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The HKNet Project:  
From Technical Innovation to Creative Group Problem Solving<sup>1</sup>

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<sup>1</sup> This paper contains an extended abstract based on the forthcoming paper "Group Support Systems and Virtual Collaboration: The HKNet Project" to appear in the Journal of Decision and Negotiation. For more details regarding the HKNet project, see Vogel et al. (2001).

## **Abstract**

With the development of new technologies, and particularly communication technology, societies have evolved to encompass new forms of interaction and collaboration. It is an illusion to think that relationships between human beings and their institutions will not change in essence in the future. We assume that the very nature of e-communication and of groupware such as Group Support System can support innovation and creativity in a context of cultural and professional diversity. In 1998, 1999 and 2000 an educational project (HKNet) between the City University of Hong Kong (China) and the Eindhoven University of Technology (The Netherlands) has shown that remote collaboration can lead to successful and innovative problem solving in multicultural groups. This study focused on 178 participants, all of whom were involved in academic courses on software engineering, informatics and management using e-mail, videoconferencing, Internet phone connections and GroupSystems™ for both synchronous and asynchronous interactions. The task was to participate in a joint project on a chosen IT-related subject resulting in a joint report. We assumed that if the HKNet project is a source of learning and knowledge to our participants, we should be able to measure what they learned culturally and professionally. Results revealed that the HKNet project created a win-win situation for both universities. Throughout the three-year project, GroupSystems™ supported efficient group problem solving, development of new-shared meaning and cultural attitude changes. The groups wrote creative reports that reflected their having worked successfully together. The observed factors that determined the performance of the teams in the HKNet project were: Technology Infrastructure, Interaction, Professional background and Cultural background. Following this overview on the HKNET project set-up and the lesson learned (Vogel et al., 2001; Rutkowski et al., forthcoming) the paper concludes with the description of next year experimental set-up. Special emphasis will be given to innovation and creativity in problem solving of technical nature. Participants from the "Institut Polytechnique de Grenoble" and "Grenoble University" (France) will join the HKNET teams.

## INTRODUCTION

With the development of new technologies, and particularly communication technology, societies have evolved to encompass new forms of interaction and collaboration. It is an illusion to think that relationships between human beings and their institutions will not change in essence in the future. Plato and other philosophers exchanged their ideas in the Greek Agora. Group Support Systems (GSS) appear to us to be a "virtual Agora" where information and ideas can be exchanged at different times and from various places.

GroupSystems™ is a prototype of a GSS workstation. Each member of a meeting uses his personal workstation linked to the other workstations through a network and participate to electronic activities required to support e-collaboration (Vreede, 1995). GroupSystems™ is the most widely used electronic meeting system in the world. The software allows knowledge accumulation, representation and categorisation. GroupSystems™ consists of a set of tools to support idea generation, idea organisation, votings and issue exploration [Nunamaker, Vogel and Konsynski, 1989]. It is mainly based on the technique of brainstorming [Osborn, 1953] that attempts to increase creative ideas by avoiding criticism and by focusing on quantity. Four rules support the activity of brainstorming, express all ideas that come to mind, even if sound crazy (1); the more ideas, the better (2); don't worry whether the ideas are good or bad, they can be evaluated later (3); all ideas belong to the group, so members should feel free to build on each other's work (4). The technique of brainstorming is well recognized as reducing bias of "production blocking" (Diehl and Stroebe, 1987). The activity in essence is democratic and is mostly conducted in anonymous context.

The literature on group communication software, and particularly Group Support System (GSS) tools, is vast and has been examined over the years from a variety of perspectives [Nunamaker *et al.* 1997]. More recent GSS literature looks especially at support organisational co-ordination and interaction between various organisational structures working within a decentralised market that evolves in different times and places [e.g., Qureshi and Vogel 2001]. Empirically, the majority of GSS research has been conducted with groups in a laboratory context at the same time and same place. Studies conducted in educational contexts with the support of GSS at the asynchronous level and in the real world are relatively rare [Alavi *et al.* 1997; Vogel *et al.* 1999]. However, research conducted indicated that distance education when employing group communication software can produce educational results as good as face to face and in some case even better (Jarvenpaa and Leidner, 1998; Turoff and Hiltz, 2000).

In 1998, 1999 and 2000 an educational project (HKNet) between the City University of Hong Kong (China) and the Eindhoven University of Technology (The Netherlands) has shown that remote collaboration can lead to successful problem solving in multicultural groups. The HKNET project presented in the paper is an example of a win-win e-collaboration between Chinese and Dutch engineers. For the past three years, 178 students participated in this educational project. The participants were involved in an academic course on software engineering, informatics and

management. They used e-mail, videoconferencing, Internet phone connection (Firetalk) and GroupSystems™ to communicate synchronously and asynchronously. This project brought together participants from a Western and an Eastern culture to collaborate outside the laboratory in a distributed environment.

Following this overview on the HKNet project set-up and the lesson learned (Vogel et al., 2001; Rutkowski et al., forthcoming) the paper concludes with the description of next year experimental set-up. Special emphasis will be given to innovation and creativity in virtual team. The task of the participants will be to develop the most creative and innovative e-market place. Other technologies such as webboard, videolectures will support the virtual interactions between the participants and the instructors. A third culture should be involved in the design with the participation of French students from the "Institut polytechnique de Grenoble" and "Grenoble University".

### **THE HKNet-1-2-3 PROJECT SET-UP**

The HKNet project consisted of already existing academic courses on software engineering, informatics and management (MBA) at both universities. The goal of the project was to make a valuable contribution to the knowledge of its participants by letting teams do a joint project on a specific IT-related subject resulting in a joint report. At both locations, students formed their own local team consisting of three to four team members. Thereafter, local teams were allocated to global teams, each with a specific assignment. Examples of assignments were: status and actions taken in Hong Kong versus the Netherlands with respect to Y2K issues, software management in large projects, trends in embedded software, software quality control, labour shortages in the IT sector and critical success factors for successful development of software. By communicating with their team members overseas through group support technologies, the students also gained experience in using these technologies and the team dynamics within these distributed multi-cultural teams.

The four main educational objectives in this experiential learning context were:

- 1) Let the students gain insight into software engineering, informatics and managerial issues from a business perspective and increase the understanding of the differences and similarities between Europe and Asia.
- 2) Let the students experience the pros and cons of co-operating in a distributed team, with members from different cultures and backgrounds.
- 3) Let the students experience the advantages and disadvantages of using a remote Group Support System.
- 4) Let the students become familiar with several applications of GroupWare, which can be valuable to their study and (future) work.

GroupSystems™ served as a shared group memory and a common environment for both synchronous and asynchronous brainstorming, discussion, voting and report writing. Thin client technology was used to supply all participants with Internet connectivity to enable GroupSystems access from their homes and businesses as well as from their universities. All participants additionally had an e-mail account at their disposal. Microsoft NetMeeting was used the first year (HKNet-1) for synchronous face-to-face contact. The NetMeeting sessions could be booked in the agenda in the

main project folder of GroupSystems. ISDN videoconferencing was used the second two years (HKNet-2, -3) and audio-conferencing via Internet (Firetalk) was introduced in the last year of the project.

The time schedule was rigorous and short (6 weeks). The first two activities (namely brainstorming research questions and voting on research questions) took two weeks in HKNet-1. In HKNet-2 the students were guided through the brainstorming in three days, after which the convergence was done in a videoconference. In HKNet-3 it was enlarged to one week. This gave the project an interactive and fast start. The aim of this rigorous schedule was to encourage time management; preventing rushed and hurried work at the end. Students were made more aware of educational and cultural differences and their possible implications through virtual lectures on cultural diversity.

### **Cultural background: Western versus Confucius**

Hofstede [1980, 1983] defined Culture as the collective programming of the mind which distinguishes one category of people from another. In the broadest sense culture is a patterned ways of thinking, feelings and reacting that is shared by a set of individuals. Culture is a system of knowledge, a set of learned behavior and beliefs, a way to categorised experience shared by a society, population, group of individual, governing behaviour and beliefs.

Hofstede's studies on cultural characteristics provide important information for gaining an understanding of the two groups and the nature of their interactions. Actually, the two groups scored differently on the four well-known dimensions: Power Distance (high versus low), Uncertainty Avoidance (high versus low), Individualism (versus Collectivism), Masculinity (versus Femininity). The index for each dimension is presented in Table 1, which clearly underlines the gap between the Hong Kong and the Netherlands cultures. As the table indicates, these cultures have very different meanings and conceptualisations of relationships between individuals and are almost antagonist.

		Power Distance	Uncertainty Avoidance	Masculinity	Individualism
Hong Kong	Index	68	29	57	25
	Rank	37-38	4-5	32-33	16
Netherlands	Index	38	53	14	80
	Rank	14	18	3	46-47

\*Rank Number: 1= Lowest; 50= Highest.

*Table 1. Hong Kong and Netherlands index and rankings on Hofstede's four dimensions of culture [Hofstede 1983]*

The Individualism/Collectivism dichotomy observed in the Chinese culture is supported by many studies [Bond and Hwang 1986]. Confucianism and Buddhism centre on "five 'cardinal relations' Wu Lun: in which power differentials and responsibilities are prescribed: relations between emperor and minister, father and son, husband and wife, among brothers, and among friends". In other words, the organisation of the Chinese society follows the rules of 'guanxi' that can be defined as

a network of personal relationship or of interpersonal connections regulating social interaction [Hwang 1987]. Guanxi is the predominant social structure of Chinese society and is based on the principles of reciprocity in social interaction. A person's guanxi drives interpersonal attitudes and behaviour. The guanxi is representative of the collectivist aspect of the Chinese culture. The Eastern concept of guanxi is very similar to the Western concept of interdependence. Interdependence exists when the outcomes of individuals are affected by another person's actions. Of major interest is that Chinese social psychology considers positive outcomes as the product of a harmonious interdependent group (i.e., in the sense that members cannot be seen as distinct from each other), while Western social psychology considers that positive outcomes are individual products. Interdependence [Rijsman 1997; Rutkowski *et al.* 2001] is not seen as required and constant but [Veght van der *et. al* 1999] rather dependent on the manner team members believe their personal goals and rewards are related (i.e., outcome interdependence). Furthermore, the perceived value of interdependency depends on the structural feature of the relationships between team members and stems from the tasks within the team (i.e., task interdependence).

The role of a leader in Chinese organisations follows the guanxi. In this way, the leader's primary function is to maintain harmonious relationships with the followers and to define the task. The leader is expected to take control and be in possession of solutions that will be offered to the group. A democratic style of leadership is generally advocated and is more representative of a tendency to reach a consensus rather than representative of the Western process of reification. Reification is defined as the social process that converts an abstraction or mental construct into a supposed real entity [Gemmill and Oakley 1992]. In the Western culture, a democratic style of leadership refers more to an extraordinary personality (i.e., charisma) and the ability to balance freedom and authority.

We assumed during the three years of the project that if the HKNet project is a source of learning and knowledge to our participants, we should be able to measure what they learned culturally and professionally. Based on the observation of the HKNet-1 project, questions were selected and constructed to measure the evolution of each participant in a pre-test/post-test configuration.

## METHODOLOGY

### Participants

One-hundred-seventy-eight students participated in the three years of the HKNET project. Dutch participants were mainly students from the Technical University Eindhoven and were younger ( $23 < m < 25$ ) than the Chinese participants from the City University of Hong Kong ( $25 < m < 35$ ). Despite the age differences, their interests in the project were similar. To complete the methodology, two independent control groups of students from the same cohort, one Dutch ( $n=32$ ) and another Chinese ( $n=20$ ), who did not participate in the project completed in parallel the same survey as the HKNet participants. Central to our research is that these students showed no particular attraction to work in a virtual environment on a multicultural project. The selected results for the HKNet-2 and -3 project that will be presented are based on the participation of  $N=106$

students and 204 surveys and linked to the results gather during the first year of the project [Vogel *et al.* 2001].

### **Design, procedure and material**

A total of 204 questionnaires were completed during the time of the HKNet-2 and -3 projects. The participants were asked to fill in a first questionnaire (i.e., pre-test) prior to working in their group and a second questionnaire (i.e., post-test) at the end of the project before receiving their grades. This manipulation is classically used to measure the effect of the treatment (i.e., virtual communication in group) on the participants' evaluation in the post-test [Howell 1997; Brown 2000]. The pre-test and the control groups provided two baselines of comparison.

The pre-test and the post-test questionnaire were constructed on a similar basis, adapted according to the results of the previous project. The theoretical corpus was borrowed from the classical literature referenced in the previous section of the paper. In the first part of the questionnaire, participants were asked to rate items relative to core cultural concepts such as Guanxi, leadership and interdependence on a 10-point-scale [Osgood and Tannenbaum 1955; Himmelfarb and Eagly 1974]. In the last part of the questionnaire, a set of various questions on technology, learning and satisfaction were also asked.

### **LESSON LEARNED**

Given the consistent and dramatic differences both within and between teams over the course of the project the question arises as to the role of project processes and technological support. We conclude that effectively supporting virtual teamwork with current available off-the-shelf technology is possible but begs improvement.

The observed factors that determined the performance of the teams in the HKNet project were: Technology Infrastructure, Interaction, Professional background and Cultural background. Each factor is a potential hurdle that must be dealt with before a team can effectively perform its task. All the factors interact heavily with each other. The more a factor is linked to human identity, the harder it is to influence the impact of that variable on the performance of a virtual team. The characteristics of virtual teamwork and especially the fragile interaction process call for a certain set of qualities the team members should possess. The qualities that were observed to positively affect the teamwork during the HKNet project were: discipline, assertiveness and the ability to express oneself clearly and concisely. With sufficient personal and personnel support, groups rise to the occasion in spite of technological shortcomings. When designing virtual teamwork processes it is important to minimise the negative aspects of the factors that influence the performance of virtual teams. To achieve this in an educational environment, the following rules of thumb are suggested:

#### Create common ground for the students

Design unambiguous deliverables that are equally challenging to all students.  
Make sure students are able to spend an equal amount of time on the project.  
Create a common frame of reference by supplying the same preceding lectures (preferably by linking classrooms with a videoconference).

### Make sure that technology forms no barrier

Choose the right mix of technologies by making a trade off between maximising functionality and minimising the need for training.

Train the users to ensure that they know how to use the technology.

Provide quick support in case of any kind of technical problem.

### Stimulate interaction from the start

Supply training in the required qualities for working in virtual teams.

Start a project with (synchronous) teambuilding exercises to establish trust.

Plan frequent synchronous interactive activities to maintain trust and facilitate decision-making.

### Apply a "sandwich structure"

For the overall design of virtual teamwork processes, it is recommended to apply a "sandwich" structure. This means starting with a same time/same place meeting, then continues with asynchronous distributed work and finalise with again a same time/same place meeting. If it is not feasible to meet in the same place, a high quality videoconference meeting could be organised instead.

All the HKNet participants enjoyed the project. However, the Dutch participants liked it significantly more than the Chinese ( $m_{Net}=7.353$  and  $m_{HK}=6.362$ ). This may be explained by the different background in age and professional experience. They both agreed and declared that they socially ( $m_{hknet}=6.25$ ) and professionally ( $m_{hknet}=6.5$ ) learned and gained knowledge. According to the descriptive results emerging from the post-test in HKNet-1 and -2, time pressure and lack of face-to-face interaction were judged to be the two main problems during the project. When the students were asked in the post-test, "Which technologies were the most important to support your activity and the virtual team spirit?" the answers were as indicated in Table 2. Results reflect a combination of technology familiarity and resolution of project concerns. For example, e-mail was heavily used and useful not only for communication but also for exchanging report drafts at attachments. Of particular interest is the relative perceived importance of videoconferencing to the Dutch compared to the Chinese. Further, the Chinese felt that the Internet rated higher in terms of support than did the Dutch. It would suggest that the Chinese were more focused on content while the Dutch were more concerned with establishing interpersonal relationships. Lack of face-to-face contact was consistently rated more highly by the Dutch in terms of problems anticipated and encountered. The Chinese had significantly more work experience than the Dutch which gave them more confidence in working in teams. The Chinese were also under more time pressure since they also worked full-time and were typically more focused in terms of generating project content, albeit often times at the last minute, relatively speaking.

	Chinese	Dutch
Email	26.76	27.83
Internet	19.95	18.45
Videoconference	16.33	18.45
Asynchronous use of GSS	15.65	14.88
Synchronous use of GSS	15.65	
Firetalk	5.67	5.06

Table 2. Technology support required

The results of ANalysis Of Variance (ANOVA) conducted on the item "Is the presence of a leader in the group required?" and revealed a significant Nationality main effect ( $p=.001$ ) in the pre-test on a 10-point scale. The Dutch HKNet participants classically thought that a leader is less required ( $m_{Net}=6.5$ ) than the Chinese HKNet participants ( $m_{HK}=7.8$ ) did. It is interesting to note that the ANOVA conducted on the same item revealed no significant main effect in the post-test. Hence, the two groups joined a virtual consensus ( $m_{Net}=5.6$ ;  $m_{HK}=6$ ). Leadership was less important in the virtual framework than both groups expected. The within comparisons for each groups show that the Hong Kong participants changed significantly ( $t(44) = 5.675$ ,  $p<.0001$ ) their opinion between the pre-test ( $m_{HK}=7.8$ ) and the post-test ( $m_{HK}=6$ ). The same effect is observed for the Dutch who also changed their opinion significantly ( $t(50)=3.294$ ,  $p=.018$ ) between the two tests. The results are summarised in Table 3.

	Hong Kong** nHK=45		The Netherlands*** nNet=51	
	M	SD	M	SD
Pre-test *	7.8	1.4	6.5	1.8
Post-test <sup>ns</sup>	6	1.7	5.6	2

$p=.001$ ; ns: non-significant difference between the two groups in the post-test,

\*\*  $p<.0001$ , \*\*\*  $p=.018$

Table 3 Between and within comparisons on the item "leadership"

The pattern of results is similar for most of the items in the questionnaire. It shows that participants changed their attitudes toward a virtual consensus on core cultural concepts (i.e., interdependence, team compatibility, and homogeneity).

## CONCLUSION

Overall it can be concluded that the HKNet participants enjoyed the project and that they gained socially and professionally from it. The HKNet project created a win-win situation for both universities. Throughout the three-year project, GroupSystems™ supported efficient group problem solving, development of new-shared meaning and cultural attitude changes. The groups wrote creative reports that reflected their having worked successfully together. Of interest is that consensus on very sensitive cultural items such as leadership and Guanxi was reached without specific activities of negotiation between the participants. Virtual collaboration led both cultures to recognise the complex nuances of social interaction in cross-cultural distributed teams.

Based upon the lesson learned, next year project will be based on four new objectives:

- 1) Let the students gain insight into Business to Business (B2B) issues.
- 2) Let students experience the practical side of developing a e-market place and to solve more technological complex problems.
- 3) Let the students become familiar with more groupware applications and tools such as Blackboard, GroupI™.
- 4) Let students experience co-operation in a distributed team with members from three diverse cultures (Chinese, Dutch and French) and from different educational background (technology and management).

The process of creativity can be defined as the development of novel ideas that are useful and based on divergent thinking (Amabile, 1983). To conclude, we expect that the social diversity supported by group communication software such as GroupSystems™ and GroupI™, and inherent to the nature of the e-collaborating teams will lead participants to develop creative and innovative work. The methodology will be based on a positivist experimental design, allowing to compare social diversity versus homogenous teams.

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