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# The Impacts of Personnel Rotation on Performance of Distributed Teams: An Experimental Study

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## ABSTRACT

This study employed an experimental simulation to examine how well individuals and an entire distributed team could perform tasks when some members changed locations. Meanwhile, on a theoretical level it probed into the mechanism of how personnel rotation affected performance. We found that the impacts of personnel movements were asymmetric within a distributed team. Individuals shifting from a collocated office to a computer-mediated communication (CMC) site and those remaining at CMC sites performed worse after the rotation treatment. In contrast, people moving from a CMC site to a collocated site and those remaining in the collocated office did better after the rotation. Due to the cancel-out effect of the asymmetric impacts, the performance of an overall team seemed to be stable throughout personnel movements. The findings of this paper help unify the inconsistent literature and optimize the personnel rotation strategies.

### Keywords

Personnel rotation, distributed teams, computer-mediated collaboration.

## INTRODUCTION

Personnel rotation can be a dilemma in the management of distributed teams. On the one hand, moving to a remote site allows coworkers to “step into each other’s shoes” and build common ground within a distributed team. Common ground or shared knowledge is a critical factor in the success of distributed teamwork (Olson & Olson, 2000). On the other hand, personnel movement in a distributed team often means travel to an unfamiliar work environment. Visiting members may face a variety of challenges such as a new communication protocol and isolation from coworkers. The stress incurred by the challenges can offset the positive experience of a rotation. As distributed teamwork becomes a vital part of today’s economy (Hinds & Bailey, 2003), an understanding of when and how personnel rotation will positively or negatively affect task performance is critical to both researchers and practitioners.

In this study, we brought the dilemma of personnel rotation into the controlled setting of a laboratory. The experimental apparatus, Shape Factory (Bos et al., 2004), simulates a distributed team environment with some members collocated and some remote at CMC sites. In the experiment with the personnel rotation treatment, two collocated and two remote participants exchanged places midway through a session. By comparing observations from the controlled and the experimental sessions, we examined how well individuals and an overall team could perform tasks when personnel rotation occurred. Our thesis is that heterogeneities between collocated and CMC sites create adjustment challenges, the adjustment challenges demand cognitive effort, and the amount of cognitive effort affects the performance of distributed team members.

To facilitate the discussion, we use shift-out as the shorthand for moving from a collocated office to a CMC site. Shift-in refers to moving from a CMC site to a collocated office. Meanwhile, we categorize team members into:

- rotating collocators: those shifting from the collocated office to a CMC site

- rotating telecommuters: those moving from a CMC site to the collocated office
- permanent collocators: those remaining in the collocated office all the time
- permanent telecommuters: those staying on the CMC sites all the time

This paper addresses the following research questions:

1. What is the mechanism of the impacts of personnel rotation?
2. How does shift-out affect the performance of rotating collocators?
3. How does shift-in affect the performance of rotating telecommuters?
4. How does rotation of teammates affect the performance of permanent collocators?
5. How does rotation of teammates affect the performance of permanent telecommuters?
6. How does personnel rotation affect the performance of a distributed team as a whole?

## LITERATURE REVIEW

Related literature has not offered a consistent view on the impacts of personnel rotation. Some studies indicated positive effects of personnel movement, while others found negative impacts. For example, in field studies of distributed teamwork, personnel movement, often referred to as travel, was identified as a remedy to various management issues. These studies saw travel among distributed sites as a strategy to achieve common ground (e.g., Olson & Olson, 2000), a repair to communication breakdowns (e.g., Grinter et al., 1999), a means to build personal network (e.g., Grinter et al., 1999), a way to maintain trust among distant teammates (e.g., Rocco, 1998) and a preventive measure of conflicts in distributed teams (Hinds & Bailey, 2003). Similarly, in the lab, experimenters found that membership shift among work groups (either collocated or CMC) increased performance of individual groups (Arrow & McGrath, 1993) and enhanced knowledge sharing across groups (Kane et al., 2005).

In contrast, studies on transition to telecommuting, job transfer or technology adaptation revealed difficulties and negative impacts of personnel rotation. In the literature about telecommuting, researchers found that shift-out imposed both technological and social-psychological challenges. On the one hand, telecommuters had to set up new equipments at remote sites and acquired the skills to use them (Hartman et al., 1992). On the other hand, telecommuters tended to feel isolated, frustrated and deprived of a group identity (Harpaz, 2002). As a consequence to these challenges, there was often a reduction in productivity (with increases in absenteeism, turnover and medical claims) during the transition period (McShulskis, 1997). In studies of job transfer, it was reported that changes in work pattern or routines between the new and the old positions could cause anxiety and stress (Brett, 1982). Consequently, the anxiety and stress would negatively affect employment proficiency following a job transfer (Pinder & Schoreder, 1987). Meanwhile, adaptation theories from the management information systems (MIS) literature indicated that individuals and organizations had to develop new social processes to accommodate technological changes (DeSanctic & Poole, 1994; Tyre & Orlikowski, 1994). When team members move among distributed sites, they may face the difficulty of adopting new social structures or rules. Such a difficulty can impair their performance.

In our view, the inconsistent findings in the literature are due to the diverse research perspectives, confounding effects in fieldwork and a lack of theoretical explanations for the observations. This paper attempts to reconcile the literature by explicitly addressing these issues. First of all, we probe into the mechanism behind the impacts of personnel movement on job performance. Such a mechanism offers a theoretical framework to evaluate and integrate previous studies. Based on the mechanism, this paper hypothesizes the impacts of all possible rotation types (shift-in and shift-out) on members in all possible situations (permanent collocators, permanent telecommuters, rotating collocators and rotating telecommuters). Thus, we can obtain a comprehensive view of the impacts of personnel rotation on distributed team performance. Then, the controlled setting of a laboratory isolates confounding variables present in field studies.

## MECHANISM OF IMPACTS OF PERSONNEL ROTATION

There are three key elements in our thesis: adjustment challenges, cognitive effort, and the relationship between the cognitive effort and job performance. We borrow related theories from cognitive psychology, social psychology, communication, and MIS to explore each element and the connections among them.

### Adjustment challenges

Distributed teams are defined by geographically dispersed coworkers and technology-mediated communications (Hinds & Bailey, 2003). Consequently, two types of heterogeneities exist across collocated and CMC sites. First, physical distance among coworkers is different. Secondly, communication protocols vary across face-to-face (FTF) and CMC sites. These two types of heterogeneities are the sources of adjustment challenges in a personnel rotation.

A significant challenge resulted from uneven physical distance is the adjustment of group identity. Group identity is defined as "awareness of and attraction toward an interacting group of interdependent members, by self-identified members of that group." (Bouas & Arrow, 1996, p155-156) It is a critical factor in the cooperative behaviors of a distributed team. Previous research has recognized that distance matters in the formation and maintenance of group identity (Olson & Olson, 2000). In a collocated office, physical or social closeness (Riolo et al., 2001), visibility of others' behaviors (Buchan et al., 2002) and informal FTF contacts (Teasley et al., 2000) are major drivers of group identity. On remote sites, where people lack rich interpersonal cues, they depend on texts, voices and videos from CMC for a sense of connection to a team (Daft & Lengel, 1986). Naturally, when individuals move from one site to another, they may be frustrated by unfamiliar new norms to acquire and maintain their association with teammates.

In addition to the issue of group identity, one of the most obvious difficulties for rotating members is to switch between FTF and CMC protocols. In communications research, it has been recognized that FTF and CMC require two distinctive sets of competencies (Wright, 2004). FTF communications involve heavy use of speech, facial expression, body language, and inherent rules of privacy and overhearing (Teasley et al., 2000). CMC is highly dependent on text, symbols, and explicit rules of turn-taking and responding speed (Raffoni, 2000). When distributed team members shift between FTF and CMC sites, they may experience stress due to the changed communication protocols.

In summary, within a distributed team, uneven physical distance and varied communication protocols create the challenges of adjusting group identity and communication skills. Members have to exert cognitive effort to deal with the challenges. Here, "cognitive effort" means the level of brain activity (i.e., neural connection firing) required to accomplish a certain task (Lieberman 1991, 1998). A novel psychobiological model (Kock, 2004) helps us align the amount of cognitive effort required with different adjustment challenges.

#### Alignment between the adjustment challenges and cognitive effort

The psychobiological model applies Darwin's evolution theory to explain variations in cognitive effort in FTF versus computer-mediated collaborative tasks. According to the evolutionary principles of repeated use and brain-body coevolution, our biological communication apparatus have been designed primarily for FTF interactions. Our ability to use CMC tools is not a result of natural selection, rather enabled by the evolutionary development of increasing intelligence (Kock, 2004).

A key argument of the psychobiological model is that certain characteristics of CMC tools, particularly those that make interaction less "natural," make them more difficult, or cognitively demanding, for human beings. In distributed teams, a collocated site, by enabling FTF interactions, is a more natural environment than a CMC site. When members move from a collocated site to a CMC site, they are confronted by a more difficult and cognitively demanding environment than they used to have. Consequently, it will take them high degree of cognitive effort to adjust group identity and communicate skills. In contrast, when individuals shift from a CMC site to a collocated site, they face a more favorable environment than before. It takes them low level of cognitive effort to adjust. According to the focus theory of team productivity (Briggs, 1994), different amounts of cognitive effort can lead to varied job performance.

#### Relationship between cognitive effort and job performance

The focus theory of team productivity (Briggs, 1994) offers a framework to predict the effects of cognitive effort on task performance. Based on the assumption that human cognitive capacity is limited, the focus theory argues that team members have to allocate their limited cognitive capacity to the processes of exchanging and deliberating information in order to be productive. Therefore, team productivity is a reverse function of cognitive effort required for communication and deliberation.

The focus theory implies that lower amount of cognitive effort allows team members to better allocate their cognitive capacity and achieve better task performance. In contrast, higher level of cognitive effort may exceed the cognitive capacity of team members, thus hurts job performance. Figure 1 visualizes the mechanism of personnel rotation.

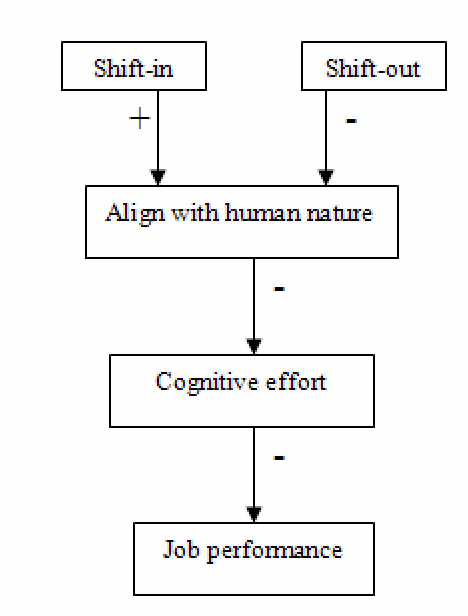


**Figure 1: mechanism of impacts of personnel rotation**

In the framework of the mechanism, we hypothesize that:

H1: shift-out has a negative impact on the performance of rotating collocators.

H2: shift-in has a positive impact on the performance of rotating telecommuters.

Previous studies have shown that in a distributed team, collocated members and remote members tend to form subgroups of their own (Bos et al., 2004). Performance of the distributed team members is mainly dependent on the efficacy of people in the same subgroup. On a collocated site, the improved performance of rotating telecommuters can enhance the work effectiveness of permanent collocators. On CMC sites, when rotating collocators have a hard time adjusting, their decreased performance may drag down the productivity of their fellow telecommuters. Thus, we propose that:

H3: rotation of teammates has a positive impact on the performance of permanent collocators

H4: rotation of teammates has a negative impact on the performance on permanent telecommuters

For distributed teams as a whole, performance changes of individual members are likely to affect the performance of the team. Therefore, we expect that:

H5: personnel rotation has an impact on the performance on a distributed team as a whole

## METHODS

### The experimental simulation: Shape Factory

To test the hypotheses, we employed an experimental simulation called Shape Factory. Shape Factory is an online game that we believe creates realistic dynamics of interdependent workgroups with a cooperative/ competitive incentive structure. In Shape Factory, participants played the part of specialty producers of one of five different shapes (square, circle, X, triangle, diamond). At the same time, each player had the task to collect shapes, different from ones specialty part, from other players to fill "customer" orders. Players earned game scores by selling their specialty shapes and filling orders. All players could produce each of the five shapes. However, non-specialty parts are very expensive for players to produce. If all parts for an order were produced by a player, no profit would be gained from filling an order. We imposed production limits to players so that there was a scarcity of shapes relative to customer demand. Therefore some players would need to produce some shapes on their own to be able to fill orders. Players had varied communication channels. To be successful in Shape Factory, players had to use the available channels to contact, negotiate and cooperate with others.

### Subjects

A total of 260 people participated in our experiments. Among the participants, 50% were female and 95% were students. Participants received $30 as the baseline payment plus a bonus up to $10. The bonus was proportional to their scores in the game. This payment scheme gave them more incentive to engage in the game.

### Configuration

There were 10 players in each session. Five of them were arranged in one room as "collocated" players and another five were put into separate rooms to work as "remote" players (also called "telecommuters" in this paper). Each of the collocated players was a specialty producer of one of the five shapes. And each of the remote players was specialized in one of the five shapes. All players were aware of the overall configuration of the game.

Collocated players could communicate face-to-face across the table or exchange text messages through the game interface. Remote players could only interact with other players via text messages in the game interface. Typically, distributed teams have a variety of ways to communicate--telephone conversations, occasional meetings, etc. In our experiment, the contrast between FTF and text messaging was to represent heterogeneity between collocated and CMC sites. We believe that it is this inequality rather than the exact technology that accounts for the challenges and impacts of personnel rotation.

### Procedure

Participants were assigned a color and condition by random draw. Before the game began participants were given 20 minutes to read game instructions. Each experiment session consisted of five rounds. During an experimental session, we recorded face-to-face conversations in the collocated room, and transaction details and text messages in the game interface.

At the end of the experiment all players met in the large room where a short joint debriefing took place. Participants were paid according to scores and were dismissed. It was assured that no participant could participate in the simulation more than once.

### The personnel rotation intervention

In the experimental sessions with personnel rotation, two collocated players and two remote players switched places during a short break between rounds 3 and 4. The two rotating collocators were specialized in the same shapes as the two rotating telecommuters, so that the overall configuration of shapes remained the same.

### Performance measures

In Shape Factory, performance means (1) how well players established relationship with others, (2) how well they finished assigned tasks and (3) how much profits they made in total. We employed number of non-specialty shapes produced, number of orders filled and game scores to measure the three dimensions respectively. In addition, to remove any session specific variables, we standardized game scores by their experimental session's mean and standard deviation. Based on the four measures, the hypotheses are further specified as:

H1: shift-out has a negative impact on the raw scores (H1a), standardized scores (H1b), number of orders filled (H1c) and number of non-specialty shapes produced (H1d) of rotating collocators

H2: shift-in has a positive impact on the raw scores (H2a), standardized scores (H2b), number of orders filled (H2c) and number of non-specialty shapes produced (H2d) of rotating telecommuters

H3: rotation of teammates has a positive impact on the raw scores (H3a), standardized scores (H3b), number of orders filled (H3c) and number of non-specialty shapes produced (H3d) of permanent collocators

H4: rotation of teammates has a negative impact on the raw scores (H4a), standardized scores (H4b), number of orders filled (H4c) and number of non-specialty shapes produced (H4d) on permanent telecommuters

H5: personnel rotation has an impact on the raw scores (H5a), standardized scores (H5b), number of orders filled (H5c) and number of non-specialty shapes produced (H5d) on a distributed team as a whole

## RESULTS

The statistics analysis was conducted on data from 13 controlled experimental sessions and 13 sessions with the personnel rotation treatment. In the sample, there were 65 baseline collocators (those from the controlled sessions), 65 baseline telecommuters, 39 permanent collocators, 39 permanent telecommuters, 26 rotating collocators and 26 rotating telecommuters. Our general approach was to compare performance measures between baseline, permanent and rotating players for every round. Then, we looked for any drastic changes of performance discrepancies after round three, when the rotation treatment occurred.

We employed independent sample t-test to compare data from the controlled and the experimental sessions. In this way, we saw the pure effect of personnel rotation on performance. Meanwhile, we used Mann-Whitney test to compare performance of rotating and permanent players from the same experimental sessions. The non-parametric test could accommodate the interdependence among measures from the same session. The contrast between permanent and rotating players allowed us to observe the relative performance changes within a distributed team.

### Impacts on rotating collocators

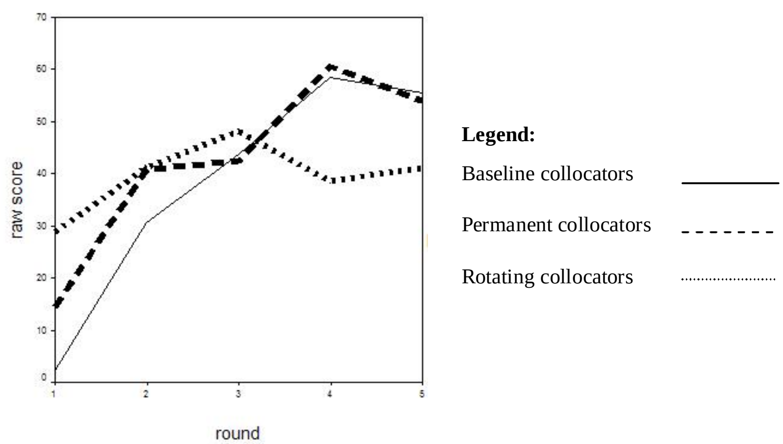


**Figure 2: raw scores of baseline, permanent, and rotating collocators**

Figure 2 illustrates the raw game scores of baseline, permanent and rotating collocators from round one to round 5. As is shown, there were no substantial differences among their scores from round one to round three. However, after round three, we saw a drop in the scores of rotating collocators. Similar patterns occurred on the other three indicators of performance.

T-tests confirmed that, in the third round, there was no difference between their raw scores, standardized scores, orders filled and non-specialty shapes produced (all $p$ values are greater than .05). In the fourth round, rotating collocators had significant lower raw scores than baseline collocators ($p$=.027), and produced significantly more non-specialty shapes than baseline collocators (*p*=.015). The performance difference became even more pronounced in round five. Rotating collocators earned less raw scores (*p*=.026), less standardized scores (*p*=.047) and filled less orders (*p*=.029) than baseline collocators.

Comparing the performance of permanent and rotating collocators, we saw similar results. Mann-Whitney tests showed that there was no significant difference between their four performance measures from round one to three. However, in round four, rotating collocators performed significantly worse than permanent collocators in terms of raw scores (*p*=.019), standardized scores (*p*=.02), orders filled (*p*=.05) and non-specialty shapes produced (*p*=.036). Similar performance discrepancies showed in round five. Rotating collocators earned less raw scores (*p*=.008), less standardized scores (*p*=.008), and filled less orders (*p*=.047) than permanent collocators. Both the t-tests and the Mann-Whitney tests provided evidence to support hypotheses H1a, H1b, H1c and H1d.

#### Impacts on rotating telecommuters

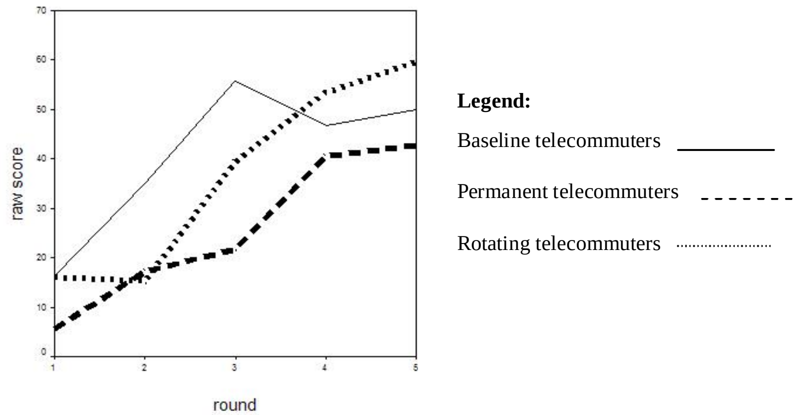


**Figure 3: raw scores of baseline, permanent, and rotating telecommuters**

Figure 3 displays the raw game scores of baseline, permanent and rotating telecommuters from round one to round five. Statistics tests indicated that rotating telecommuters performed better than baseline telecommuters after the rotation treatment. In the third round, baseline telecommuters earned more raw scores than rotating telecommuters (*p*=.013). In round four, rotating telecommuters caught up and made equal scores as baseline telecommuters (*p*=.27). In addition, from round one to three, there was no difference in numbers of non-specialty shapes produced by baseline and rotating telecommuters. After the rotation, rotating telecommuters produced significantly less non-specialty shapes than baseline telecommuters in round four (*p*=.012) and round five (*p*=.025).

In the thirteen experimental sessions, we saw that relative performance of permanent and rotating telecommuters changed after the rotation treatment. From round one to round three, there was no difference between their performance measures. In the fourth round, rotating telecommuters earned more raw scores (*p*=.032) and more standardized scores (*p*=.048) than permanent telecommuters. In the fifth round, rotating telecommuters filled more orders (*p*=.037) and produced less non-specialty shapes (*p*=.028) than permanent telecommuters. Hypotheses H2a, H2b, H2c and H2d were supported by the data.

#### Impacts on permanent collocators

T-tests did not reveal any difference between performance of baseline and permanent collocators throughout the five rounds (all five *p* values are greater than .05). However, as reported above, permanent collocators did significantly better than rotating collocators after round three on all four performance measures. Therefore, hypotheses H3a, H3b, H3c and H3d were partially supported.

#### Impacts on permanent telecommuters

Although baseline and permanent telecommuters had equal performance after the rotation treatment (all five *p* values were greater than .05), permanent telecommuters did significantly worse than rotating telecommuters in the fourth and fifth rounds (see above section for statistics details). Therefore, H4a, H4b, H4c and H4d were partially supported.

### Impacts on the overall team

We compared the average raw scores, standardized scores, orders filled and non-specialty shapes produced from the baseline and the experimental sessions. T-tests did not show any significant difference (all *p* values are greater than .05). Therefore, H5a, H5b, H5c and H5d were not supported.

Table 1 displays the summary of the hypotheses testing results.

| Hypothesis | | Supported? |
|---|---|---|
| H1: negative impacts on rotating collocators | H1a: raw scores | Yes |
| | H1b: standardized scores | Yes |
| | H1c: orders filled | Yes |
| | H1d: non-specialty shapes produced | Yes |
| H2: positive impacts on rotating telecommuters | H2a: raw scores | Yes |
| | H2b: standardized scores | Yes |
| | H2c: orders filled | Yes |
| | H2d: non-specialty shapes produced | Yes |
| H3: positive impacts on permanent collocators | H3a: raw scores | Partially |
| | H3b: standardized scores | Partially |
| | H3c: orders filled | Partially |
| | H3d: non-specialty shapes produced | Partially |
| H4: negative impacts on permanent telecommuters | H4a: raw scores | Partially |
| | H4b: standardized scores | Partially |
| | H4c: orders filled | Partially |
| | H4d: non-specialty shapes produced | Partially |
| H5: impacts on the overall team | H5a: raw scores | No |
| | H5b: standardized scores | No |
| | H5c: orders filled | No |
| | H5d: non-specialty shapes produced | No |

**Table 1: hypothesis testing results**

## DISCUSSION

As shown in table 1, our data analysis supported the first and second hypotheses, partially supported the third and fourth hypotheses, and rejected the fifth hypothesis. In general, we see that impacts of personnel rotation were asymmetric in a distributed team. Individuals who shifted-out experienced a significant decrease in their performance. In contrast, people who shifted-in had a substantial increase in their performance. The performance of permanent collocators tended to be boosted by the rotation of colleagues, whereas the performance of permanent telecommuters was impaired by the movement of coworkers. Due to the cancel-out effect of the asymmetric impacts, the performance of an overall distributed team seemed to be stable throughout personnel movements.

The laboratory findings strengthen our confidence in the proposed mechanism of impacts of personnel rotation. The asymmetric effects are consistent with the reasoning of the mechanism. The settings of the collocated and the CMC sites in our experiments created unequal adjustment challenges. The unequal challenges imposed uneven demands of cognitive effort on the rotating members. Because of the limited cognitive capacity of human beings, the uneven cognitive effort demands led to the asymmetric performance observed in the lab.

The theoretic mechanism and empirical findings of this paper provide a framework to unify the inconsistent literature. Studies reporting positive effects of personnel rotation might have captured the favorable results of a shift-in, or the improved performance of rotating telecommuters and permanent collocators (e.g., Olson & Olson, 2000). On the other hand, research showing a negative effect of personnel movement might have focused on consequences of a shift-out, or the impaired performance of rotating collocators and permanent telecommuters (e.g., McShulskis, 1997). Alternatively, the adjustment challenges of their research sites could require varied levels of cognitive effort. The inconsistent observations were indications of the varied cognitive demands (e.g., Kane et al., 2005 versus Brett, 1982).

This paper has three managerial implications. First of all, it is important for managers to recognize the disparity in adjustment challenges faced by rotating members. Even when the performance of an overall team seems intact, individual members may have opposite experience in a rotation due to uneven cognitive loads. Managers should provide customized support and training to members in different situations. Secondly, when trying to identify the individual needs of rotating members, managers can use the two principles of human nature: (1) human beings have limited cognitive capacity, and (2) we are hard-wired for FTF rather than CMC channels. Managers can predict the demand of cognitive effort in a rotation by assessing how many CMC related skills have to be learnt on a new site. The more skills one has to learn, the less cognitive effort one can spare for the tasks of distributed teamwork. Thirdly, personnel movements also affect non-rotating members. While enjoying the increased performance of permanent collocators, managers should help permanent telecommuters prepare for and cope with the “down time” of new comers to the CMC sites.

## CONCLUSION

In this study, we employed a laboratory experiment to examine the impacts of personnel rotation on distributed team performance. Data analysis confirmed most of our hypotheses. We found that personnel movement had a detrimental effect on performance of rotating collocators and permanent telecommuters, and a positive effect on rotating telecommuters and permanent collocators. Due to the cancel-out effect of the asymmetric impacts, the performance of an overall distributed team seemed to be stable throughout personnel movements.

With the growing importance of distributed teamwork, an understanding of when and how personnel rotation will affect task performance is critical to both researchers and practitioners. This paper offers a theoretical explanation for the impacts of personnel rotation. The theoretical framework helps subsequent studies integrate the literature and identify new issues. Empirically, we isolate the relationship between personnel rotation and performance in the controlled settings of a lab experiment. Our findings provide a clear and comprehensive view of how different rotation types (shift-in vs. shift-out) affect individuals in all possible situations (rotating vs. non-rotating members). To practitioners, we provide managerial guidelines to tackle the dilemma of personnel rotation. With the guidelines, both managers and employees can be more effective in planning and accomplishing personnel movements in a distributed team.

As the first step in the study of personnel rotation, this paper only focused on observations of a narrow sample (mostly college students), with simple assignment (Shape Factory), and in a short time frame. Previous studies have indicated that development patterns of group identity and communication skills change over time (e.g., Bouas & Arrow, 1996). The external validity of this study can be improved with broader samples (e.g., managers of distributed-teams), more realistic tasks and longer periods of time. In addition, the findings of this study may be confounded by the skill level of team members. Future work can test the effect of personnel rotation when controlling the skill variable.

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## REFERENCES

1. Arrow, H. and McGrath, J. E. (1993). Membership matters: How member change and continuity affect group structure, process and performance. *Small Group Research*, 24, 334-361.
2. Bos, N., Sadat Shami, N., Olson, J.S., Cheshin, A. and Nan, N. (2004) In-group/out-group effects in distributed teams: An experimental simulation. In *Proceedings of CSCW 2004*, ACM Press, 429-436.
3. Bouas, K. and Arrow, H. (1996) The development of group identity in computer and face-to-face groups with membership change. *Computer Supported Cooperative Work*, 4, 153-178.
4. Brett, J. M. (1982). Job transfer and well being. *Journal of Applied Psychology,* 67, 450-463.

5. Briggs, R.O. 1994. The focus theory of group productivity and its application to the design, development, and testing of electronic group support technology. Doctoral Dissertation, University of Arizona.
6. Buchan, R.N, Croson R.A. and Dawes, R.M. (2002) Swift neighbors and persistent strangers: A cross-cultural investigation of trust and reciprocity in social exchange *The American Journal of Sociology*, 108, 1,168-206.
7. Daft, R. L. and Lengel, R. H. (1986). Organizational information requirements, media richness, and structural design. *Management Science*, 32, 554-571.
8. DeSanctis, G., and Poole, M. (1994) Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization Science*, 5, 2, 121-147.
9. Grinter, R. E., Herbsleb, J. D. and Perry, D. E. (1999). The geography of coordination: dealing with distance in R&D work. *Proceedings of the international ACM SIGGROUP conference on Supporting group work*, Phoenix, Arizona, USA, 306 – 315.
10. Harpaz, I. (2002). Advantages and disadvantages of telecommuting for the individual, organization and society. *Work Study*. 51, 2/3, 74 - 81.
11. Hartman, R. L., Stoner, C. R., and Arora, R. (1992). Developing successful organizational telecommuting arrangements: Worker perception and managerial prescriptions. *SAM Advanced Management Journal*. 57, 3, 35 -42.
12. Hinds, P. J. and Bailey, D. E. (2003) Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science*, 14, 6, 615-632.
13. Kane, A. A., Argote, L. and Levine, J. M. (2005). Knowledge transfer between groups via personnel rotation: Effects of social identity and knowledge quality. *Organizational Behavior and Human Decision Processes*, 96, 56-71.
14. Kock, N. (2004) The psychobiological model: Towards a new theory of computer-mediated communication based on Darwinian evolution. *Organization Science*. 15, 3, 327-348.
15. McShulskis, E. (1997). Ease the transition to alternative office arrangements. *HRMagazine*. 42, 10, 20 – 22.
16. Olson, G.M., and Olson, J.S. (2000). Distance matters. *Human Computer Interaction*, 15, 139-179.
17. Pinder, C. C., and Schoreder, K. G. (1987) Time to proficiency following job transfer. *Academy of Management Journal*, 30, 2, 336-353.
18. Raffoni, M. (2000) Managing your virtual company: Create a communication plan. *Harvard Management Communication Letter*, April, 7-8.
19. Riolo, R.L., Cohen, M.D. and Axelrod, R. (2001) Eolution of cooperation without reciprocity. *Nature*, 4, 22, 441-443.
20. Rocco, E. (1998) Trust breaks down in electronic contexts but can be repaired by some initial face-to-face contact, *Proceedings of the Conference on Human Factors in Computing Systems* (CHI'98), 496-502.
21. Teasley, S.D., Covi, L., Krishnan, M.S., and Olson, J.S. (2000). How does radical collocation help a team succeed? *Proceedings of Computer-supported cooperative work*. New York: ACM.
22. Tyre, M. J., and Orlikowski, W. J. (1994) Windows of opportunity: Temporal patterns of technological adaptation in organizations. *Organization Science*. 5, 1, 98-118.
23. Wright, K.B. (2004). On-line relational maintenance strategies and perceptions of partners within exclusively internet-based and primarily internet-based relationships. *Communication Studies*, 55, 2, 239-253.