Teams: The Influence of Team’s Transactive Memory*, working paper, University of Southern California, Marshall School of Business, Los Angeles, 2004. Describes how a virtual team’s mental map of expertise drives the use of virtual workspace features.


Majchrzak, A., A. Malhotra and R. John, *Individual Know-How Development in Distributed Teams Through IT-Enabled Contextualization*, working paper, University of Southern California, Marshall School of Business, Los Angeles, 2004b. Discusses the matching of information technology support with type of task being performed by virtual teams.

Malhotra, A., A. Majchrzak, R. Carman and V. Lott, “Radical Innovation Without Collocation: A Case Study at Boeing-Rocketdyne,” *MS Quarterly* 25, no. 2 (June 2001): 229-249. A case study outlining the practices of a highly successful innovative interorganizational virtual team.


need for all members to share information by allowing rapid feedback that clarifies issues and provides referential integrity with a common document or drawing. Maintenance of a persistent record for the team enables virtual team members to understand the context of information as they see other team members sharing the information, and it aids them in revising their own ideas accordingly, in full view of the team. Contextualization is supported by virtual workspace features that highlight annotations others have made to documents, link summary and detailed documents to connect an overview with its associated details, allow members to contribute informal documents and comment on others’ contributions, and attach evolving keywords to contributions to make retrieval easier (Boland et al., 1994).

Different component features of the virtual workspace — for example, multichannel synchronous communication or a persistent record of knowledge — might be needed under different circumstances. In particular, the value of each dimension may be determined in part on the basis of the pre-existing “mental map” that the team has developed regarding the expertise each member provides. If the expertise of each virtual team member is well understood by all (as might be the case in an outsourcing arrangement), it may be possible to use simple e-mail (especially in the case of highly homogeneous teams). However, when expertise is only partially understood (as is the case with innovation-oriented teams), features that keep track of shared knowledge by incorporating contextualized information is likely to be quite valuable. Further, when tasks faced by virtual team members are nonroutine, such as new product development or strategic planning, research has shown that the greater the number of features supporting contextualization used, the more knowledge that virtual team members gain from teammates, enabling them to perform nonroutine tasks (Majchrzak et al., 2004b).

Finally, in cases when the expertise of virtual team members is poorly understood (such as when teams have changing membership), multichannel synchronous support allows members to immediately clarify issues related to unclear cues and language.

Measuring Benefits
Measuring the reciprocal gains obtained by companies that use these technologies is one method of justifying their expense. For example, in one study, a team using a virtual workspace designed a thrust chamber for a new rocket engine, raising the quality of the final product while reducing its costs. With only six component parts instead of the usual hundreds of parts, the thrust chamber obtained a predicted quality rating of 9 sigma (less than one failure out of 10 billion) instead of the traditional 3 sigma (66,807 defects per million), at a first unit cost of $50,000 and a predicted production cost of $35,000 (both below the millions of dollars usually spent). The virtual team was able to achieve all of this with no member serving more than 15% of his or her time on the team (Malhotra et al., 2001). In addition to increased innovation, teams using virtual workspaces have increased the speed and quality of decision making, especially in such difficult situations as mergers. These gains have been traced back to enhancements in knowledge sharing that are provided by the virtual workspace. Through the use of appropriately designed virtual workspaces, know-how about solving problems can be more effectively developed among team members, timely information can be more effectively shared and disagreements can surface and be discussed earlier. Therefore, the efficacy of virtual workspaces now in use may be better measured by taking into account the more immediate effects on knowledge sharing rather than ultimate team outcome measures. Team leaders must bear in mind that the use of virtual workspaces per se cannot cause behavioral change; it is the employees themselves and how they utilize the virtual workspaces that create impressive gains, especially as manifested in innovation (Majchrzak and Malhotra, 2003).

Assessing Future Needs
Today’s members of virtual teams are no longer at the bleeding edge of collaborative support. Integrated into virtual workspaces, technology features now exist that enable members to stay close to their local situations while engaging in global activities critical to their company’s sustainability. Managers need to understand that collaboration limited to face-to-face, e-mail or audioconferencing communication can impair their companies’ ability to derive competitive advantage from the pooling of global expertise.

Additional research on the value of virtual workspace technologies in enabling effective virtual team communication is still evolving, and there are many questions that remain unanswered. What functionalities of virtual workspaces are effective when the team’s mental map of expertise is poorly developed and the global nature of the team prohibits significant use of synchronous communication? How do the social conditions of the virtual team members, such as social identity and trust, influence the use and impact of virtual workspaces? Are there some ways of organizing these workspaces that facilitate knowledge sharing better than others? Will the next wave of virtual workspace functionalities, such as concept mapping and intelligent agents, help virtual team members anticipate others’ reactions to their ideas beforehand, thereby initiating collaborations that would not have occurred otherwise? As the use of these technologies becomes ubiquitous for global companies, research will begin to investigate how these issues will alter the virtual workplace of the future, and how globally focused companies can best utilize the emerging virtual workplace to their strategic advantage.

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