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UNDERSTANDING VIRTUALITY IN A GLOBAL ORGANIZATION: TOWARD A VIRTUALITY INDEX

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Abstract

"We are getting more virtual all the time!" was a phrase frequently uttered during recent planning sessions for remote collaboration support at Intel Corporation; some form of this statement is no doubt made in other global firms as well. But what virtual *comprises is not well understood. The construct of virtuality cannot be directly measured, so* how *virtual and how fast the stated change is occurring is mostly an enigma. Certain high level metrics of corporate information infrastructure can give indications, but much of virtuality is not obvious. The lack of definition makes it hard to understand the impact of virtual work on performance, or to evaluate the infrastructure and collaborative toolset needed to support distributed knowledge workers. Building on the concept of discontinuities, or factors contributing to a decrease in cohesion, we propose a virtuality index to assess the degree to which virtual work occurs and the pace at which this phenomenon progresses. The index was derived from data gathered in a study with sound psychometrics of over 1,200 employees at Intel Corporation. Preliminary analyses suggest that work predictability and general sociability (on or off teams), along with a range of media for expressivity and visualization can mitigate the consequences of working in discontinuous environments, while discontinuity of practices (e.g., more cultural and work process diversity) and worker mobility negatively impact the perception of team performance. Being distributed in and of itself was found to have no impact on team performance. These findings, along with others yet to be analyzed, promise to give us a handle on how the discontinuities of working virtually can be most effectively supported with collaboration tools.*

Keywords: Virtual work, virtuality, discontinuities, collaboration, distributed teams, global firm, Intel Corporation

Introduction

It is now widely assumed that corporate knowledge work requires collaboration with people who are not collocated. This virtual work environment poses unique challenges for workers. Workers collaborate electronically with coworkers or with employees of other companies, frequently relying on information and communication technologies (ICT) in place of face-to-face meetings

(Lipnack and Stamps 1997). People may work with multiple teams distributed over different locations. Some of the participants never meet face-to-face.

While virtual work is endemic in global organizations today, it is difficult to find a definition that is applicable across multiple contexts. Among the ways researchers have defined virtual work are outsourcing key components of production (Kraut et al. 1999); temporary *ad hoc* teams assembled from diverse locations to solve problems (Jarvenpaa et al. 1998); temporary *ad hoc* assemblages of professionals who team around a common topic (Nardi et al. 2002), and a variety of mobile and telework situations (Davenport and Pearlson 1998). Some of the literature on virtual teams focuses on distance: the challenges virtual teams face to conduct communications, resolve conflicts, and maintain social interactions over time, space, or organizational distance. Armstrong and Cole (2002) proposed that distance among group members is multidimensional; objective measures of distance include not just geographic distance, but also time differences, organization distance, and cultural distance. Griffith et al. (2003) proposed three dimensions of virtualness: physical distance (close to far), level of technology support, and percent of time spent apart when working on a task.

To make sense of these multiple views of virtual work, Watson-Manheim et al. (2002) introduced the concept of discontinuities, or factors contributing to a decrease in cohesion. Examples of discontinuities include physical location, temporal location, national culture, professional culture, and organizational affiliation. Different types of discontinuities are logically separable, but they often come in bundles (e.g., location + organizational membership + national culture). For example, performance of work activities by members of an interorganizational team may mean that individuals who are separated in time and/or space have to interact with colleagues from a different professional, organizational, or even national culture (Boudreau, et al. 1998; Carmel 1999). Building on the idea of discontinuities, we propose a virtuality index, or way to assess the extent of virtual work.

Characterizing virtual work is important for at least three reasons. A virtuality index structures the concept of virtual work so that it encompasses each of the above definitions; this will lead to precision in actually documenting this condition. Secondly, it can be combined with outcome measures to assess the effects of virtuality on performance. A virtuality index can help managers adjust work conditions in specific ways when problems arise because of virtual work arrangements (e.g., wireless communication for mobile workers, better use of workflow tools). Third, it provides a metric for IT staff to use when designing and selecting the tools and infrastructure a distributed organization needs. Given the array of solutions currently offered, the index can help narrow down the scope to those with the most likelihood of being effective. This would greatly decrease the risk and improve the cost effectiveness of collaboration tools.

In this report, we describe a study at Intel Corporation that gathered data from over 1,200 employees located around the world. From the data, we derived a psychometrically sound multifaceted conceptualization of virtuality and the extent to which Intel employees experience conditions identified as virtuality. Future analyses should provide insights into how virtual work does and does not affect the performance of employees, along with other factors that mitigate or aggravate the facts of being distributed.

We begin with a description of the theory underlying the development of our virtuality index, followed by our methods, including sample characteristics and psychometric properties of the index. We conclude with a discussion of how the index can be used.

Virtuality and Discontinuity

Working in proximity used to be the norm for employees. When a project team needed someone with unique skills, that person would move to work in the same location as the rest of the team. For example, until recently, workers at International Business Machines Corporation commonly considered IBM to mean, "I've been moved." In the past decade, however, it's come to mean, "I'm by myself." Coworkers rely on ICT instead of face-to-face interaction, and these most certainly enable aspects of virtual work. These technologies are integrated into work processes because they overcome barriers to collaboration and improve the flexibility required in rapidly changing work environments (Boudreau et al. 1998).

However, even as ICT enables people to span boundaries of time, space, organization, and so forth, its use presents new challenges. In lifting some barriers to collaboration, the technology can expose differences that contiguity covered over, suggesting less cohesion in work environments. In short, by lowering some barriers to collaboration, use of technology simultaneously exposes previously unobserved divisions. As Scott and Timmerman noted, " the very technologies that provide … [workers] with the freedom and flexibility they desire, also allow them to be further removed from key aspects of the organization" (1999, p. 241). Watson-Manheim et al. (2002) referred to these boundaries as discontinuities: *factors contributing*

to a lack of cohesion between workers in a collective situation, such as geographic separation, cultural differences, or organizational membership.

Discontinuities are not necessarily negative or to be avoided, but they don't offer any way of assessing the value or harm arising from their presence. For example, while remote work enables positive outcomes like organizational flexibility or innovation, the introduction of discontinuities may interrupt established communication activities and information flow formerly summed up as the community of practice (Nardi et al. 2002; Wenger 1998). Although it may be easy to add a new member with skills critical to the team, adding a new first language or dialect to the team may require renegotiating previously developed communication norms. The group may need to prepare written minutes of meetings following same-time telephone conference calls to ensure everyone has a common understanding of roles and responsibilities. Group members may need to adjust the use of colloquialism from communication to ensure understanding transcends language boundaries. This adjustment may be simple or complex, depending on prior differences among team members (Gaborro 1990).

Some factors that overcome these difficulties were previously identified as continuities (Watson-Manheim et al. 2002); these are factors that contribute to increased cohesion among individuals in a collective situation. Continuities can vary across work arrangements and organizations. Workers may consciously act on continuities, or they may be implicit and unrecognized. For example, Maznevski and Chudoba (2000) found that a team with members across two organizations and located in three countries had a similar approach to problem solving on a complex task, which they attributed to the fact that all team members were trained as engineers. This professional continuity was reflected in written and spoken communication between team members. Continuities can also be explicitly developed to provide support for cohesion. In her study of global software development teams in one organization, Orlikowski (2002) noted:

> The ongoing generation and reinforcement of a strong Kappa identity and "Kappa way of doing things" allows members to internalize and identify with a common way of thinking about and engaging in their product development work. This facilitates the communication and coordination of hundreds of product developers. (p. 267)

The use of ICT can be a continuity by permitting workers to bridge discontinuities such as time and space (Watson-Manheim et al. 2002). Technologies such as NetMeeting™ and WebX™ provide shared access to text documents during same-time, different-place meetings, while knowledge repositories such as LotusNotes™ and company intranets provide 24-hour access to documents and information, all indicative of efforts to build connections and foster knowledge networking. Over time, rules, norms, expectations, and roles may evolve. These continuities create a sense of team identity that facilitates interaction and performance (Early and Mosakowski 2000).

The renegotiation of meaning and behaviors due to changes in an existing team is not new and neither is the fact that organizations are global. What is new, however, is the ease and speed with which discontinuities can be introduced as teams become more reliant on ICT and growing numbers of people interact with colleagues located far away. These teams and their members face new complexity in their work. The groups must develop norms for communication, and redefine and negotiate their common understanding of the task. The increased pervasiveness of discontinuities in the work environment offers a basic explanation for the problematic nature of virtual work. As Olson et al. (2002) observed, collocated teams were twice as productive as teams with members who were nearby, a suggestion that while ICT may enable virtual work, there can be negative effects on group performance. A virtuality index can identify the contributing discontinuities and provide a mechanism for determining their impact on performance.

In summary, virtuality is increasingly integrated into the work process and takes a variety of different forms. At the same time, we lack understanding of the extent of virtuality and its consequences. The objective of this research is to credibly characterize virtuality.

Toward a Virtuality Index

The Setting

Since Intel Corporation is a large global organization with multiple sites in the United States, IT planners there feel they might have unique needs for collaboration tools that reflect this distribution. Not only have travel budgets been sharply reduced since 2000, but frequently Intel does not require employees to change locations if they change job responsibilities. Job functions

themselves are distributed, rather than just divisions, so collaboration across the globe is a fact of life. Remote reporting relationships are common. People are familiar with the everyday practices that they experience, but it is difficult to put a dollar value on designing state of the art tools without knowing how much knowledge worker productivity actually depends on the facilitation of remote work. The purpose of the virtuality index was to understand "how virtual is Intel?" and "what difference does it make?" The definition of virtuality as discontinuities of time, space, organization, culture, and media provided concrete measurables that would roll up into an index of virtuality. In addition, we asked some questions about sociability, and also asked respondents to scale their team performance according to "Intel values," a set of commonly understood dimensions of performance that are included in employees' annual evaluations. This allowed us to further break performance into specific areas that are or are not impacted by virtuality so that planners could see what specific kinds of support workers need to cope with remote work.

Methods

We conducted a Web-based survey with Intel employees in a stratified random sample of 2,100 employees drawn from Intel's employee database: 700 from each of the America, Greater Asia (GAR), and Greater Europe (GER) regions. The questionnaire was posted to the Web and personalized invitation e-mails were sent to each respondent, reaching 2,050 valid e-mail accounts, with reminders following one week later. A total of 1,269 employees submitted responses, with an overall response rate of 62 percent. Respondents reflected the initial stratification in terms of region and Intel job categories except that manufacturing was under represented (37 percent of population, 25 percent of sample) and management over-represented (less than 1 percent of population, 5 percent of sample).

Teamwork is prevalent at Intel. Most people (64 percent) are currently on 3 to 10 different teams. A large majority (82 percent) reported that each of their teams had 3 to 10 people. Team members are distributed across national and international sites. In all 70 percent had team members distributed across one to four sites, while 21 percent have current team members from more than five sites.

Virtuality Index

Eighteen questions were used to create an index of virtuality. Respondents were asked to use a six-point scale to indicate how frequently they conducted tasks related to team work and collaboration, such as collaborating with people from different business groups, time zones, or cultural backgrounds; using different media and technologies; working at discontinuous environments; and collaborating with colleagues outside of Intel. The six-point frequency scale has options of never, yearly, quarterly, monthly, weekly, and daily.

Correlation and principal component factor analyses with Varimax rotation resulted in an index with 12 items that has three components with eigenvalues greater than 1.0, as indicated in Table 1. The inter-item correlations range from .17 to .77, with an average of .35. The following dimensions of virtuality resulted from this analysis.

Team distribution: the degree to which people work in distributed teams that have people from different regions and time zones, which results in extensive uses of Intel's basic collaboration technologies. The four items for this dimension have a reliability of $\alpha = .85$.

Workplace mobility: the degree that employees work in environments other than regular offices, including different Intel sites, home, travel routes, and locations outside Intel. The five items measuring this dimension have a reliability of $\alpha = .70$.

Variety of practices: the degree to which employees experience cultural and work process diversity on their teams. The three items have an $\alpha = .73$.

The factor analysis results in Table 1 suggest solid albeit not perfect convergent and discriminant validity of the above dimensions of virtuality, which means the items measuring one particular dimension are strongly associated with it, and not another concept (Chin et al. 1997). The convergent validity is demonstrated by the items' high loadings on their own component, which are all close to .60. The items' low loadings with other two components (less than .38) suggest the items are distinguishably associated with only one dimension of virtuality. The validity of the scales is reinforced by the high reliability measures.

Future Analyses

The validated virtuality index will enable us to assess the impact of virtuality on team performance. Data to assess team performance that correspond to a stated set of Intel values such as risk-taking, discipline, quality, and great place to work were gathered. The values are familiar to all employees because they are part of annual performance evaluations. Respondents used a seven-point scale (never to very frequently) to register their experience of team performance to values in interpersonal relationship, communications, commitment, and outcomes. In addition, we gathered data about factors that may moderate the relationship between virtuality and performance, based on prior research, such as *tool use* (Internet-based document and information sharing, knowledge management, and communication applications), *social interaction* (how often people socialize for work and nonwork purposes with team members and Intel employees who are not on their teams, as well as adequacy of team interaction frequency), *work predictability* (how much people rely on established procedures and processes in their work, or how predictable their work was), and *expression repertoire* (to understand the role of expression media in remote interaction). Since data to derive the virtuality index and performance data were gathered from the same sample, we will split the sample for future analyses, using half to generate the index and the remainder to assess its impact on performance.

Table 1. Factor Loadings on Dimensions of Virtuality (n = 1175)

	Component		
	1	2	3
Team distribution			
Collaborate with people in different time zones	.827	.237	.267
Work with people via Internet-based conferencing applications	.807	.245	.131
Collaborate with people you have never met face-to-face	.831	.162	.219
Collaborate with people who speak different native languages or dialects than your own	.604	.116	.269
Workplace mobility			
Work at different Intel sites	.287	.736	.073
Have professional interactions with people outside Intel	.065	.560	.356
Work with mobile devices	-.005	.587	.260
Work at home during normal business days	.370	.557	-.042
Work while traveling, for example, at airports or hotels	.267	.807	.125
Variety of practices			
Work on projects that have changing team members	.162	.329	.539
Work with teams that have different ways to track their work	.379	.154	.763
Work with people that use different collaboration technologies	.225	.082	.824
Eigenvalues	4.985	1.288	1.066
Cumulative variance	41.5	52.3	61.2

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Discussion

We have described a study about how to measure virtuality in Intel Corporation, which has been conceptualized as discontinuity over time, space, media, cultures, and organizations. One contribution of this study is an index measuring the virtuality that knowledge workers experience in Intel. We identified three dimensions of virtuality—team distribution, workplace mobility, and variety of practices—that have important implications for our understanding about how virtual collaboration and remote work impact team performance. Statistics analyses suggest strong validity and reliability of the index.

The three dimensions of virtuality that emerged from our data are somewhat different from what we had initially assumed, based on prior research (see Watson-Manheim et al. 2002). We find it interesting that in addition to a common conceptualization of virtual work based on team distribution (e.g., distance), variety of work practices is also an important component of virtuality. By variety of practices, we measured the extent to which employees at Intel collaborated with people who track their work in different ways, use different ICT tools, or the extent to which they experience process changes due to changes in team membership. Exploring the implications of practice-related discontinuities is an important avenue for future research because of its focus on the *process* of working virtually. The third component of our virtuality index, workplace mobility, is also interesting. Workplace mobility is the extent to which employees need to work at different locations, including home, different offices, and travel locations. This raises the possibility that today, many employees face challenges commonly associated with marketing and salespeople who conduct their work from briefcases on the road. Possible ramifications include impacts on organizational commitment and identity, and the portfolio of ICT that is required to support mobile workers.

In addition to the virtuality index, our study offers interesting insights on multi-teaming, a relatively unexplored aspect of virtual work. Two-thirds of the employees in our study reported being on at least three teams, with frequent interactions among team members. Although multi-teaming is not a new condition, our research suggests it is more prevalent today, perhaps indicative of organizations emphasis on flatter organizations, downsizing, and teamwork. Multi-teaming is characterized by participation in a greater number of teams and more rapid movement between teams (e.g., back-to-back meetings with different teams) with less time between interaction incidents (e.g., more frequent communication, either face-to-face or with ICT). Thus, we posit that multi-teaming is a discontinuity. The rate at which multi-teaming occurs and the number of differences that people face (e.g., different team norms, different backgrounds) creates a lack of cohesion. In addition, where previously people created their own somewhat informal and local network of teams (and still do), they are now on many teams with varied membership with whom they have less time or opportunity to integrate.

Multi-teaming as a discontinuity has implications for both ICT tool design and use and for researchers. First, to enhance effectiveness, ICT tools should be designed to take away some of the integration load people face as they move from interaction with members of one team to interaction with members of other teams. Solutions may include recognition that multi-teaming is the new reality and the provision of more support for an employee's ability to adapt to changing conditions by having standard means of working together. At the same time, a repertoire of ICT to support a variety of virtual work conditions may also be required. The more an organization can recognize that it needs this kind of loose coupling with scaffolding of ICT rather than rigid structure, the more it can optimize these employee networks. Second, most research on virtual teams and workgroups has looked at membership in a single team and resultant challenges and benefits. The fact that virtual work in the 21st century means concurrent participation in multiple teams suggests research that narrowly focuses on conditions within a single virtual team may miss important contextual issues and interactions. Future research should investigate the synergies that may arise from multi-teaming as well as the problems.

Using the virtuality index as a tool to characterize virtual work has important implications within Intel and for other organizations with distributed workforces. By using the index to assess impacts of virtual work on performance, organizations have a mechanism to identify specific problems and provide guidance on appropriate remedial actions. A common assumption is that distance itself is problematic for virtual workers (e.g., Armstrong and Cole 2002; Olson et al. 2002), resulting in negative consequences such as miscommunication, conflict, and unequal participation. We question whether this is unilaterally the case, in part because virtual workers may develop strategies to mitigate negative repercussions of virtual work. We anticipate that further analysis of our data using the virtuality index to predict team performance outcomes will surface specific insights for effective management of virtual work.

In conclusion, we have described a study of employees at Intel Corporation to assess virtual work within the organization, and its impact on performance. The virtuality index was derived from the concept of discontinuities, or factors contributing to a decrease in cohesion. It suggests that virtual work be characterized in terms of team distribution, workplace mobility, and variety of work practices. In addition to expanding the way in which virtual work is characterized, the virtuality index is a useful tool for investigating very specifically the impacts of virtual work on performance. Finally, our study has surfaced the prevalence of multi-teaming and identified it as a discontinuity that should be considered in future research of virtual work.

References

Armstrong, D., and Cole, P. "Managing Distances and Differences in Geographically Distributed Work Groups," in *Distributed Work*, P. Hinds and S. Kiesler (eds.), The MIT Press, Cambridge, MA, 2002, pp.167-186.

Boudreau, M.-C., Loch, K. D., Robey, D., and Straub, D. "Going Global: Using Information Technology to Advance the Competitiveness of the Virtual Transnational Organization," *The Academy of Management Executive* (12:4), 1998, pp. 120-128.

Carmel, E. *Global Software Teams: Collaborating Across Boarders and Time Zones,* Prentice Hall, Upper Saddle River, NJ, 1999

Chin, W. W., Gopal, A., and Salisbury, W. D. "Advancing the Theory of Adaptive Structuration: The Development of a Scale to Measure Faithfulness of Appropriation," *Information Systems Research* (8:4), 1997, pp. 342-367.

Davenport, T. H., and Pearlson, K. "Two Cheers for the Virtual Office," *Sloan Management Review* (39:4), 1998, pp. 51-65.

Early, C., and Mosakowski, E. "Creating Hybrid Team Cultures: An Empirical Test of Transnational Team Functioning," *Academy of Management Journal* (43:1), 2000, pp. 26-49.

Gabarro, J. J. "The Development of Working Relationships," in *Intellectual Teamwork*, J. Galegher, R. E. Kraut, and C. Edigo (eds.), Lawrence Erlbaum Associates, Hillsdale, NJ, 199, pp. 79-110.

Griffith, T. L., Sawyer, J. E., and Neale, M. A. "Virtualness and Knowledge in Teams: Managing the Love Triangle of Organizations, Individuals, and Information Technology," *MIS Quarterly* (27:2), 2003, pp. 265-287.

Jarvenpaa, S. L., Knoll, K., and Leidner, D. E. "Is Anybody Out There? Antecedents of Trust in Global Virtual Teams," *Journal of Management Information Systems* (14:4), 1998, pp. 29-64.

Kraut, R., Steinfield, C., Chan, A. P., Butler, B., and Hoag, A. "Coordination and Virtualization: The Role of Electronic Networks and Personal Relationships," *Organization Science* (10:6), 1999, pp. 722-740.

Lipnack, J., and Stamps, J. *Virtual Teams: Reaching Across Space, Time and Organizations with Technology*, John Wiley and Sons, Inc., New York, 1997.

Maznevski, M. L., and Chudoba, K. M. "Bridging Space Over Time: Global Virtual Team Dynamics and Effectiveness," *Organization Science* (11:5), 2000, pp. 473-492.

Nardi, B., Whittaker, S., and Schwarz, H. "NetWORKers and Their Activity in Intensional Networks," *Journal of Computer-Supported Cooperative Work* (11:1-2). 2002, pp. 205-242.

Olson, J., Teasley, S., Covi, L., and Olson, G. "The (Currently) Unique Advantages of Collocated Work," in *Distributed Work*, P. Hinds and S. Kiesler (eds.), The MIT Press, Cambridge, MA, 2002, pp. 113-135.

Orlikowski, W. J. "Knowing in Practice: Enacting a Collective Capability in Distributed Organizing," *Organization Science* (13:3), 2002, pp. 249-273.

Scott, C., and Timmerman, C. "Communication Technology Use and Multiple Workplace Identifications Among Organizational Teleworkers with Varied Degrees of Virtuality," *IEEE Transactions* on Professional Communication (42:4), 1999, pp. 240-260.

Watson-Manheim, M.-B., Chudoba, K., and Crowston, K. "Discontinuities and Continuities: A New Way to Understand Virtual Work," *Information, Technology and People* (15:3), 2002, pp. 191-209.

Wenger, E. *Communities of Practice: Learning, Meaning and Identity*, Cambridge University Press, New York, 1998.