Managing virtual teams: A review of current empirical research

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Abstract

This review summarizes empirical research on the management of virtual teams, i.e., distributed work teams whose members predominantly communicate and coordinate their work via electronic media (e-mail, telephone, video-conference, etc.). Instead of considering virtual teams as qualitatively distinct from conventional teams, the degree of "virtuality" of teams is understood as a dimensional attribute. This review is guided by a lifecycle model in which five phases are distinguished in the management of teams with high virtuality: Preparation, launch, performance management, team development, and disbanding. The main focus of the review is on quantitative research with existing virtual teams in organizational contexts. However, experimental research and case studies are considered when no field studies are available. The major research results are summarized for human resource management tasks within these phases, and recommendations for practitioners are derived.
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1. Introduction

In light of the increasing de-centralization and globalization of work processes, many organizations have responded to their dynamic environments by introducing *virtual teams*, in which members are geographically dispersed and coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, etc.). Additionally, the rapid development of new communication technologies such as the Internet has accelerated this trend so that today, most of the

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larger business organizations employ virtual teams to some degree (Duarte & Snyder, 1999; Gibson & Cohen, 2003; Hinds & Kiesler, 2002; Townsend, DeMarie, & Hendrickson, 1998). For instance, a recent survey among 376 business managers from different branches in Germany (AFW, 2002) revealed that about 20% of the managers worked predominantly as a member of a virtual team, and about 40% worked at least temporarily in virtual teams. Similar numbers have been reported for other countries (Gibson & Cohen, 2003; Hinds & Kiesler, 2002). Virtual teams can be found in various fields, such as R&D, problem solving task forces, or customer services, and they also exist in non-economic organizations such as virtual collaboratories in sciences (e.g., Finholt, 2002).

Despite the growing prevalence of this new work form, little is known about the management of virtual teams and the human resources within these teams (Axtell, Fleck, & Turner, 2004; Kirkman, Rosen, Tesluk, & Gibson, 2004). A number of conceptual papers provide initial suggestions based on theoretical considerations, experience reports and explorative case studies (for recent reviews see Axtell et al., 2004; Gibson & Cohen, 2003; Hinds & Kiesler, 2002; Powell, Piccoli, & Ives, 2004). However, as a next step, these suggestions should be compared with empirical results from quantitative (field) studies using larger sample sizes. Currently, such comparisons are difficult because the available research is published in quite different journals and books. Accordingly, the main objectives of this review are:

   a) To summarize empirical research relevant for the management of virtual teams and the human resource management (HRM) within this context,
   b) To provide a conceptual model for the integration of this research, and
   c) To derive recommendations for HRM practices based on the research available.

Thus, extending earlier work, this paper provides a comprehensive review on the different management tasks in virtual teams based on empirical research. After providing a definition of virtual teams, an integrative lifecycle model of virtual teams will be presented that covers crucial HRM issues such as selection, performance management, rewards and personnel development, but also contains new issues such as the question of a constructive disbanding of virtual teams. The following presentation of the available empirical work is guided by this lifecycle model summarizing empirical results and their implications for each of these issues. In contrast to research on computer-mediated collaboration (CMC) that predominantly compares media effects between computer-mediated and face-to-face groups using experimental settings (cf. Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Fjermestad & Hiltz, 1998), this review focuses particularly on quantitative field research of existing virtual teams in order to acknowledge effects of time and organizational context. However, results from experimental CMC research as well as case studies and experience reports will be considered for issues that have not yet been addressed by quantitative field studies.[1]

2. Definition of virtual teams

Distributed work across different locations and/or working times is not a phenomenon of the last 15 years. There are many instructive examples of how people collaborated across larger distances in earlier

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[1] Our focus on quantitative field research should not be misunderstood as devaluation of experimental work or case studies which, of course, comprise important steps for theory building in new research fields (e.g., Eisenhardt, 1998).

times (King & Frost, 2002; O'Leary, Orlikowski, & Yates, 2002). However, with the rapid development of electronic information and communication media in the last years, distributed work has become much easier, faster and more efficient. The attribute "virtual" designates distributed work that is predominantly based on electronic information and communication tools.

Generally, we can differentiate various forms of "virtual" work depending on the number of persons involved and the degree of interaction between them. The first is *telework* (telecommuting) which is done partially or completely outside of the main company workplace with the aid of information and telecommunication services (Bailey & Kurland, 2002; Konradt, Schmook, & Mälecke, 2000). *Virtual groups* exist when several teleworkers are combined and each member reports to the same manager. In contrast, a *virtual team* exists when the members of a virtual group interact with each other in order to accomplish common goals (Lipnack & Stamps, 1997). This distinction between virtual group and virtual team is parallel to the distinction between conventional groups and teams in the organizational literature (e.g., Guzzo & Dickson, 1996; Kozlowski & Bell, 2003). Finally, *virtual communities* are larger entities of distributed work in which members participate via the Internet, guided by common purposes, roles and norms (Wellman, 1997). In contrast to virtual teams, virtual communities are not implemented within an organizational structure but are usually initiated by some of their members. Examples of virtual communities are Open Source software projects (Hertel, Niedner, & Herrmann, 2003; Moon & Sproull, 2002) or scientific collaboratories (Finholt, 2002). For reasons of feasibility, the current review is restricted to virtual teams.

Apart from these more general differentiations, the more specific definition of virtual teams is still controversial (Bell & Kozlowski, 2002; Duarte & Snyder, 1999; Griffith & Neale, 2001; Haywood, 1998; Lipnack & Stamps, 1997; Maznevski & Chudoba, 2000). As a minimal consensus, virtual teams consist of (a) two or more persons who (b) collaborate interactively to achieve common goals, while (c) at least one of the team members works at a different location, organization, or at a different time so that (d) communication and coordination is predominantly based on electronic communication media (e-mail, fax, phone, video conference, etc.). It is important to note that the latter two aspects in this definition are considered as dimensions rather than as dichotomized criteria that distinguish virtual teams from conventional "face-to-face" teams. While extreme cases of virtual teams can be imagined in which *all* members are working at different locations and communicate *only* via electronic media, most of the existing virtual teams have some face-to-face contact. At the same time, electronic communication media are not only used in virtual teams but also in conventional teams. Instead of trying to draw a clear line between virtual and non-virtual teams, it might be more fruitful to consider the relative "virtuality" of a team and its consequences for management (see also Axtell et al., 2004; Bell & Kozlowski, 2002; Griffith & Neale, 2001). From this perspective, virtuality of a team is one aspect among other team characteristics (e.g., diversity, autonomy, time-restriction) that might broaden our understanding of teamwork in general. Potential indicators or measures of virtuality are the relation of face-to-face to non-face-to-face communication, the average distance between the members, or the number of working sites represented in the team together with the number of members at each site (see also Kirkman et al., 2004; O'Leary & Cummings, 2002). For reasons of simplicity, we will use "virtual team" throughout the text as a label of teams with high degrees of virtuality.

Similar to other human resource policies, the consequences of implementing high virtuality in teams can be evaluated at the individual, organizational, and societal level (Beer, Walton, & Spector, 1985). At the *individual level*, potential advantages of high virtuality include higher flexibility and time control together with higher responsibilities, work motivation, and empowerment of the team members.

Challenges on the other hand are feelings of isolation and decreased interpersonal contact, increased chances of misunderstandings and conflict escalation, and increased opportunities of role ambiguity and goal conflicts due to commitments to different work-units. At the *organizational level*, virtual teams have particularly strategic advantages. For instance, teams can be staffed based on members' expertise instead of their local availability, teams can work "around the clock" by having team members in different time zones, speed and flexibility in response to market demands can be increased, a closer connection to suppliers and/or customers can be accomplished, and expenses for traveling and office space can be reduced. Potential challenges at this level include difficulties to supervise team members' activities and to prevent unproductive developments in time, along with additional costs for appropriate technology, issues of data security, and additional training programs. Finally, at the *societal level*, the implementation of virtual teams can help to develop regions with low infrastructure and employment rate, to integrate persons with low mobility due to handicaps or family care duties, and to decrease environmental strains by reducing commuting traffic and air pollution. However, virtual teams can also increase the isolation between people due to a technical work environment. These numerous advantages and challenges at all three evaluation levels call for guidance in order to profit from the advantages and to minimize the potential drawbacks.

3. A lifecycle model of virtual team management

At this early state of research on teams with high degrees of virtuality, we consider a heuristic lifecycle model as most appropriate to organize the different topics relevant for virtual team management. As with work teams in general (Hackman, 1987; McGrath, 1991), developmental aspects have to be considered acknowledging that different management tasks are crucial at different phases of a team implementation process (for case examples with virtual teams, see Gluesing et al., 2003). Moreover, a lifecycle model takes into account that disadvantages due to new communication technologies might differ depending on the phases of teamwork (e.g., Hollingshead & McGrath, 1995). In the model presented here, we discus those HRM issues that might be particularly affected by high degrees of virtuality. That is, the higher the virtuality level of a team is, the more important are the key activities summarized in the lifecycle model. Finally, our lifecycle conceptualisation helps to order the implications of this review for practitioners (key activities) in a clear and comprehensive "step by step" overview.

In contrast to conventional input–process–output models (e.g., Powell et al., 2004), our lifecycle model distinguishes five general phases with specific management tasks that have to be addressed during virtual teamwork (cf. Table 1). The *first phase*, "Preparations" contains tasks and decisions that are relevant when an organization is planning to implement virtual teams (mission statement, personnel selection, task design, etc.). The *second phase*, "Launch" describes the activities that are relevant at the actual beginning of the teamwork, such as conducting a kick-off workshop. The distinction between this "Launch" phase and the following "Performance management" phase acknowledges that teams with high degrees of virtuality often need more time to establish reliable work processes compared to conventional teams. The *third phase*, "Performance management" includes issues of leadership and the maintenance of motivation and communication within virtual teams. The *fourth phase*, "Team development" entails evaluation activities of team processes together with team training and assimilation of new members. Both the third and fourth phases can be considered as major leadership functions that are critical in all teams (Kozlowski & Bell, 2003). Consequently, the issues described in the third and fourth phase are

Table 1
Key activities in the lifecycle of virtual team management

Phase A:	Phase B:	Phase C:	Phase D:	Phase E:
Preparations	Launch	Performance management	Team development	Disbanding
Mission statement	Kick-off workshop	Leadership	Assessment of	Recognition of
Personnel selection	Getting acquainted	Regulation of	needs/deficits	achievements
Task design	Goal clarification	communication	Individual and/or	Re-integration of
Rewards systems	Development of	Motivation/emotion	team training	team members
Technology	intra-team rules	Knowledge management	Evaluation of	
Organizat. integration			training effects	

Please note that this presentation is a simplified model. Some of the phases can be additionally interrelated with feedback loops (e.g., Phases C and D). Moreover, activities and decisions of earlier phases can transcend to later phases of the lifecycle.

somewhat transcendial and also relevant in other phases. However, for didactic reasons it might be helpful to distinguish between performance management and optimizing/correction tasks. Finally, the *fifth phase*, "Disbanding" includes tasks such as the proper recognition of team achievements and the re-integration of team members that are often neglected in team management models. Particularly for virtual teams that often collaborate only for a short time-period, a careful disbanding process is important to maintain a network of motivated experts that can be combined again for future projects in a quick and flexible way.

In the next sections, we review the available empirical research that addresses main management issues within each of the five phases.

4. Phase A: preparations

The initial task during the implementation of a team is the definition of the general purpose of the team together with the determination of the level of virtuality that might be appropriate to achieve these goals. These decisions are usually determined by strategic factors such as mergers, increase of the market span, cost reductions, flexibility and reactivity to the market, etc. However, conceptual and empirical work is desirable examining what levels of virtuality are suited for which task from a psychological perspective. Next, issues of personnel selection, task and reward system design, technology use, and organizational integration of the team have to be addressed.

4.1. Personnel selection and diversity

One of the strategic reasons for virtual teams is to combine core competencies of specialists from different locations. In these cases, the main selection criteria for virtual team members are their professional/technical KSAs (knowledge, skills, abilities) and expertise, for instance, specific sales or procurement skills. In addition, however, more general attributes of team members might be considered as well. Based on research with conventional teams (e.g., Barrick, Stewart, Neubert, & Mount, 1998; Neuman & Wright, 1999; Stevens & Campion, 1999), such general attributes belong to three main
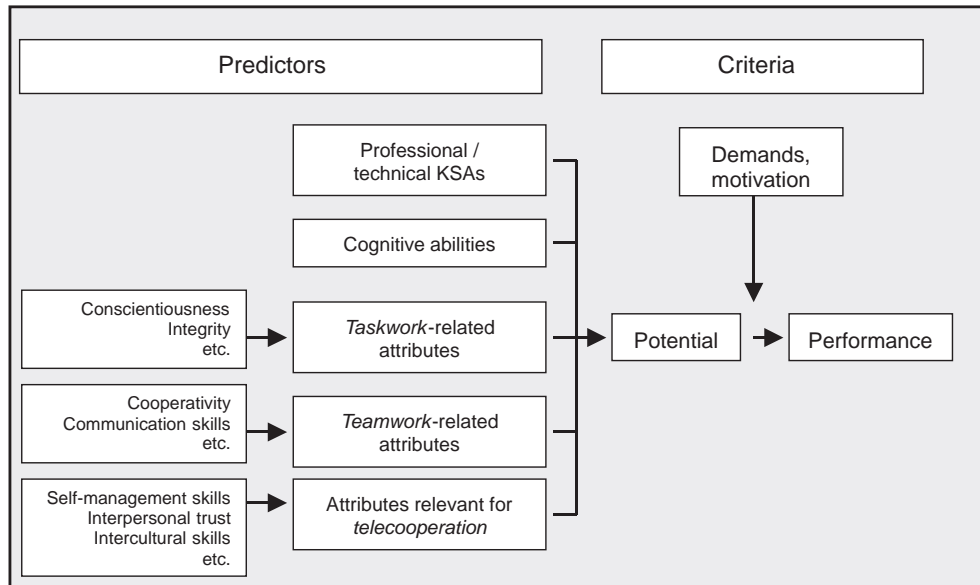
Fig. 1. The Virtual Team Competency Inventory (VTCI).

dimensions: *General cognitive abilities*, *taskwork-related attributes* (e.g., conscientiousness, integrity) and *teamwork-related socio-emotional attributes* (e.g., emotional stability, extraversion, agreeableness). While most of these variables seem to be compensatable among different team members (Barrick et al., 1998), some aspects such as agreeableness or conscientiousness require a minimum level that should be met by all members in order to prevent conflicts and motivation losses (Neuman & Wright, 1999).

These dimensions should be also crucial for virtual teams. In addition, however, high degrees of virtuality require also attributes relevant for telecooperation, such as expertise with new media and groupware technology, self-management skills along with certain personality attributes, such as self-sufficiency, interpersonal and intercultural sensitivity, interpersonal trust, and dependability (Blackburn, Furst, & Rosen, 2003; Duarte & Snyder, 1999; Jarvenpaa & Leidner, 1999; Konradt & Hertel, 2002; Warkentin, Sayeed, & Hightower, 1997).

Initial empirical work (Hertel, Konradt, & Lehmann, 2004) compared attributes of team members in effective and less effective virtual teams of an internet provider company. Based on interviews with business managers, a multi-scale questionnaire (VTCI: Virtual Team Competency Inventory) was developed that contained taskwork-related attributes (e.g., conscientiousness, integrity), teamwork-related attributes (e.g., cooperativity, communication skills), and attributes relevant for telecooperative work (i.e., self-management skills, interpersonal trust, and intercultural skills). These three groups of attributes were considered as determinants of the performance potential of virtual team members in addition to their professional KSAs and their general cognitive abilities (see Fig. 1).[2]

As criteria, effectiveness ratings were collected from the team managers both at the individual and at the team level. The results of the field study showed good reliability of the taskwork-related attributes, teamwork-related attributes, and attributes related to telecooperative work. Moreover, correlations

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[2] It should be noted that the mentioned personality attributes and KSAs are not considered to be independent from cognitive abilities. However, due to the organizational policy, cognitive abilities could not be measured in this study.

between a composite of the VTCI and managers' ratings of team effectiveness revealed satisfying concurrent validity of the measure ($r=.40$). Particularly, the attributes related to telecooperation (self-management skills, interpersonal trust, etc.) showed substantial contributions.

While the described study explored selection instruments for virtual team *members*, no empirical study is available addressing the attributes of virtual team *managers*. Initial conceptual considerations largely overlap either with competencies of virtual team members or with competencies of managers of conventional teams (e.g., Duarte & Snyder, 1999). Thus, future research is necessary that explores selection criteria for managers of teams with high degrees of virtuality.

Virtual teams often include members with different cultural backgrounds (due to different nations, organizations, professions, etc.), thus, *diversity* is another important issue. Diversity is often connected with the hope of "synergistic" effects, assuming that different expertise and perspectives increase the team effectiveness. Indeed, research with conventional teams suggests that diversity should be particularly advantageous for difficult and complex team tasks that are not well defined and require creativity and high integration of data (e.g., Bowers, Pharmer, & Salas, 2000). However, restricted communication opportunities in virtual teams might prevent a constructive use of diversity and might rather increase misunderstandings and conflicts. Whether (and how much) diversity is advantageous for virtual teams is still an open empirical question.

A related issue is the question of whether certain cultural backgrounds might be more advantageous for virtual teamwork than others. For instance, Jarvenpaa and Leidner (1999) argue that persons from individualistic cultures might be more prone to trust than persons from collectivistic cultures because they show a higher willingness to respond to ambiguous messages. However, the reverse might also be true because persons from collectivistic cultures are more prone to identify with a group (Bouas & Arrow, 1996). In an initial empirical study of cultural effects on virtual teamwork, Jarvenpaa and Leidner (1999) did not find any clear effects. Perhaps both collectivistic and individualistic cultures have advantages for virtual teamwork: While an individualistic culture might help to cope with isolated work conditions, collectivistic cultures might help to actively overcome isolation by seeking contact with remote co-workers.

Similar to other "non-functional" aspects of virtual teams, cultural diversity is often not something a manager can choose. Thus, recommendations are desirable how diversity can be handled constructively. One way is to establish specific team roles. Hofner Saphiere (1996) reported that in highly productive intercultural virtual teams, some members acted as "cultural interpreters", for instance by speaking for another person when this person was frustrated or lacked language proficiency. Assigning such roles explicitly might help to decrease potential strains that are connected with this role when taken spontaneously (Hofner Saphiere, 1996). Other ways to handle diversity in virtual teams are team trainings and group support systems (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996/97) or the integration of cultural sensitivity as a selection criteria of team members (Hertel et al., 2004).

4.2. Task design

More general considerations of task design for virtual teams refer to the question which kind of work might be suitable for high levels of virtuality (Konradt & Hertel, 2002). Generally, tasks are better suited for virtual teams the lower their degree of physical work and the higher the degree of information-based work is (e.g., R&D, project management, sales, procurement). Another issue is that separation of subtasks (modular structure) should be feasible in order to reduce coordination

requirements when subtasks are distributed among different locations. Finally, clear success criteria should be available to facilitate feedback processes across distance. The currently available studies on teams with high virtuality are related to two main questions: First, comparisons between computer-mediated and face-to-face teams on different task types, and second, the effects of task interdependence in virtual teams.

4.2.1. Task types

The growing technical opportunities to support teamwork have initiated a number of studies that compared the effectiveness of computer-mediated teams with conventional face-to-face teams. Nearly all of these studies have been conducted as laboratory studies simply because it is difficult to find existing computer-mediated and face-to-face teams that accomplish comparable tasks. Following the taxonomy developed by McGrath (1984), these studies provide results for generating tasks (e.g., brainstorming), choosing tasks (decision making), negotiating tasks, and executing tasks (e.g., production).

The largest bulk of studies have been accumulated for *generation tasks*, many of them exploring advantages of electronic brainstorming systems (EBS) for group creativity (e.g., Connolly, 1997; Cummings, Schlosser, & Arrow, 1996; Dennis & Valacich, 1993; Gallupe, Cooper, Grisé, & Bastianutti, 1994; Hollingshead & McGrath, 1995; Pinsonneault, Barki, Gallupe, & Hoppen, 1999; Valacich, Dennis, & Connolly, 1994). EBS is usually part of a larger groupware system and presents users with a random selection of ideas generated by all group members. Moreover, group members can sometimes access further sets of ideas if they run out of own ideas (e.g., Ziegler, Diehl, & Zijlstra, 2000). It has been demonstrated that EBS can lead to higher performance compared to face-to-face group brainstorming because EBS can help to prevent typical motivation and coordination problems (e.g., production blocking, evaluation apprehension; see Dennis & Valacich, 1993).

However, the robustness of these effects is controversial (Pinsonneault et al., 1999; Roy, Gauvin, & Limayem, 1996; Ziegler et al., 2000). For instance, reading the ideas of other group members online might both have stimulating as well as inhibiting or distracting effects because members' search for ideas might be focused on similar categories (Pinsonneault et al., 1999; Ziegler et al., 2000). Also, while anonymous processing as one option of EBS might decrease evaluation apprehension (e.g., Connolly, Jessup, & Valacich, 1990), it can also increase the risk of motivation losses in groups so that the net effect might be zero (Pinsonneault et al., 1999; Valacich, Dennis, & Nunamaker, 1992). Finally and perhaps most importantly, while the superiority of EBS over face-to-face group brainstorming has been demonstrated, evidence of EBS superiority over *brainstorming of nominal groups* (i.e., team members generate ideas individually without interacting with other members) is weak or not present at all, even though participants sometimes believe their productivity is higher with EBS (Pinsonneault et al., 1999). Thus, in order to maximize the number of unique ideas, brainstorming in nominal groups seems to be still the most effective strategy also in computer-mediated work settings.

Another typical team task for which electronic support systems have been developed are *decision tasks* (e.g., Kiesler, Siegel, & McGuire, 1984). However, Hollingshead and McGrath (1995) conclude in their review that decisions of computer-mediated groups are inferior compared to face-to-face groups. Valacich and Schwenk (1995) found that computer-mediated groups required more voting rounds to reach agreement than face-to-face groups. Summarizing these and other research results in a meta-analysis, Baltes et al. (2002) conclude that there is little support for the "unbridled rush by organizations to adopt computer-mediated communication as a medium for group decision making" (Baltes et al., 2002, p. 156). Compared to face-to-face conditions, computer-mediated decision making takes more

time, less information is exchanged and the satisfaction of team members is rather low (Benbasat & Lim, 1993; Fjermestad & Hiltz, 1998).

This pessimistic conclusion might be too harsh because a number of possible moderators have not been considered, e.g., time span, composition of the group, group size, and availability of facilitators (Alge, Wiethoff, & Klein, 2003; Dennis & Wixom, 2002). For instance, the described process losses in computer-mediated decision groups might diminish over time as group members adjust to the technology (Cummings et al., 1996; Hollingshead & McGrath, 1995; Walther, 2002) or have a longer temporal scope (Alge et al., 2003). Moreover, the importance of an appropriate *fit* between communication media and task has been often neglected.

Differences between computer-mediated and face-to-face teams for *negotiation tasks* have seldom been explored. It is usually recommended that negotiation and conflict management should rather be realized face-to-face than at a distance because they involve complex interaction and the need to build trust (Bos, Olson, Gergle, Olson, & Wright, 2002; Jensen, Farnham, Drucker, & Kollock, 2000). However, according to a study by Moore, Kurtzberg, Thompson and Morris (1999), e-mail communication can also have advantages in negotiations. Due to the asynchronous character of e-mails, negotiators have sufficient time between the messages to calculate the values of various outcomes and to consider the best counter-offers. Moreover, the complete documentation of the communication allows more thorough information acquisition.

The lowest number of studies comparing computer-mediated and face-to-face teams are those exploring *executing tasks*. Relevant here might be studies which explore whether motivation gain effects observed in conventional teamwork can be replicated in computer-mediated groups. A recent study using a computer-based sales scenario could indeed demonstrate higher performance of participants during groupwork compared to individual work, even when the team members worked anonymously (Hertel, Deter, & Konradt, 2003).

Together, teams with high virtuality seem to have some advantages compared to face-to-face teams for generating tasks, but difficulties for decision tasks in particular. However, these results have to be interpreted with caution because they are mainly based on experimental research with ad hoc groups. When teams have more time to adjust to new technologies and to develop stable work routines, the disadvantages of high virtuality might diminish or even reverse (Chidambram, 1996; Hollingshead & McGrath, 1995; Walther, 2002).

4.2.2. Task interdependence

Task interdependence describes the degree or requirement of task-driven interaction among group members (Shea & Guzzo, 1987) and is also determined by the design of the group task. For instance, high task interdependence is created when team members have to coordinate their activities frequently so that the performance of one member strongly affects the work process of other team members (e.g., Thompson, 1967). Potential positive effects of high task interdependence are increases of teams cohesion, trust, and the sense of indispensability of personal contributions to the team (Hertel, Konradt, & Orlikowski, 2004; Kirkman et al., 2004). Moreover, team communication can be increased due to coordination requirements (Bouas & Arrow, 1996). This is particularly relevant for virtual teams in which feelings of cohesion, the importance of personal contributions, and communication are more difficult due to the low degree of face-to-face contact. In a recent field study with 31 virtual business teams, task interdependence was conceptualized as one out of three possible management practices to increase the experience of connectedness within the teams (Hertel, Konradt, & Orlikowski,

2004). Consistent with this expectation, the results showed significant correlations between task interdependence and team effectiveness which was partly mediated by members' ratings of motivational indicators.

Conversely, high task interdependence can also increase process losses and conflicts within the team due to coordination needs and opportunity costs. As a consequence, one would assume a curvilinear relation (inverted U-shape) between task interdependence and team performance, and this relation might also co-vary with the development of the team over time. Consistent with this idea, in the mentioned field study (Hertel, Konradt, & Orlikowski, 2004), task interdependence was related to team effectiveness particularly in the beginning of teamwork (<12 months) when coordination needs increase the amount of communication between the team members. In more experienced teams (>12 months), the relation between task interdependence and team effectiveness diminished (see also Kirkman et al., 2004). Thus, high task interdependence seems to be advantageous particularly at the beginning of virtual teamwork in order to support feelings of connectedness. Later, task interdependence might be reduced in order to diminish coordination and opportunity costs.

4.3. Reward systems

The development of a fair and motivating reward system is another important issue at the beginning of virtual teamwork. As with conventional teams, team-based incentives can be appropriate to stress the importance of cooperation within virtual teams. However, team-based rewards can also lead to de-motivation particularly for stronger team members (DeMatteo, Eby, & Sundtrom, 1998). According to Lawler (2003), reward system have to be adapted to specific aspects of a team, such as goals, task interdependence, autonomy, diversity, and degree of virtuality. The main objectives in this process are to reward those behaviors that are required by the company's strategy. For pay systems in virtual teams, Lawler (2003) recommended skill-based instead of job-based systems in order to encourage individuals to learn the necessary new skills, and pay-for-performance systems that focus more on collective than on individual performance in order to motivate and support cooperative behaviors.

Consistent with the second recommendation, the use of recognition plans related to the overall team success (e.g., a mutual dinner or publication of outstanding team success in the company newsletter) correlated significantly with the effectiveness of virtual business teams (Hertel, Konradt, & Orlikowski, 2004). Moreover, consistent with the expectation that team-based incentives increase the motivation of team members, the relation between team-based incentives and team effectiveness was partly mediated by members' ratings of motivational indicators. Thus, although much more research is needed here, the first empirical results are promising and consistent with the conceptual assumptions.

4.4. Technology

A variety of groupware systems and tools have been developed over the years to support the collaboration of virtual teams, for instance, tools for information exchange, communication, coordination, shared authoring or collaborative learning (e.g., Briggs, Nunamaker, & Sprague, 1998; Nunamaker et al., 1996/97). The variety of groupware tools and systems can be categorized according to the required coordination efforts or their implicit interdependence, ranging from tools with low interdependence that mainly support exchange of information and communication (e.g., bulletin boards, video-conferencing, electronic data interchange) to tools with high interdependence

that coordinate activities within a team and facilitate cooperation (e.g., group decision systems, electronic brainstorming systems, ranking or voting tools, group authoring software, electronic meeting systems).

Most of the research addressing groupware focused on Group Support Systems (GSS), which are interactive computer-based environments that support concerted and coordinated team effort toward completion of joint tasks (Fjermestad & Hiltz, 1998; Nunamaker et al., 1996/97). Besides supporting information access, research has shown that GSS can improve communication, structure problem-solving processes, and maintain an alignment between personal and group goals. Moreover, according to recent meta analyses GSS can indeed increase team performance (Benbasat & Lim, 1993; Fjermestad & Hiltz, 1998). To facilitate acceptance and adoption of groupware systems, Olaniran (1996) suggests that groupware should be easy to use and understand, should allow prompt information, help to generate, organize and evaluate ideas, and allow reliable, adequate, and equal participation.

4.5. Integration into the organizational context

Research with conventional teams has shown that organizational context variables such as boundary management and organizational support have considerable effects on the effectiveness of teams (e.g., Devine, Clayton, Philips, Dunford, & Melner, 1999; Ilgen, 1999). Although such research is lacking for virtual teams, sufficient organizational support and frequent communication with other organizational units should be even more important the higher the virtuality of a team is. Teams with high virtuality work more often across different organizational units, increasing the need for effective boundary management to maintain organizational support and resources. Moreover, members of highly virtual teams often have also commitments to their local sites, and these commitments can be in conflict with the interests of the virtual team (Axtell et al., 2004). Thus, a careful integration into the organizational context is particularly important for virtual teams. Empirical research is needed to explore these processes systematically.

5. Phase B: launch

Almost all authors of conceptual work on virtual team management recommend that, in the beginning of virtual teamwork, all members should meet each other face-to-face (e.g., Duarte & Snyder, 1999; Gibson & Cohen, 2003; Haywood, 1998; Lipnack & Stamps, 1997; Powell et al., 2004; Warkentin & Beranek, 1999). Crucial elements of such a "kick-off" workshop are getting acquainted with the other team members, clarifying the team goals, clarifying the roles and functions of the team members, information and training how communication technologies can be used efficiently, and developing general rules for the teamwork (Duarte & Snyder, 1999; Konradt & Hertel, 2002; Montoya-Weiss, Massey, & Song, 2001). As a consequence, "kick-off" workshops are expected to promote clarification of team processes (Duarte & Snyder, 1999), trust building (Rocco, 1998), building of a shared interpretative context (Warkentin et al., 1997), and high identification with the team (Wiesenfeld, Raghuram, & Garud, 1999).

Initial field data that compare virtual teams with and without such "kick-off" meetings confirm a general positive effects on team effectiveness (Warkentin & Beranek, 1999), although more differentiated research is necessary. Experimental studies demonstrate that getting acquainted before

the start of computer-mediated work facilitates cooperation and trust (Alge et al., 2003; Moore et al., 1999; Zheng, Veinott, Bos, Olson, & Olson, 2002).

6. Phase C: performance management

After the launch of a virtual team, work effectiveness and a constructive team climate has to be maintained using performance management strategies (Bell & Kozlowski, 2002). The following discussion is again restricted to issues on which empirical results are already available. These issues are leadership, communication within virtual teams, team members' motivation, and knowledge management.

6.1. Leadership

Leadership is a central challenge in virtual teams. Particularly, all kinds of direct control are difficult when team managers are not at the same location as the team members. As a consequence, delegative management principles are considered that shift parts of classic managerial functions to the team members. However, team members only accept and fulfill such managerial functions when they are motivated and identify with the team and its goals, which is again more difficult to achieve in virtual teams. Next, empirical results on three leadership approaches are summarized that differ in the degree of autonomy of the team members: Electronic monitoring as an attempt to realize directive leadership over distance, management by objectives (MBO) as an example for delegative leadership principles, and self-managing teams as an example for rather autonomous teamwork.

6.1.1. Electronic Performance Monitoring

Electronic Performance Monitoring (EPM) is based on performance recordings by the computer hardware (number of keystrokes, claims, log-in hours etc.) and/or service observations by a supervisor (e.g., on the telephone) of qualitative aspects such as courtesy tone and accuracy of information (Lund, 1992). Using network technology, EPM systems allow managers to control employees' working pace, degree of accuracy, log-in and log-off times, and customer orientation at any moment (Aiello & Kolb, 1995), and enable some realization of direct performance controlling similar to conventional work settings. In doing so, EPM applies rather Tayloristic principles to job design (Lund, 1992), putting an emphasis on standardization, separation and simplification of work processes.

Most of the studies exploring effects of EPM are conducted with single work rather than teamwork settings (Lund, 1992; Stanton & Barnes-Farrell, 1996). These studies reveal strong evidence that EPM is linked to *increased* stress experience by employees (Aiello & Kolb, 1995). The effects of EPM on performance are at best ambiguous and moderated by the individual characteristics of the workers, such as locus of control or working skills (Aiello & Kolb, 1995; Kolb & Aiello, 1996). For instance, EPM increased performance speed of high skilled workers but decreased performance speed of low skilled workers (Aiello & Kolb, 1995; Davidson & Henderson, 2000). Moreover, participation and control over the monitoring system seem to be suitable means to decrease stress due to EPM systems (Douthitt & Aiello, 2001; Stanton & Barnes-Farrell, 1996). The few studies that have investigated the effects of EPM at the group level revealed that cohesive teams can buffer stress experiences due to EPM (Aiello & Kolb, 1995). However, no overall performance effects of group level EPM were observed compared to individual EPM. In summary, it seems to be difficult to employ EPM without negative effects on

employees' experienced stress and work satisfaction, and its relation to performance is ambiguous. Thus, the practical use of EPM for virtual teams seems to be rather low.

6.1.2. Management by objectives and feedback

While direct leadership strategies are possible in conventional teams, members of virtual teams might be managed more effectively by empowerment and by delegating managerial functions to the members (e.g., Duarte & Snyder, 1999; Hofner Saphiere, 1996). Such an approach changes the role of a team manager from traditional controlling into more coaching and moderating functions (Kayworth & Leidner, 2001). As one prominent example of such delegative leadership concepts, management by objectives (MBO) can be summarized as a group of management practices with an emphasis on goal setting, participation, and feedback about task fulfillment. According to Odiorne (e.g., 1986), these three basic components account for high motivation, performance, and job satisfaction of employees in traditional work settings. While the relevance of each of the MBO components is supported within conventional work settings of *individual* work (e.g., Kluger & DeNisi, 1996; Rodgers & Hunter, 1991), there is still little evidence for conventional *teamwork* (Wegge, 2000).

Even fewer studies have explored MBO in remote work settings. An initial field study with teleworkers showed that quality of MBO was a significant predictor of stress and job satisfaction in addition to other task- and non-job-related strains (Konradt, Hertel, & Schmook, 2003). A field study that explored effects of MBO in existing virtual teams (Hertel, Konradt, & Orlikowski, 2004) showed a significant correlation between the quality of goal setting as perceived by the team members and the effectiveness of the teams as rated by the team manager. Moreover, this correlation was partly mediated by motivational indicators of the team members.

Performance related feedback as an important element of MBO should be frequent, concrete and timely both on the individual and the group level. This might be particularly important under distributed work conditions where information about the goal achievement of the other team members is more difficult to receive. Indeed, introducing graphical feedback about the actual performance led to higher performance in electronic brainstorming groups (Shepherd, Briggs, Reinig, Yen, & Nunamaker, 1996). Apart from social comparison processes, partner related performance feedback can help to build trust and to prevent feelings of exploitation and related motivation losses in virtual teams.

Feedback about social processes might be another important factor in virtual teams because it can help to bridge spatial disconnectedness and increase cohesion and trust. Research on computer-supported communication in groups indicated that a lack of process feedback led to a reduction in social exchanges (e.g., Losada, Sanchez, & Noble, 1990). On the other hand, the support of socio-emotional feedback can lead to an increase in motivation, satisfaction and performance of virtual team members (Huang & Lai, 2001; Weisband, 2002). In a similar way, members of the more successful virtual business teams in a field study felt better informed about the team processes compared to members of less successful teams (Hertel, Konradt, & Orlikowski, 2004). Thus, virtual teamwork might be supported by providing opportunities for socio-emotional feedback, for instance by computerized feedback tools (Geister, Konradt, & Hertel, 2003) or groupware systems (Jang, Steinfield, & Pfaff, 2002; Gutwin & Greenberg, 1999; Handel & Herbsleb, 2002).

6.1.3. Self-managing teams

While delegative management approaches still rely on a formal team leader, it is also conceivable that virtual teams might be completely self-managing. Indeed, according to a study of Vickery, Clark,

and Carlson (1999), autonomy from the parent organization led to higher performance (in terms of customer satisfaction) of ad hoc virtual acquisition teams compared to controls. Virtual teams can even be envisioned as completely self-organizing systems that develop and dissolve by themselves without any external structure. However, although some examples of highly self-organized virtual collaboration exist (Hertel, Niedner, & Herrmann, 2003; Moon & Sproull, 2002), researchers agree that most virtual teams need some guidance and managerial support beyond the mere provision of an electronic groupware system (Duarte & Snyder, 1999; Jarvenpaa & Leidner, 1999; Lipnack & Stamps, 1997; Nunamaker et al., 1996/97).

In an initial field study of self-managing virtual teams, 19 procurement teams of an electronic company were investigated (Hertel, Orlikowski, & Konradt, unpublished data 2002). Instead of a team manager, the top management had assigned one person in each team to the role of a moderator who is responsible for some managerial functions such as information sharing, organization of meetings, and facilitating communication within the team and with other parts of the company. While the team goals were discussed with a board of directors that also had control over member assignments, the teams had autonomy over work processes and the design of contracts with the supplier companies. The results of the study revealed again significant correlations between goal setting principles (goal clarity, lack of goal conflict, sufficient feedback, etc.) and team effectiveness.

In summary, the available evidence on leadership in virtual teams suggests that Tayloristic principles such as EPM are not well suited for virtual teamwork. Instead, more delegative principles are promising as they address the challenge of distributed work by shifting managerial functions to the team members.

6.2. Regulation of communication

Communication processes are perhaps the most frequently investigated variables relevant for the regulation of virtual teamwork (for reviews see Bordia, 1997; DeSanctis & Monge, 1999; Potter & Balthazard, 2002). By definition, communication in virtual teams is predominantly based on electronic media such as e-mail, telephone, video-conference, etc. The main concern here is that electronic media reduce the richness of information exchange compared to face-to-face communication. Predominant research issues have been conflict escalation and disinhibited communication ("flaming"), the fit between communication media and communication contents, and the role of non-job-related communication.

6.2.1. Disinhibited communication ("flaming") and conflict management

Particularly in the earlier years, a number of scholars suspected that communication in virtual teams might be more disinhibited and more hostile ("flaming"; Kiesler et al., 1984) because electronic media are more restricted than face-to-face communication (e.g., fewer channels, asynchronicity, etc.). However, most of the empirical evidence documenting such flaming episodes is based on studies conducted in rather anonymous settings (laboratory, internet chat-rooms) with short-time interaction and with no or only restricted reprisal opportunities (e.g., Kiesler et al., 1984; Siegel, Dubrovsky, Kiesler, & McGuire, 1986; cf. Bordia, 1997; Kayany, 1998). As soon as collaboration was expected to be longer, a common group identity was present, anonymity was lower, and/or reprisal was more likely, flaming diminished or was not observed at all (Reinig, Briggs, & Nunamaker, 1998; Walther, Anderson, & Park, 1994). Thus, instances of flaming should be rather rare in existing virtual teams. Moreover, virtual teams often develop implicit or even explicit norms and rules of communication (Montoya-Weiss et al., 2001) that are enforced by means ranging from social peer pressure to explicit sanctions and punishment.

However, this does not imply that conflicts are rare in virtual teams. But these conflicts seem to be rather due to misunderstandings and reduced communication instead of uninhibited aggressive acts. Moreover, timely detection of (and reaction to) conflicts is difficult in virtual teams due to the reduced co-presence of team members. Thus, there is need for guidance on conflict prevention and conflict management adapted to conditions of virtual teams. First suggestions can be found in conceptual work and case studies (e.g., Duarte & Snyder, 1999; Griffith, Mannix, & Neale, 2003) but still await systematic validation (see Montoya-Weiss et al., 2001, for a notable exception).

Finally, it should be noted that anonymity and asynchronous communication do not only have negative effects on virtual teamwork. Research on electronic brainstorming in groups (e.g., Valacich et al., 1992; Valacich & Schwenk, 1995) has documented that anonymity in computer-mediated communication can encourage participants to view their ideas more objectively (Nunamaker et al., 1996/97), increase positive criticism and prevent people being overly agreeable due to personal sympathy or status differences (Warkentin & Beranek, 1999). Also, when conflicts are highly escalated it might be wise to first mediate between the parties in asynchronous text-based communication that helps to keep emotions down and the parties focused on task-related issues. For instance, Rhoades and O'Connor (1996) showed that the affect of team members (anger, happiness) played a less substantial role in computer mediated groups compared to face-to-face groups. Thus, computer-mediated teamwork might be particularly appropriate for tasks in which affective interaction play a minor or even negative role so that team members can better concentrate their energy on the task (see also Montoya-Weiss et al., 2001; Tidwell & Walther, 2002; Walther, 1995). Together, while electronic communication in virtual teams involves specific challenges due to increased anonymity and decreased information richness, these aspects can also have specific advantages when used correctly.

6.2.2. Fit between communication media and communication content

Communication media are not *per se* better or worse for teamwork. Instead, their use depends on the *fit* to the communication objectives (Daft, Lengel, & Trevino, 1987; DeSanctis & Jackson, 1994; Warkentin & Beranek, 1999). In a study with global business teams (Hofner Saphiere, 1996), members of successful teams used text-based media (e.g., e-mail) more often for task-related issues, and face-to-face meetings more often for teamwork and relationship building. Maznevski and Chudoba (2000) reported in their case study that effective teams had a better fit between the level of decision processes and the richness of the communication medium. According to their observations, e-mail, faxes and phone calls are better used for *gathering information*, longer phone calls and conference calls for *solving problems*, and face-to-face meetings for *generating ideas* and making *comprehensive decisions*. On the other hand, frequent use of rich media in distributed teams does not guarantee team success, providing further evidence that leaner electronic media can sometimes overcome rich face-to-face communication (Finholt, Sproull, & Kiesler, 1990). Overviews suggesting guidelines for the proper use of communication media in virtual teams can be found in conceptual work (e.g., Duarte & Snyder, 1999; Haywood, 1998; Konradt & Hertel, 2002). However, systematic research is needed to explore the optimal fit between communication media and different contents or purposes.

6.2.3. Non-job-related communication

A final way of compensating for anonymity and decreased cohesion in virtual teams is to facilitate personal communication between the team members. Hofner Saphiere (1996) showed in her study of global business teams that more productive teams had more non-job-related communication topics than

less productive teams. Similarly, in a field study with virtual business teams (Hertel, Konradt, & Orlikowski, 2004), the amount of non-task-related communication correlated positively with both team effectiveness and team members' satisfaction. Of course, such correlations do not testify causality. While non-job-related communication can facilitate social processes in virtual teams (cohesion, trust, motivation, etc.), it is also possible that high effectiveness leads to more non-job-related communication, or that both variables are influenced by a third variable such as the personality of team members or the style of leadership. However, causal relations between non-job-related communication and team effectiveness are supported by experimental research showing that higher degrees of personal communication increased trust and cooperation in computer-mediated student teams (e.g., Bos et al., 2002; Moore et al., 1999; Rocco, 1998; Zheng et al., 2002).

6.3. Maintenance of motivation and emotion

A third theme for the regulation of virtual teamwork is the management of motivational and emotional processes. Three groups of such processes have been addressed in empirical investigations so far: Motivation and trust, team identification and cohesion, and satisfaction of the team members. Since most of the variables are originated within the person, they can vary considerably among the members of a team, requiring appropriate aggregation procedures for multilevel analyses (Kozlowski & Klein, 2000).

6.3.1. Motivation and trust

Physical disconnectedness in virtual teams can lead to various challenges of members' work motivation due to any of the following reasons: It is more difficult to implement common goals, feelings of anonymity and low social control may lead to social loafing, self-efficacy is more difficult to maintain due to reduced feedback, and trust is more difficult to build (e.g., Hertel, Konradt, & Orlikowski, 2004; Jarvenpaa & Leidner, 1999; Kirkman et al., 2004; Moore et al., 1999; Shapiro, Furst, Spreitzer, & von Glinow, 2002). The motivational processes of virtual team members can be conceptualized based on a model that integrates expectancy×value concepts (e.g., Vroom, 1964; Karau & Williams, 2001) with research on social dilemmas that stress the importance of trust for the development of cooperation, particularly in teams with restricted communication (e.g., Pruitt & Kimmel, 1977). The VIST model (Hertel, 2002; Hertel, Konradt, & Orlikowski, 2004) specifies four main components as predictors of individuals' motivation in groups.

Valence describes the subjective evaluation of the team goals by each team member, which is proportional to the motivation to contribute to these goals. Moreover, valence is determined by the degree a member identifies with the team and adopts the team goals. Finally, the valence component is affected by goal conflicts due to commitments to other work units. The other three VIST components describe expectancy components. *Instrumentality* is defined as the perceived indispensability of personal contributions for the team outcome. The *self-efficacy* component builds on work by Bandura (e.g., 1977) and includes team members' perceived capability to perform the required activities for the team. Finally, *trust* is defined as the expectancy of team members that their efforts will be reciprocated and not exploited by other team members (interpersonal trust), and that the team processes work reliably (trust in the system). Together, it is assumed that each of the four components contribute positively to members' motivation in virtual teams similar to predictors in a regression approach.

Empirical support for the VIST construct in virtual teams can be considered both for each component separately and for the complete construct. Among the separate effects of the VIST components, *trust* has

been most frequently addressed in the conceptual literature (e.g., Duarte & Snyder, 1999; Haywood, 1998; Lipnack & Stamps, 1997). Laboratory studies demonstrated that trust can increase cooperation in computer-mediated groups (e.g., Jensen et al., 2000; Rocco, 1998; Zheng et al., 2002). Moreover, trust within virtual teams changes over time. According to a longitudinal study with global student teams (Jarvenpaa & Leidner, 1999), trust at early stages seem to be facilitated by social aspects (communication, mutual encouragement) while trust at later stages was mainly determined by process- and task-related aspects (reliability, predictability, etc.). However, systematic field studies are yet lacking that demonstrate trust as a causal factor of effectiveness in virtual teams.

Separate evidence for the *valence* component under virtual team conditions can only be derived from experience reports (e.g., Lipnack & Stamps, 1997). Evidence for the *instrumentality* component was obtained in experimental studies of computer-mediated teamwork (Hertel, Deter, & Konradt, 2003), showing significant motivation gains during teamwork compared to individual work when participants felt that their personal contribution to the team was indispensable. Finally, the importance of *self-efficacy* for remote work has been initially demonstrated in a field study by Staples, Hulland and Higgins (1999) with 376 remote managed employees from different organizations. In this study, self-efficacy ratings correlated both with self-ratings of overall productivity and satisfaction. Antecedents of high self-efficacy were experience and training in remote work, general IT capabilities, and lack of computer anxiety. Positive correlations between self-efficacy and subjective performance indicators at the group level were also observed in virtual teams of software developers (Hertel, Niedner, & Herrmann, 2003).

Research exploring all four VIST components in virtual teams has been conducted in three studies so far (Hertel, Konradt, & Orlikowski, 2004; Hertel, Niedner, & Herrmann, 2003; Hertel et al., unpublished data 2002). The validity of the VIST model could be confirmed in all three studies, showing only moderate intercorrelations between the four components. Moreover, the VIST components successfully explained effects of different management practices on the motivation of team members and on the resulting team effectiveness (Hertel, Konradt, & Orlikowski, 2004). Apart from a conceptual integration of motivational factors in teams, the VIST model also provides guidelines for diagnosis and intervention planning (Hertel, 2002). Thus, managers or moderators can explore each of the four components and initiate correcting interventions if necessary. Questions related to the valence component are whether team goals are clear, if goal conflicts exist, or whether incentive systems and team structure fit sufficiently. Questions related to instrumentality are whether members are aware of the importance of their personal contributions, whether the contributions of each member are identifiable, and whether the feedback system keeps members accurately updated about the progress of the teamwork. Self-efficacy can be explored by asking whether team members feel well prepared for their tasks, and whether feedback is constructive and supporting. Finally, trust can be tested by exploring whether enough opportunities for informal communication exist, whether communication is safe and predictable, and whether the groupware works reliably. Apart from such diagnostic steps, the VIST components can be implemented in feedback tools that provide managers and team members with timely information about the current team climate (Geister et al., 2003).

Extending this research on individual motivational processes within virtual teams, a recent study by Kirkman et al. (2004) has examined effects of team empowerment which can be considered as a combination of team-level indicators of valence, expectancy, and instrumentality together with team autonomy. In this study, team empowerment correlated significantly with process improvement and customer satisfaction of 35 virtual teams providing IT services in the travel industry, and these

correlations were stronger the higher the virtuality of the teams was. Thus, team empowerment seems to be particularly crucial in teams with low degrees of direct face-to-face contact.

6.3.2. Team identification and team cohesion

Team cohesion and team identification, as another group of process variables relevant for the regulation of virtual teamwork, are both related to motivation (e.g., valence of team goals) as well as cognitive processes within virtual teams (e.g., assimilation of team roles and norms). As with motivation, developing cohesion and team identification can be difficult in virtual teams due to reduced face-to-face contact, and both are usually lower in computer-mediated teams compared to conventional teams both in the laboratory (Bouas & Arrow, 1996; Warkentin et al., 1997) and in the field (Fjermestad & Hiltz, 2000).

At the same time, team cohesion and identification are considered as highly important for the success of virtual teams because they can facilitate group functioning, encourage extra-role helping, and decrease the fluctuation of employees (Wiesenfeld et al., 1999). In fact, identification is considered as an efficient mean by which organizations can replace the external control of employees with internal controls (Walther et al., 1994). In field studies of existing virtual teams, team members' identification ratings correlated significantly with team effectiveness rated by the team manager (Geister, 2004). In a similar way, group cohesiveness has been considered relevant for a number of positive outcomes in virtual teams, such as enhanced motivation, better decisions, more open communication and higher satisfaction (Bouas & Arrow, 1996; Warkentin & Beranek, 1999).

6.3.3. Satisfaction of team members

A final group of variables related to the management of motivational and emotional factors comprises the satisfaction of members in virtual teams. Similar to concerns about the motivation and affective bonds in virtual teams, it has been stated and shown that satisfaction ratings in computer-mediated teams are often less positive compared to face-to-face teams (e.g., Baltes et al., 2002; Bordia, 1997; Hollingshead & McGrath, 1995; Warkentin et al., 1997). However, the effect might diminish when team members adapt to the new working environment (Bordia, 1997; Chidambram, 1996; Hollingshead & McGrath, 1995; Walther, 2002). Indeed, higher satisfaction ratings were found in field studies compared to laboratory experiments according to recent meta analyses (Fjermestad & Hiltz, 1998, 2000).

In either case, managers might want to maintain the satisfaction level of virtual teams in order to prevent significant obstacles. According to field studies with existing virtual teams (Hertel, Konradt, & Orlikowski, 2004), teams with high member satisfaction were particularly characterized by (a) more opportunities to meet each other face-to-face at the beginning of teamwork, (b) more non-job-related communication, and (c) more constructive conflict management. Moreover, satisfaction ratings of team members were significantly correlated with the effectiveness of the teams, suggesting that members' satisfaction was not in conflict with team performance.

6.4. Knowledge management

The fourth important issue for the regulation of virtual teamwork is the management of knowledge and the development of shared understanding within the teams (Olson & Olson, 2001). The development of such "common ground" might be particularly difficult in virtual teams because sharing of information and the development of a "transactive memory" (i.e., who knows what in the team; e.g., Hollingshead, Fulk, &

Monge, 2002) is harder due to the reduced amount of face-to-face communication and the reduced information about individual work contexts (Axtell et al., 2004; Cramton, 2002; Griffith & Neale, 2001).

Systematic research is needed on these issues, particularly since theoretical analyses sometimes lead to conflicting expectations (Axtell et al., 2004). For instance, while developing a shared understanding of team goals and tasks might be more difficult in virtual teams due to reduced synchronous communication, the same process might also lead to less biased usage of shared information (and less neglect of unshared information) due to a higher degree of asynchronous processing and greater psychological safety (lower group pressure) in virtual teams (Griffith & Neale, 2001). Together, for virtual teams it seems to be important to both increase mutual knowledge about the individual working contexts (e.g., by common experiences and mutual training), and at the same time to profit from technologies to enhance equal information distribution, systematic processing of unshared information, and a thorough documentation of existing knowledge structures.

7. Phase D: training and team development

In addition to the discussed regulation practices, virtual teams can be supported by personnel and team development interventions. The development of such training concepts should be based on an empirical assessment of the needs and/or deficits of the team and its members, and the effectiveness of the trainings should be evaluated empirically. Possible foci of personnel development activities are the team leaders/moderators, the team members, or the team as a whole.

Suggestions for the training of remote managers and virtual team development can be found in the literature (e.g., Duarte & Snyder, 1999; Lawler, 2003). Typical issues are communication with electronic media (e.g., Warkentin & Beranek, 1999), the clarification of goals and roles, and cultural diversity (Hofner Saphiere, 1996). However, the concepts are usually based on experience reports and are rarely evaluated empirically. Warkentin and Beranek (1999) report an initial exploratory study in which the effects of a face-to-face training addressing communication aspects in virtual teams were investigated. The training included the discussion of virtual teamwork dynamics and possible drawbacks of electronic communication (e.g., information overload). Moreover, guidelines for sharing socio-emotional contents and "rules of netiquette" were introduced. Participants were students who worked in virtual teams over a course of 8 weeks. The results suggested that the training led to increased cohesiveness and team satisfaction compared to a control group. However, significant training effects on team performance could not be observed.

A first evaluation study of virtual team training with non-student participants is documented by Hertel, Orlikowski, Jokisch, Haardt, and Schöckel (2004). The authors developed a 2-day training for 10 virtual procurement teams of a large business company. An initial empirical examination of the teams before the training suggested three major areas for improvement: Clarification of the team goals, effective use of communication media, and the development of agreement for intra-team processes (communication, conflict management, etc.). These topics were addressed by different training modules. Three months after the trainings, questionnaire results revealed that participants perceived significant improvements regarding the trained aspects as well as regarding the overall team effectiveness and working climate within the team.

In summary, initial evidence suggests that training of virtual teams is possible and advisable. The composition of such training includes both typical contents of conventional team development (e.g.,

clarification of roles and team goals) and contents more specific for virtual teams (e.g., communication with electronic media). Future research might explore more variants of virtual team trainings, for instance training in remote settings (Kreijns, Kirschner, & Jochems, 2003).

8. Phase E: disbanding and re-integration

Finally, the disbanding of virtual teams and the re-integration of the team members is an important issue that has been neglected not only in empirical but also in most of the conceptual work on virtual teams. However, particularly when virtual project teams have only a short life-time ("transient" teams) and reform again quickly, careful and constructive disbanding is mandatory in order to maintain high motivation and satisfaction among the employees. According to Bouas and Arrow (1996), members of transient project teams anticipate the end of the teamwork in the foreseeable future, which in turn overshadows the interaction and shared outcomes. As a consequence, the authors expect that team identity which is based on common fate should start high in the beginning of the teamwork but should shrink constantly over time. Bouas and Arrow (1996) describe the final stage of group development by a gradual emotional disengagement that includes both sadness about separation and (at least in successful groups) joy and pride in the achievements of the team. When only insufficient time is available for this separation process, a "reminiscence" period might occur that interferes with the formations of new teams.

To date, no empirical work is available that explores these considerations more systematically. Research is needed that examines which steps are helpful for a careful disbanding of virtual teams, and how experiences and best practices can be passed on to future virtual teams. Moreover, ways to celebrate and acknowledge the achievements of the teamwork should be explored, particularly because this is often neglected in the ongoing business. Also, managers need to know which specific challenges arise when members with different experience background in telecooperation are combined to new virtual teams. Finally, given that cohesion and team identification are rather difficult to develop in (transient) virtual teams, it is interesting to what degree interpersonal trust and cohesion are necessary, or whether these might be replaced by other processes (Jarvenpaa & Leidner, 1999). It is evident that longitudinal studies would be particularly helpful for these questions.

9. Summary and further research

The main objectives of this review were to summarize the available empirical research related to the management of virtual teams, to integrate this research into a lifecycle model, and to enable recommendations for practitioners. In doing so, we focused predominantly on quantitative studies of existing teams in organizational settings while experimental or case studies were considered when no field studies were available. Concrete practical recommendations are already mentioned in each of the sub-chapters that will not be restated here. However, the research reviewed also suggests more general principles for the management of virtual teams:

• A strong need for clarified team goals and team roles that are not in conflict with commitments to other work units,

- Careful implementation of efficient communication and collaboration processes that prevent misunderstandings and conflict escalation due to reduced communication cues,
- Continuous support of team awareness, informal communication, and sharing of socio-emotional cues together with sufficient performance feedback and information about the individual working situation of each virtual team member,
- Creating experiences of interdependence within the team in order to compensate for feelings of disconnectedness, for instance via goal setting, task design, or team-based incentives, and
- Developing appropriate "kick-off" workshops and team training concepts to prepare and support the teams for the specific challenges of virtual teamwork.

On the other hand, many issues have only slightly been addressed by systematic research, and many others not at all. Although the exploration of related research in experimental settings lead to a number of helpful assumptions and ideas, these still have to be tested in the field under "real-life" conditions. The following issues are among the most pressing to date.

Following the idea that "*virtuality*" *of teams* is not a distinct but a dimensional attribute, more systematic research is needed that explores different levels of virtuality and their moderating effects on team processes (e.g., Kirkman et al., 2004). Possible measures of virtuality have been mentioned above. Along with the rapid development of new communication and groupware technologies, these measures have to be updated periodically in order to keep up with the reality of collaboration in organizations. Moreover, the type of virtual teams together with the team tasks should be considered as additional moderators.

Apart from the heuristic use of integrating different empirical studies, the lifecycle model has revealed major differences between the phases in terms of systematic research. Particularly the later phases (team development, disbanding) lack systematic empirical research. Longitudinal studies are desirable to address these issues, and also to acknowledge the *developmental aspects of virtual teams*. As mentioned above, many disadvantages of virtual teams that are suggested by experimental research with ad hoc teams seem to diminish when a longer temporal scope is taken into account (e.g., Alge et al., 2003). More knowledge is needed whether this adaptation concerns only certain aspects of teamwork, what the underlying processes are, and whether these adaptation processes can be additionally supported by HRM strategies. Particularly fruitful in this context might be analyses of mediating and/or moderating effects of intra-team processes (motivation, communication, etc.; Hertel, Konradt, & Orlikowski, 2004).

Another important issue is the *role of the team manager* in virtual teams. Although different models of team autonomy are conceivable, research also suggests that virtual teams need guidance, structure and management. Managers are often not sufficiently prepared for this task because the specific demands of remote management are unclear. Future research should address these demands in order to enable appropriate selection and training practices. Moreover, a contingency model is desirable to connect different degrees of autonomy as well as different ways of leader–member interaction to different types of virtual teamwork.

Virtual teams are a new and exciting work form with many fascinating opportunities. Due to these opportunities, virtual teamwork becomes increasingly popular in organizations. Although many practical questions how such teams should be managed still await empirical investigation, this review of systematic research already documents many concrete recommendations that might support those managers and employees for whom virtual teamwork is common practice today.

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