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Group Support Systems and Virtual Collaboration: The HKNET Project

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Abstract

Groupware, and particularly Group Support System (GSS) tools, support organisational co-ordination and interaction between various organisational structures working within a decentralised market that evolves in different times and places. 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. 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. 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. This paper presents selected results in an abbreviated form and the lessons learned from the last three years of the HKNet experience. Special emphasis is given to social and cultural phenomena. Limitations of our study will be discussed before to conclude with future research plans.

1. 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.

Classically, universities are the place within society where new knowledge is developed and tested in a laboratory setting. Congruently, universities are made up of students who want to learn and to experience new things. For the past three years, 178 of such students participated in an educational project entitled HKNet between the City University of Hong Kong (China) and the Eindhoven University of Technology (The Netherlands). 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. Of interest was that this project brought together participants from a Western and an Eastern culture to collaborate outside the laboratory in a distributed environment.

A characteristic of the HKNet project was to be a longitudinal study. Each new project, theoretical corpus, research problem and measurement tools were adapted according to the results of the previous project. Since three years the motivation to carry on with the HKNet project built on the original ones (Vogel et al. 2001).

1. Educational objectives, e.g., prepare and let students experience e-collaboration in a context of cultural and professional diversity;
2. Business objectives, e.g. to improve our knowledge of virtual teams and their chemistry, to propose efficient solutions to virtual teams in business;
3. Fundamental objectives, e.g. gather data to better understand the rich and diverse social phenomena arising in this distributed and multicultural environment.

After, the three years of the project we felt it could be of interest to summarise the results and the main conclusions drawn from this Sino-Dutch virtual collaboration.

The paper begins with the presentation of the HKNet project set-up and the participants' background. Special emphasis is given to social and cultural aspects. A section related to methodology and measurements follows. Throughout the three-year project, we assumed that if the HKNet project is a source of learning and knowledge to the participants, we should be able to measure what they learned culturally and professionally. Before we discuss processes and technological supports required to efficient collaboration in virtual team, selected results will be presented in an abbreviated form. Limitations of our study will be discussed before we conclude with future research plans.

2. Background

The literature on Groupware, 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 (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).

Classically, the level of analysis in GSS studies has not included in-depth case observation and longitudinal observation (Jarvenpaa and Leidner 1998). There has, however, been some attention to the nature and impact of culture that serves as a starting point for more in-depth study in this area. For example, Watson et al. (1994) examined some cultural implications of the use of GSS in Singaporean student contexts. Mejias et al. (1997) compared consensus and satisfaction levels of Mexican and US student groups as a function of cultural dimensions. Tan et al. (1998) looked at how status influence is affected in comparing Singaporean and US students. They concluded that the GSS reduced high power distance in the Singaporean groups. In the current study, we are especially interested in the impact of culture on cross-cultural teams, i.e., where each team has members from two distinct cultures. Of interest, research conducted indicated that distance education when employing group communication software can produce educational results as good as face-to-face and in some cases even better (Jarvenpaa and Leidner 1998; Turoff and Hiltz 2000).

2.1. Project set-up

The didactical set up of 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 multicultural 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.

2.2. Cultural background: Western vs. Confucius

Hofstede's (1980, 1983) 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.

Hofstede (1999) defined each of the dimensions as follows:

- The dimension of power distance (high versus low) represents the extent of power inequality/equality in a society.
- The dimension of uncertainty avoidance represents the extent to which individuals of a culture feel threatened by unknown situations or not.

Table 1. Hong Kong and Netherlands index and rankings on Hofstede's four dimensions of culture (Hofstede 1983)

		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.

- The dimension of Masculinity (versus Femininity) represents the extent to which a society favours performance and assertiveness or relationship and modesty.
- The last dimension of individualism (versus collectivism) stands for a society in which the ties between individuals are loose. The opposite, collectivism, stands for a society in which people from birth onwards are integrated into strong, cohesive in-groups that throughout their life time continue to protect them in exchange for unquestioning loyalty (Hofstede 1999, 39).

The index and ranks provided for each of the four dimensions should be seen as a global picture of national variety more than as a strict and definitive cultural state. We used those dimensions bearing in mind the impermanence of any psychological constructs (Gergen 1973). In this framework persons should be viewed as guardians of culturally based assets and not their owner (Sampson 1989). In other words we may see the person and the cultural context as mutually defining (Gergen et al. 1996).

As Table 1 presents, the picture of national variety describes two almost antagonist cultures. The Chinese culture places emphasis on the position of the individual *within* the group, while the Dutch culture stresses the position of the individual *towards the group* in terms of structural position. Steidlmeier's (1999) comparison of the West and countries influenced by Confucian philosophy is congruent with the Individualism/Collectivism dichotomy observed by Hofstede (1983). A summary of the effects of these cultures on organisations can be found in Table 2.

The Individualism/Collectivism dichotomy observed in the Chinese culture is supported by many studies (Bond and Hwang 1986). Confucianism and Buddhism centre on "five

Table 2. Organisational keywords to understand Confucian versus Western philosophies in organisations (Steidlmeier 1999)

Individualism	Collectivism
Low status, formal rules based.	High status, relationship, rules based.
Conflictive, regulatory, individual achievement, merits.	Co-operative, personal trust, loyalty, security.
Time is money.	Time is put to the service of relationship.

'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". Bond (1986) summarises Chinese social psychology in four items: (1) Man exists through and is defined by his relationships with others, (2) relationships are structured hierarchically, (3) social order is enshrined through each party honouring the requirements in the social relationship, (4) ties between individuals may be seen as expressive (reserved to close family), instrumental, or a mixture of both. 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.

Interestingly, 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) 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.

2.3. Compatibility and homogamy/heterogamy

The HKNet project brought together participants from a Western and an Eastern culture to collaborate in a distributed environment. As noted by Jarvenpaa and Leidner (1998), two aspects that greatly impact the quality and progress of distributed team dynamics when working on a project are team feeling and trust between team members. Compatibility between colleagues working at the same time in the same place is very important to sup-

port positive outcomes. Feelings of compatibility between colleagues are an indicator of trust and give information on the state of the team spirit.

From the standpoint of view that the two cultures are almost antagonists and that persons show the tendency to be guardians of their culture, will the group develop feeling of compatibility and positive team spirit in such a short time?

The concept of homogamy bridges these two notions of compatibility and team spirit.

Research in social sciences shown that we all have a tendency to be attracted to those we believe are attracted to us (Curtis and Miller 1986). Research shows that humans are sensitive to homogamy (i.e., a fit between similarities when likeness attract) that brings demographic similarity (Newcomb 1961), similarity of personality (Antill 1983; Barry 1970) and attitudinal similarity (Byrne 1971).

As pictured in Figure 1 the attraction process is a two-step model leading human beings, function of the level of similarity with the other person, to continue or not the interaction. In perceiving similarity, people believe that others share their attitudes. This psychological phenomena increases attraction and trust between similar individuals. The phenomena is known as "positive screen of similarity" (Byrne *et al.* 1986) and as many attitudes is automatically activated without conscious or awareness (see Bargh et al. 1996) and particularly in the presence of culturally different target groups (Yzerbitz et al. 1997). Congruent is the established fact that human beings are largely unaware of the explicit factors that determine their judgement (see Nisbett and Wilson 1977). Stereotypes become active automatically on the mere presence of ideational features associated with the stereotype group and particularly when the cognitive system is overloaded e.g., situation of high pressure, new environment.

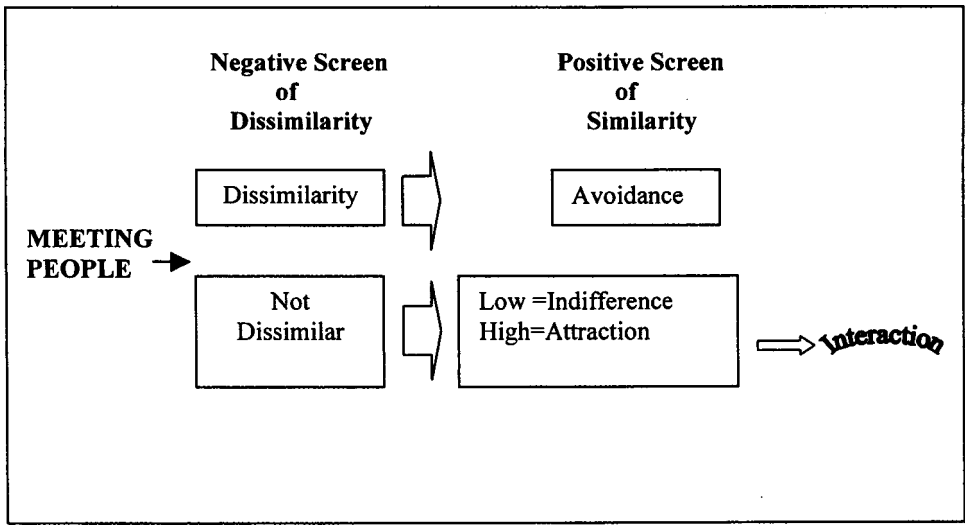

Figure 1. The two models of the attraction process (from Byrne et al. 1986 extract from Brehm et al. 1990).

Hofstede's national picture, Byrne's model of the attraction process and the very nature of the HKNet teams, should induce the participants of the HKNet project to feel quiet incompatible and thus should affect the team spirit. According to the previous theories, the HKNet participants should not be inclined to interact intensively with one another. However, in this particular context of social and professional diversity, we assumed that participants who engaged in the project on a free basis might show a natural propensity to be attracted to foreign culture and to social diversity. From a superordinate motivational perspective, the alternative assumption is that the behavioral consequences of participating to the HKNet project will lead participants to correct their social perception and to adapt their attitudes to the social situation of a multicultural context. Of importance is that behavioural responses to the social environment remain under conscious control (see Bargh 1989).

In both cases, we first assume that the HKNet participants should show a tendency to be less sensitive to cultural homogamy and to the need for a cultural "screen of similarity" and to be more prone towards heterophily. Second, we assume that the participants should seek a goal/task compatibility more than for interpersonal compatibility. Third, patterns of compatibility within the team toward foreigner and local team-mates should provide some information concerning team spirit.

A questionnaire was constructed on these theoretical arguments. We felt 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 (see appendices).

3. Methodology

3.1. 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. They wanted mainly to discover another culture and to work efficiently with the support of new technologies. In both countries, two-thirds of the participants were male.

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).

3.2. Design and procedure

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, see appendix A) prior to working in their group and a second questionnaire (i.e., post-test, see appendix B) 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 (Brown 2000; Howell 1997). The pre-test and the control groups provided two baselines of comparison.

The between subject experimental design allowed us to first compare the two independent groups (Virtual and Control) in a pre-test/control configuration (n = 102) and a post-test/Control configuration (n = 102) when relevant. Manova was run on the questionnaire. The results of the associated ANOVA are presented for some selected items. Within t-test subjects were used to secondly compare data obtained in the pre-test and the post-test (N = 204). The variable 'Nationality' refers in the text to the cultural origin of the participants; Chinese (HK) versus Dutch (Net). The variable 'Story' refers in the text to the participation in the HKNet project (Virtual) versus no participation (Control).

3.3. Material

The pre-test and the post-test questionnaires were constructed on a similar basis, in English, and adapted according to the results of the previous project. For example, the first questionnaire was developed on the basis of the result of the HKNet-1 project. The second questionnaire was derived from the results of HKNet-2. New items (questions) were introduced and others were simplified or replaced. The theoretical corpus was borrowed from the classical literature referenced in the previous section of the paper.

To ensure the robustness of the results, each theoretical construct was first linked to at least two representative items. Second, different scales were used to measure, on one hand, the level of agreement of the participant with a statement (from "strongly disagree" to "strongly agree") and, on the other hand, to measure the participants' evaluation on a 10-point-scale (from 1 "not at all" to 10 "very much") of a particular opinion or belief (Himmelfarb and Eagly 1974; Osgood and Tannenbaum 1955).

Leadership and Guanxi:

1. "Any kind of relationship has to be structured hierarchically to be harmonious." (on a 5-point scale, from - 2 "strongly disagree" to +2 "strongly agree")
2. "How much is the presence of a leader in the group required?" (on a 10-point scale, from 1 "not at all" to 10 "very much")

Interdependence:

3. "Man exists through and is defined by his relationship with others." (on a 5-point scale, from -2 "strongly disagree" to +2 "strongly agree")
4. "How much do you like that your own performance depends on your colleague's work and support?" (on a 10-point scale, from 1 "not at all" to 10 "very much")

Compatibility/trust:

5. "How compatible do you feel (or did you feel) with your local colleagues?" (on a 10-point scale, from 1 "not at all" to 10 "very much")
6. "How compatible do you feel (or did you feel) with your foreign colleagues?" (on a 10-point scale, from 1 "not at all" to 10 "very much")
7. "Is the level of compatibility of goals between colleagues important?" (on a 10-point scale, from 1 "not at all" to 10 "very much")

Homogamy/Homophily versus Heterogamy/Heterophily

8. "How much would you like to live in a foreign country for more than one year?" (on a 10-point scale, from 1 "not at all" to 10 "very much")
9. "How much do you feel attracted to working with foreign people?" (on a 10-point scale from 1 "not at all" to 10 "very much")
10. "How much would you like to be involved in a long-term relationship with a foreign person?" (on a 10-point scale, from 1 "not at all" to 10 "very much")

The concept of homophily (versus heterophily) is related to homogamy. The gradation is necessary to measure the degree of homophily/heterophily. A person who scores positively on the three items will obtain the maximum score for heterophily.

In the last part of the questionnaire, a set of various questions on technology, learning and satisfaction were also asked. First, these items were used at the experiential and social levels to assess virtual team success. Secondly, the reports were cross-examined by four instructors. Many years of experience in education and business allow them to compare with more classical "same place/same culture" reports the quality of these virtual products. The quality of the report (e.g., innovation, originality, informativeness, structure and presentation) and the grades were used to measure educational success. At a very basic level, the primary criterion of success was simply the capacity of the group to handle the final report. In this context of cultural and professional diversity, the main success criterion was for the teams to work together.

4. Lessons learned

Statistical tests (Manova and Anova) revealed no significant differences between the answers collected in the second year or the third year of the project. Nationality or Involve-

ment significant statistical effects appeared consistently through the years. Thus the results are presented for the data sum through the two years (Hknet-2 and HKNet-3).

4.1. Lessons from the post-test

All the HKNet participants enjoyed the project. However, the Dutch participants liked it significantly more than the Chinese did (*mNet* = 7.353, *StD* = 0.1.25 and *mHK* = 6.362, *StD* = 1.6). This may be explained by the different background in age and professional experience. They both agreed and declared that they socially (*mhknet* = 6.25, *StD* = 1.71) and professionally (*mhknet* = 6.5, *StD* = 1.72) learned and gained knowledge.

Not all of the virtual teams fulfilled the criteria of success number one. In the first year of the project, two teams failed and did not manage the report. In the second and third year, three groups had to write an extra assignment to obtain a sufficient final grade. However, most of the reports were of good quality and brought innovative and creative perspectives that reflected their having worked successfully together.

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. Of interest is that 100% of the students from the control group expected the problems to be cultural!

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 3. 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 may have given them more confidence in working in teams. The Chinese were also under more time pressure since they also worked full-time and were typi-

Table 3. Technology support required in percentage

%	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	14.29
Firetalk	5.67	5.06

cally more focused in terms of generating project content, albeit often times at the last minute, relatively speaking.

4.2. Leadership and Guanxi: A virtual consensus

The ANOVA was 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 (from 1 "not at all" to 10 "very much").

The Dutch HKNet participants classically thought that a leader is less required (*mNet* = 6.5) than the Chinese HKNet participants (*mHK* = 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 (*mNet* = 5.6; *mHk* = 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 (*mHk* = 7.8) and the post-test (*mHk* = 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 4.

The ANOVA conducted on the item "Any kind of relationship had to be structured hierarchically to be harmonious" on a 5-point scale (from -2 "strongly disagree" to +2 "strongly agree") revealed a significant Nationality main effect ($p < .0001$) in the pre-test. The Chinese HKNet participants rated on that item significantly more positively (*mHK* = 0.4, *StD* = 0.72) than the Dutch HKNet participants did (*mNet* = –0.741, *StD* = 1). Again, it is noteworthy that the ANOVA conducted on the same item revealed no significant main effect in the post-test. The two groups joined a virtual consensus (*mNet* = 0.8, *StD* = 0.71; *mHk* = 0.67, *StD* = 0.7).

4.3. Interdependence

Interdependence was first measured in the pre-test with the item: "How much do you like that your own performance depends on your colleague's work and support?" on a 10-point

Table 4. Between and within comparisons on the item "leadership"

	Hong Kong** NHk = 45		The Netherlands*** nNet = 51	
	M	StD	M	StD
Pre-test*	7.8	1.4	6.5	1.8
Post-test^{ns}	6	1.7	5.6	2

p = .001; ns: non-significant difference between the two groups in the post-test,
**p < .0001; ***p = .018.

scale (from 1 "not at all" to 10 "very much"). The ANOVA revealed a Nationality main effect (p = .0068) and a Nationality * Story interaction effect (p = .0003). The results indicated the Dutch students (*mNet* = 5.2, *StD* = 2) showed the tendency (p = .067) to be more resistant to that operationalization of interdependence than did the Hong Kong participants (*mHk* = 6, *StD* = 1.8). The results of the two control groups support this interpretation. The statistical tendency became evidence in this case. The results shown that the Dutch control group (*mNet* = 4.15, *StD* = 2.2) is significantly (p = .0021) more resistant to the concept than the Hong Kong participants in the control group (*mHk* = 6.5, *StD* = 1.7). The results are very interesting because they underscore Chinese cultural predisposition towards interdependence.

The results of the post-test surfaced interesting aspects. After the project, both groups (*mNet* = 6.1, *StD* = 1.31; *mHk* = 6.4, *StD* = 1.8) answered similarly to that same item. The ANOVA revealed no significant effect of nationality on the concept of task interdependence.

A first conclusion to be drawn is that this set of results may reveal that participants who belong to so-called collectivist cultures maybe better virtual team players than those who belong to individualistic cultures. In other words, interdependence is an important factor related to the effective collaboration of virtual teams.

Interdependence was secondly measured with the item: "Man exists through and is defined by his relationship with others" on 5-point scale (from -2 "strongly disagree" to +2 "strongly agree"). The ANOVA conducted on the item revealed a significant Nationality main effect (p = .0245) in the pre-test. This result is very interesting because it is the inverse of our expectations. Actually according to the guanxi, Chinese should have been more sensitive to this item than the Dutch HKNet participants. However, the Dutch HKNet-2 and-3 participants scored quite high on this item (*mNet* = 0.902, *StD* = 0.64), or in other words were in agreement with this typical guanxi notion more than the Chinese HKNet participants (*mHk* = 0.556, *StD* = 0.84). Amazingly, the effect was consistent through the two years and the pattern is similar in the post-test. Actually, the ANOVA revealed a Nationality significant main effect in the post-test (p = .0113). Dutch 'Strongly Agree' with the item (*mNet* = 1.255, *StD* = 0.9) while the Chinese HKNet participants 'Agree' with it (*mHk* = 0.756, *StD* = 0.88).

The results allow us to second conclude that the virtual collaboration led both cultures to recognise the importance of social interdependence in a group. The particular significance of this item to the Virtual teams is reflected in the Dutch control team's neutral reaction (*mControl* = 0.2, *StD* = 0.52), which is notably different (p = .0311) from the HKNet Dutch group (*mNet* = 0.902, *StD* = 0.64). A third conclusion to be drawn is that multicultural virtual teams should include individuals who score high on the interdependence item, particularly if they come from an individualistic culture.

4.4. Homogamy: Homophily versus heterophily

As we previously explained, we operationalized the attraction for different cultures using both the idea of homogamy and homophily. We assumed that our participants who accepted

on a free basis to cooperate in the project would be more attracted to different cultures than other students who did not engage in the project. The gradation is necessary to measure the degree of homophily/heterophily. The maximum score for heterophily will be obtained by a person who scores positively on the three items.

First, the results indicated that the HKNet-2 and -3 students are more or less attracted to live in a foreign country (Netherlands or China) for more than one year (*mhknet* = 5.4, *StD* = 2.4). This opinion is similar to the evaluation provided by a control group of Chinese and Dutch students (*mControl* = 5.5, *StD* = 2.7). This is not surprising as many young people feel more or less attracted to go live abroad for a certain time.

Second and more interesting, the ANOVA conducted on the second item "How much do you feel attracted to working with foreign people?" revealed that the HKNet students appeared more attracted (*mhknet* = 7.2, *StD* = 1.43) to work with foreigners than the control group (*mControl* = 6.4, *StD* = 2). The difference between the two groups indicated a tendency to significativity ($p = .069$).

Third, the ANOVA conducted on the last item "How much would you like to be involved in a long-term relationship with a foreign person?" enabled us to conclude that the HKNet participants (*mhknet* = 7, *StD* = 1.4) are significantly ($p = .007$) more sensitive to cultural homophily than the students in the control group (*mControl* = 6.2, *StD* = 1.9).

To conclude, the design did not allow us to conclude whether the effect is the result of a natural trend to be attracted to social diversity or the behavioural consequences of participating in the HKNet project. We assume both alternatives to be highly related. Of importance are the consequences of these results for distributed and multicultural teams working in business. Because stereotypes become active automatically on the mere presence of ideational features associated with the stereotype group, it is central to trigger the attention of the participants on this cognitive bias and to support them to operate at a conscious control level during such virtual interaction. However, the participants presented more heterophile characteristics than the participants of the control group. This is a relevant result that allows us to assume that heterophily may be important to virtual multicultural team collaboration. We believe that students were made more aware of educational and cultural differences and their possible implications through virtual lectures on cultural diversity. Congruent with these assumptions, the HKNet participants showed a tendency to be less sensitive to cultural homogamy and to the need for a cultural "screen of similarity" and to be more prone towards heterophily.

4.5. Compatibility and team spirit

From the standpoint that the two cultures are almost antagonists and that persons show the tendency to be guardians of their culture, did the group develop feelings of compatibility and positive team spirit?

Analyses of the results bring to kind of information to propose an answer to the question.

First, from a task/goal perspective, compatibility was measured with the item: "Is the level of compatibility of goals between colleagues important?" (on a 10-point scale, from 1 "not at all" to 10 "very much"). The ANOVA conducted on the pre-test revealed a Nationality main effect ($p = .0059$) on that item. At the beginning of the project, the level of goal compatibility appeared significantly more important to the Dutch participants (*mNet* = 7.77, *StD* = 1) than to the Hong Kong participants (*mHk* = 7.1, *StD* = 1.25). At the end of the project, the participants agreed on that item. Hong Kong participants experienced that compatibility of goals is more important than expected (*mHk* = 7.65, *StD* = 1.23). To conclude, congruent with the assumption, goal/task compatibility is more important than interpersonal compatibility in such a social and virtual context.

Second, from a team spirit perspective, the analyses surface interesting results. Dutch participants appeared much more cohesive than did the Hong Kong participants in the pre-test and the post-test. In the pre-test the Dutch (*mNet* = 7.88, *StD* = 1.13) expressed significantly more feelings of compatibility with their local colleagues than the Hong Kong students did ($p < .0216$). This result is congruent with the fact that the Dutch students composed their teams principally according to interpersonal attraction. Yet, this cannot explain the significant result revealed in the post-test: Dutch participants continued to express significantly ($p < .0003$) more feelings of compatibility (*mNet* = 8.32, *StD* = 1) with their local colleagues than the Hong Kong participants (*mHk* = 7.25, *StD* = 0.85) at the end of the project. The Hong Kong students (*mHk* = 6.25, *StD* = 1.36) expressed in the pre-test significantly ($p = .02$) less feelings of compatibility with their foreign colleagues than the Dutch participants (*mNet* = 7.08, *StD* = 1.04). This effect disappeared in the post-test. Although the results are not significant, the Dutch (*mNet* = 6.7, *StD* = 1.6) felt less compatible with their Hong Kong team-mates at the end of the project, while Hong Kong remained constant (*mHk* = 6.45, *StD* = 1.1).

To conclude, the pattern of "Hong Kong increasing- Dutch decreasing" was also reported previously in the HKNet-1 project (Vogel et al. 2001). Over time, the Dutch felt less compatible with their foreign team-mates. They appeared more sensitive to the "positive screen of similarity". This might be explained by a factor such as age. This can also be seen as a typical individualist versus collectivist group coalition. Dutch could have perceived their Dutch unit as the sum of the Dutch participants, while Hong Kong participants presented a more collective view of the group unit as the sum of all participants. Logically, the Dutch remained during the project more focussed on their "individualistic" group unit, while the Hong Kong participants developed a more internalised and collective representation of their group unit. This explanation is congruent with the following quote of a Hong Kong student reflecting clearly the general opinion of the Hong Kong students about their Dutch team-mates at the end of the HKNEt-1 project (see Vogel et al. 2001): "They are open minded, outspoken and really concerned about their individual performance". Similarly, the Dutch student claimed that Hong Kong team-mates "Won't do anything if they were not told what to do and feel responsible about their task". These quotes can reflect a particular internalisation of what is the group unit is such virtual frame.

5. Discussion

There were consistent and dramatic differences both within and between teams over the course of the project. We find these results interesting on several dimensions. In this section, we focus first on team interactions and then extend our discussion to address project process and technological support considerations. Limitation of our study will be discussed before to conclude with future research plans.

5.1. Team interactions

Given the diverse nature of the individuals on the project teams, we would expect differences to occur and change to take place. What we would not expect was the degree of convergence illustrated in our data. In terms of leadership and guanxi both Chinese and Dutch participants concluded that less leadership was required, more-so on the part of the Chinese. It is especially interesting, however, that both groups concluded that hierarchical structure was increasingly important, more-so on the part of the Dutch than the Chinese. We suggest that participants recognised that, although roles were important to maintain productivity, leadership in a classical sense was not as relevant. In fact, we saw rotating leadership occur when necessary as a function of demand for roles to be filled.

Interdependence is a central factor that may explain much of the success of the teams who participated in the project. The importance of the factor can be generalised to virtual and monocultural collaboration. Individuals called to join a virtual collaboration should be more collectivist than individualistic and should thereby be able to support interdependence. In other words, if the goal is highly linked to personal success there is a chance that the virtual collaboration will not succeed if the team is composed of mainly individualistic members. Individuality will be stressed and the communication process may become difficult.

Compatibility improved for both Chinese and Dutch with respect to relations within their local group. However, Dutch felt less compatible over time with their Chinese counterparts. We suspect this may have something to do with unrealistic expectations on the part of the Dutch students coupled with a certain amount of project process exasperation. The Dutch students had not typically worked extensively in business or government and were less familiar (and perhaps more naïve) about team interactions. Further, the Chinese students had considerably less time flexibility to focus attention on the HKNet project given that were only part-time students.

Heterogamy is also an important factor in virtual teams, and this applies to mono as well as multicultural teams. Actually, the problem will always be the same. If individuals present a high score on the dimension of homophily, they will have problems dealing with people of a different orientation, whether in their profession, specialisation, race or religion. This is amplified considerably when the teams come from very different cul-

tures and do not have the luxury of being able to meet face-to-face and work things out. We conclude that culture is considerably more malleable than we previously would have suspected. Participants reached virtual consensus without specific activities of negotiation on core cultural items such as leadership and guanxi. The question then becomes what is the influence on these dynamics of the processes and technologies associated with the project.

5.2. Project process and technological support

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. Would we achieve the same results in the absence of conscious attention to project processes and technological support? We think not based on our experiences over the years. Technology provides additional degrees of freedom that enables processes to be implemented and results to occur (e.g., in the case of the within and between group dynamics). However, the focus in virtual teamwork must be less on technology and more on the human aspects to achieve lasting success. We conclude that effectively supporting virtual teamwork with current available off-the-shelf technology is possible but begs improvement. As technology becomes more reliable and customisable to the needs of its users, the main issue becomes mastering the dynamics of the collaborative processes in virtual teams.

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 continue 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.

5.3. Limitations and future studies

The limitations of the results of our study are typical of any project running outside the laboratory. Despite all the effort to standardize procedures and measurements, it remains difficult to control each phenomenon in the real world and to provide an exclusive interpretation to the results. The limitations are principally methodological.

The first problem concerns the definition of success in virtual team. What is a good virtual team? Should they be extremely efficient, cohesive, want to pursue the collaboration on other project? Should they fight, joke, be able to solve conflict? Three years of experience had shown us that all of these activities are required. As an example, a dictatorial task-oriented Dutch leader ruled a productive group that received a 9/10. What will happen to the grade of the group if the leader was socio-emotionally-oriented? Experience had shown us that the grade in this second case of leadership as good. Team success is subjective and in the real world will depend on the goals of the organisation. In this context of cultural and professional diversity, the success was to have teams working together, co-ordinating their actions and handing in a final report.

A second problem concerns the definition of the group unit. When studying group co-operation between 3 Dutch and 3 Hong Kong participants can we assume that we are studying the behavior of one heterogeneous group of 6 individuals or the behavior of 2 homogeneous groups, one Dutch and one Hong Kong? Asch (1955), Mead (1934) and Sherif (1936) insisted on the reality and distinctiveness of social groups. Groups have unique

properties which emerge out of the network of relations between the individual members (Brown 2000). This perspective is common to statisticians that consider that the outcome produced by a group of 6 persons performing a test together is equal to 1 statistical unit of measure and not to 6. This leaves any study on the topic challenging.

A characteristic of the HKNet project was that of a longitudinal study. Each new project, theoretical corpus, research problem and measurement tools were adapted according to the results of the previous project.

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

1. Let students experience the practical side of developing a web portal and to solve more technological complex problems.
2. Let the students become familiar with more groupware applications and tools such as Blackboard, GroupI™.
3. 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 versus Management).

Firstly, team performance will be measured from a technical point of view. The web portal should be innovative, interactive (responsive) and user friendly. Instructors from different background and students will be asked to judge the web portable created by the HKNet-4 participants.

Secondly, team success will be measured from a social point of view. Interpretative analysis of team behaviours and communication will build up on previous observation.

6. Conclusion

We have learned much from this experience. 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. The results of the pre-test indicate that Hofstede's (1980) four dimensions of culture, the Confucian 'guanxi' (see Bond 1986) and the Western interdependence theory (Rijsman 1997; van der Veght et al. 1999) were clearly revealed in the project. Of interest is that consensus on those very sensitive cultural items was reached without specific activities of negotiation between the participants. Participants developed new-shared meaning and agreement on items external to their cultural traits. Virtual collaboration led both cultures to recognise the complex nuances of social interaction in cross-cultural distributed teams. We think that our findings bode well for the extended use of such teams in business and government settings.

Appendix A

Remote collaboration in virtual team

Pre-test (Abbreviated form)

Instruction

The aim of the questionnaire is to measure the opinion of the students who will participate to the HKNET project.

There are no incorrect answers! Your answers will be kept confidential and the results available in a statistical form. Please fill in the questionnaire following the original order of the questions.

Thank you!

1. Do you have any experience in remote multicultural collaboration?
(Select either Yes or No)

Yes No

2. Do you have any personal experience or links with foreign people?
(Select either Yes or No)

Yes No

3. How much would like to live in a foreign country for more than 1 year?
(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

4. Any kind of relationship had to be structured hierarchically to be harmonious:
(Select one answer)
SA: Strongly Agree
A: Agree
N: Neutral
D: Disagree
SD: Strongly Disagree

5. How much do you feel attracted to work with foreign people?
(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

6. How much do you feel attracted to engage in a long-term relationship with foreign people?
(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

7. **Do you have full time and general working experience within a company for more than one year?**
(Select either Yes or No)

Yes No

8. Do you have any experience in using these IT tools for distributed collaboration?
(Choose up a maximum of 6 selections)

- Lotus Notes
- Telephone conference (< 2 persons)
- Videoconference
- Intel pro Share or NetMeeting
- Group Support System
- Other means

9. Man exists through and is defined by his relationship with others:
(Select one answer)
SA: Strongly Agree
A: Agree
N: Neutral
D: Disagree

SD: Strongly Disagree

10. Socially, how much do you expect to learn from this multicultural distributed collaboration?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

11. Professionally, how much do you expect to learn from this multicultural distributed collaboration?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

12. What do you expect to be the causes of potential problems during the collaboration?
(Prioritize the list from highest to lowest rank. To accept the original order, double click "unranked".)

- Time pressure
- Technical problems
- Lack of interaction
- Difference in study background
- Cultural differences
- Lack of face-to-face contact
- Poor technical/organizational support
- Lack of IT skills
- Language difficulties
- Different way of working
- Division of the work
- Lack of motivation from the other participants
- Other

13. How much do you like the fact that your own performance will depend on your colleagues' work and support?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

14. Is the level of compatibility of goals between colleagues important?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

15. How important is the presence of a leader in the group?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

16. How compatible do you feel with your foreign colleagues?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

17. How compatible do you feel with your local colleagues?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10

18. Your age:

- 20–25
- 25–30
- 30–35
- over 35

19. Your gender:

- Male
- Female

20. Your location:

- Hong Kong
- The Netherlands

21. Student number:

22. Any comments…

THANK YOU FOR YOUR PARTICIPATION!

Appendix B

Remote collaboration in virtual team

Post-test (Abbreviated form)

Instruction

The aim of the questionnaire is to measure the opinion of the students who participated to the HKNET project.

There are no incorrect answers! Your answers will be kept confidential and the results available in a statistical form. Please fill in the questionnaire following the original order of the questions.

Thank you!

1. How much did you enjoy this virtual multicultural collaboration?

(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

2. Any kind of relationship had to be structured hierarchically to be harmonious:

(Select one answer)

SA: Strongly Agree

A: Agree

N: Neutral

D: Disagree

SD: Strongly Disagree

3. Man exists through and is defined by his relationship with others:

(Select one answer)

SA: Strongly Agree

A: Agree

N: Neutral

D: Disagree

SD: Strongly Disagree

4. Socially, how much did you learn from this multicultural distributed collaboration?

(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

5. Professionally, how much did you learn from this multicultural distributed collaboration?

(Rate from 1 to 10 with 10 the highest value)

1 2 3 4 5 6 7 8 9 10

6. **What were the causes of problems during the collaboration?**

(Prioritize the list from highest to lowest rank. To accept the original order, double click “unranked”.)

- Time pressure
- Technical problems
- Lack of interaction
- Difference in study background
- Cultural differences
- Lack of face-to-face contact
- Poor technical/organizational support
- Lack of IT skills
- Language difficulties
- Different way of working
- Division of the work
- Lack of motivation from the other participants
- Other

7. How much did you like the fact that your own performance depended on your colleagues' work and support?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10
8. Was the level of compatibility of goals between colleagues important?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10
9. How important was the presence of a leader in the group?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10
10. How compatible did you feel with your foreign colleagues?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10
11. How compatible did you feel with your local colleagues?
(Rate from 1 to 10 with 10 the highest value)
1 2 3 4 5 6 7 8 9 10
12. Which technologies were the most important to support your activity and the virtual team spirit?
(Prioritize the list from highest to lowest rank. To accept the original order, double click "unranked".)
- Internet
- Videoconference
- Email
- Firetalk
- Asynchronous use of GSS
- Synchronous use of GSS

13. Your age:
- 20–25
- 25–30
- 30–35
- over 35

14. Your gender:
- Male
- Female

15. Your location:
- Hong Kong
- The Netherlands

16. Student number:
17. Any comments…

THANK YOU FOR YOUR PARTICIPATION!

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