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G de Wet

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ABSTRACT

This study examined new organisational environments and environmental variables involved in the adoption and implementation of new communication technology. This includes structures within the organisation and social communication networks. Social communication networks determine the levels of the measurement of the processes associated with managerial practices and policies regarding videoconferencing implementation.

Videoconferencing as a communication management tool should not only take into account the numerous applications of videoconferencing, but also consider all the implications for management.

The study utilised focus group research, social network analysis and descriptive statistics in the investigation of the manifestation of the above-mentioned variables in the Tertiary Education Linkages Project (TELP), which is a linkage project between the Eastern Cape Technikon and Texas Southern University. The study utilises triangulation for the establishment of acceptable levels of reliability and validity.

The data analysis revealed that videoconferencing facilitates organisational communication networks on the precondition that communication networks and the communication environment are well managed. The nature of social networks reveals that it will always be in existence where human interaction is present. However, communication management strategies are indeed required to ensure that the quality of information disseminated over the social network contributes to sound managerial outcomes. It was furthermore established that communication management policies do not necessarily affect individuals' experiences of videoconferencing. However, as a communication management tool, videoconferencing must be guided by effective communication management policies and practices for the group to be effective.

Ian Saunderson is a lecturer in Public Relations at the Eastern Cape Technikon. Prof. Gideon de Wet is Chair of Department of Communications at the University of Johannesburg.

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1.   INTRODUCTION AND PROBLEMSTATEMENT

Organisations have been organising themselves to cope with different patterns of information flow (Gates, 1999:11-12). Many organisations use the strategic advantages of videoconferencing and other new communication technologies to link themselves to "a digital nervous system" of communication and information flow in the organisation, which leads to new organisational forms and accompanying management challenges.

'Organisational form' is a term that describes organisational structures in organisations. Past organisational structures "were developed to simplify and minimise communication needs in a day in which interchange of facts and ideas was very expensive". New organisational structures, "linking themselves to the digital nervous system" of the organisation, demand extensive communication (Rockhart, 1998:417-418) that is made possible through new communication technologies like videoconferencing.

New organisational forms have subsequently emerged (Monge & Fulk, 1999:83, Fulk & Boyd, 1991:409-412). These new forms are dependent on social networks and their properties that exist in the organisation (Contractor & Eisenberg, 1990:143). Communication networks are identified by asking "who communicates with whom?" (Stephenson, 1998:54, De Wet, 1995:14). The strength of the network determines the "indigenous organisational strength" (Schulz, 1998:591), which is dependent on the strength of relationships (Stephenson, 1998:58).

Dynamic social communication networks emerge due to communication technology. New forms of organisations, referred to as virtual organisations, global network organisations (Sproull & Kiesler, 1999:12) or federal organisations (Rockhart, 1996:2, Rockhart, 1998:417) are impossible to create without a sophisticated communication and information infrastructure (Child in Monge & Fulk, 1999:84, Mowshowitz, 1997:380, Rockhart, 1998:417).

These changes in modern organisations, induced by highly sophisticated communication and information infrastructures, are inter alia described in theoretical ways such as the process of adaptive structuration (Contractor et al., 1996:456), symbolic interaction, the media richness theory and the social influence theory (Fulk, 1993:921). Changes in communication are achieved through the application of new communication technologies that influence organisational structures and processes. New organisational forms are influenced by these technologies, which cause changes in structuration patterns (Stephenson, 1998:54, Burt & Taylor, 2000:141).

Videoconferencing has been described as the most interactive communication medium of all new communication technologies (Fish et al., 1993:55, Diamond & Roberts, 1996:4). Communication research on new communication technology, organisational communication and communication management has been described against the backdrop of the social learning theory, behavioural patterning, the social information processing theory, symbolic interactionism and pragmatism (Fulk, 1993:921, DeSanctis & Fulk, 1999:3, Yates & Orlikowski, 1992:299). Others have focused on the "social construction of communication technology" (Fulk et al., 1995:267). Many studies have had "a lack of theoretical

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infrastructure" (Fulk & Boyd, 1991:407), and been "technologically deterministic" (Markus & Robey, 1988:583) and "structurated" (Yates & Orlikowski, 1992:299). Not many studies (Monge et al., 1998:411) have used social network analysis to determine how communication patterns are influenced by new communication technology. The use of communication network analysis techniques becomes a core part of corporate renewal that can aid project management, innovation and performance appraisal (Stephenson, 1998:57).

This research was conducted in 2003 at the Eastern Cape Technikon (ECT), which is the youngest Technikon in South Africa located in one of the poorest and largest provinces in South Africa (Anon, 2002).

TELP with Texas Southern University (TSU) is a partnership project between the Eastern Cape Technikon (ECT), South Africa and Texas Southern University, United States of America. The four-year linkage project, ending in 2002, focused on three key aspects (not the research aims of this dissertation) with all the faculties at the ECT (Hill, 1999:2):

- Developing research capacity with distinctive research output
- Upgrading staff qualifications and skills
- Curriculum and instructional development

Videoconferencing is used in the TELP linkage project in various ways, making it ideal for analysis (Ligons & Harvey, 2002:4):

- Designing instructional outcomes/objectives
- Individualised instructional strategies
- Assessment (entry level, and pre- and post-assessment)
- Establishing collaborative friend groups (CFGs) that assist members in mastering different components in the process

The problem researched in this study was therefore formulated as follows:

What do selected social communication network properties and practices in the application of videoconferencing reveal (contribute) as a strategic communication management tool in a new organisational context at TELP?

Based on the above, the literature review will examine the following:

- Videoconferencing as a strategic management tool
- New organisational forms
- Social communication networks

2.   LITERATURE REVIEW

2.1 Videoconferencing as a strategic management tool

Videoconferencing refers to the real-time and typically interactive transmission of images and sound (usually in digital format) between two or more sites (Coetzee, 2001:1). It is described by Hoffman (2002:3) as "technology allowing meetings to take place in cyberspace and participants around the world may be included".

Weeks and Lessing (2001:2) are of the opinion that there are two schools of thought regarding the digital economy. The first includes the rationalist school with "its underlying principles of scientific management" and the second "based on the philosophy of organisations as webs of social interaction".

According to Weeks and Lessing (2001:2), the latter category, which falls within the scope of this study, includes self-directed teams, participative management, knowledge management and total quality management.

New organisational forms, falling within the second school of thought of Weeks and Lessing (2001:2), have the distinct characteristic that organisational members are geographically dispersed and decoupled from one another, subsequently creating "boundaryless organisations" (Powell in Monge & Fulk, 1999:83). These organisations are dependent on connectivity and communality, defined by Monge and Fulk (1999:85) as:

- Connectivity is the ability of the members of a defined public to communicate directly with each other.
- Communality is the ability of each member of the defined public to contribute to, access, and use a jointly held database.

While one of the most serious constraints of new communication technology lies in the lack of acceptance among users (Dutton, 1999:486), videoconferencing, once accepted, could facilitate "more extensive communication and broader network participation" (Monge & Fulk, 1999:86) and allow for the inclusion of a larger number of organisational members within meetings (Huber in Monge & Fulk, 1999:86) promoting connectivity and communality.

The need for videoconferencing in new organisational formats had a slow start with the 1971 failure of the AT&T launch of the videophone (Noll in Whittaker, 1997:4). Various studies (Wellmann, 1996:213) have however been conducted subsequent to this failure, all of which yielded positive results that qualify the need for video (Rosen, 1996:2:3 – 2:14):

- The Andersen worldwide study compared the value of non–video desktop conferencing with desktop videoconferencing and the study revealed that 75% of those in the video group and 65% of those in the non-video group said they would prefer video.

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- The University of Michigan study took 36 groups of three professionals each and designed an automated post office. Half of the groups used ShrEdit, a text-editing tool without video and the other half with video. The study found that the quality of communication without video was inferior to that with video, although it was concluded that video was inferior to face-to-face collaboration. The strongest finding rested on the conclusion that the satisfaction gained from the session was much higher with video than without.
- The Sun Microsystems Laboratories Study did not only prove that desktop videoconferencing causes a decrease in email, but also that collaborators preferred seeing one another since they could engage in personal contact.

According to Czeck (1995:5), the three main arguments for the implementation of videoconferencing are:

- Videoconferencing is supposed to replace face-to-face meetings, thereby decreasing travel costs.
- Videoconferencing is an improvement over standard forms of electronic communication like email and the telephone since video images enhance the written and spoken word.
- Videoconferencing enhances the productivity of geographically split work groups.

Human interface design problems with videoconferencing have largely been overcome, and a competitive advantage could be gained by implementing a system. If a company could gain a competitive advantage by decreasing travel costs or increasing the overall productivity of work groups, then implementation is justified. Joint ventures (e.g. Microsoft, PictureTel and Intel for Internet videoconferencing) (Forrester Research, 1997:2) could cause videoconferencing applications to shift to a necessity by replacing old technology (e.g. the telephone).

Videoconferencing is, furthermore, changing the way in which people conduct business and communicate (PictureTel, 1997:2):

- Travel savings amount to over $130 000,00 per month – Caterpillar.
- Evidence was taken by video from a witness in Hong Kong with an estimated savings of £10 000,00 – General council of the Bar, London.
- With two-way video, students off campus become active participants in class and can be treated as full members of the on-campus community – Columbia University.

Due to cost the implications, videoconferencing cannot be implemented without a successful management strategy for the implementation and day-to-day operation of a system. Such a strategy would have to be developed in line with an organisation's vision, mission, policy, objectives, goals, aims and tactics (Oliver, 2001:3).

2.2 New organisational forms

New organisational environments are the basis and origin of new organisational forms, while new organisational forms use videoconferencing as one of many multiplex communication tools. The application of these communication tools, resulting in social communication networks, does not resemble interaction patterns traditionally assigned to organisations before the advent of new communication technology.

New organisational environments, the factors giving rise to changes in organisational communication are discussed and the resultant new organisational environments are mentioned briefly.

Recognition should be given to the fact that organisations have by nature forever been changing, and that the relationship between new communication technology and organisational change should be examined to determine the change that it has made on interaction patterns in the organisation.

Organisational change is described in various ways, including the process of Structuration (Giddens, 1984:32), the Symbolic Interaction and Media Richness Theory, as well as the Social Influence Theory (in Fulk et al., 1995:260). These theories all take into account human communication processes by accentuating the fact that through communication, individuals and groups organise and shape the manner in which organisations are structured and developed (Zmud et al., 1990:440, Williams 1998:2). This draws upon the fact that changes in organisational communication (achieved through new communication technologies) in turn influence organisational structures and processes (Weick, 1979:122, Giddens, 1984:34). It can therefore be stated that emerging organisational forms are influenced by these technologies and, in turn, lead to changes in human interaction and structuration patterns.

Since these patterns are forever changing, Yates and Orlikowski (1992:300) identified what they termed "genres of organisational communication", whereby a genre is defined as "a typified communicative action invoked in response to a recurrent situation" that is governed by "the production, reproduction and modification" of the directional flow of information in the organisation.

Yates and Orlikowski (1992:302) define the factors typical of changes in organisational environments as follows:

- The recurrent situation or socially defined need includes the history and nature of practices in the organisation.
- Substance refers to social motives, themes and topics expressed in the communication.
- Form refers to observable physical and linguistic forms of communication.

The culmination of these factors coupled with the complexity that could be induced by new communication technology on social communication networks have an underlying manifestation on the way in which individuals in the organisation interact. This also

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induces certain suggestions of variations on the quality of communication in the organisation; hence, the emergence of new organisational environments.

It is known that various factors have an influence on individuals in the process of organising, especially in new organisational environments. Some of these factors can be described as follows (Fulk et al., 1995:259):

- Centralisation/decentralisation motives of the company
- New forms of organisational identification induced by globalisation and the information society
- Communicative characteristics of new communication technology used in new organisational formats
- Environmental changes like globalisation and the new economy

2.3 Social communication networks

Communication networks, by applying systems theory assumptions, largely analyse the existing social structure between people and their subsequent communication interaction(s), thereby describing the nature of the communal communication network and the characteristics of such a network (Rogers & Argawala-Rogers, 1978:296). A network is furthermore distinguished from "a group", in that "it refers to a number of individuals (or other units) who persistently interact with one another in accordance with established sociometric patterns".

The definition offered by Corman & Scott (in Daniels et al., 1997:113) stresses the perceived network perspective:

"The network is a structure of perceived communication relationships. It is a kind of latent knowledge that guides members' manifest communication behaviour. We believe that members' reports of communication reflect this knowledge, and not their recollections of specific communication episodes".

The relative value of studying the existence of these networks in social communities is described by Rogers & Kinciad (in De Wet, 1991:149) who points out that "the use of a communication network analysis is an attempt to identify communication structures in communities (organisations), which will assist the researcher in understanding the big picture".

The value of studying communication networks has also been recognised by economists, specifically opting for a centralised organisational design thereby "avoiding unnecessary duplication in communication and thus economising on overall communication costs" (Bolton & Dewatripont, 1994:811).

Research into virtual organisations by Ahuja & Carley (1998:23) made the assumption that "structural patterns of communication become institutionalised over time". This is significant since a communication network investigation reveals exactly, according to

their definition of a virtual organisation, what the nervous system of a virtual organisation looks like according to the reciprocity of communication relationships, centralisation and hierarchy.

Establishing members' reports on communication interactions using videoconferencing systems will not only indicate the nature and structure in which they communicate, but also highlight certain shortcomings of the functioning of videoconferencing in the organisation. The physical shortcomings can be improved only through better connections with a sequential price tag that is relatively easy to solve with adequate funding. The main importance of this study lies in identifying ways of altering the communication network interactions, resulting in a more fruitful functionality, the identification of (possibly necessary) grapevine interaction (or the lack thereof) and policy guideline structures for the videoconferencing implementation and the management of existing network structures.

This approach follows the warning by Glassman & Weick (in Daniels et al., 1997:124) that organisational communication scientists "… should be less concerned with traditional distinctions between formal and informal communication and more concerned about identifying and understanding the coupling characteristics of organisational communication networks".

Measuring units in communication networks are commonly referred to as nodes (Zack & Mckenney, 1999:257). While most studies regard nodes as people, nodes have had other values like groups (Zack & Mckenney, 1999:257). Nodes are also described as "the social units or actors" to be measured. Various roleplayers, as node structures, have been identified by Daniels et al., (1997:125), Kreps (1990:223), Stephenson, (1998:57) and Stephenson (1998:10). Various roleplayers (as defined by Daniels et al., 1997:125, Kreps, 1990:223 and Stephenson, 1998:57) in such a network include the following:

- Isolates: nodes not linked to the network
- Opinion leaders (also referred to as hubs): informal leaders in the network
- Gatekeepers: control information flow between members
- Cosmopolites: control information flow between the network and the external environment
- Bridges: interconnecting clique members
- Liaisons: interconnecting clique members without being associated with a specific clique
- Pulsetakers: an individual in a communication network who is an indicator to the gatekeeper on network issues

Networks are generally studied on three levels (Rogers & Argawala-Rogers, 1978:296, Scott, 1991:27 and De Wet, 1991:164):

- System: level of study whereby the relative position of all the individuals or actors are examined in relation to one another.

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- Clique: subsystem whose actors interact on a more frequent basis with one another than with the rest of the total system, various such subsystems can be identified.
- Individual: examination of the relation of a specific individual to all the other individuals in a specific clique or total network.

It can generally be accepted that through communication network analysis, the organisation as a whole must be studied. In relation to this, the sub-cluster of cliques using videoconferencing can be identified, which after the role of the individual in the larger network can be identified.

Communication networks based on new communication technology are therefore reliant on (deduced from Monge et al., 1998:411-436):

1. Physical connectivity that, in turn, establishes
2. social connectivity that, in turn, establishes,
3. communality that, over time, leads to
4. confidence, trust and organisational values, that, in time, lead to
5. key collaborators and the existence of cliques within such a network, characterised by
6. heterogeneity due to the physical displacement of network members, relating to,
7. task interdependence rather than geographic dispersion, in turn, economising the technology as it becomes cheaper, thereby increasing the
8. centrality and density of the network that, in turn, creates greater information sharing that will, over time,
9. follow the nature of the human implementation of new technology that leads to the epidemic acceleration of the technology and the network.

It can therefore be deduced that new working environments are ultimately dependent on physical connectivity. Without physical connectivity, the large overall amount of social connectivity and all of its processes acquired through communication patterns cannot be established (Rice, 1987, Kolodny, 1996 and Simpson, 1999).

It is here that the great paradox lies: developed countries and communities will continue to create their own "virtually connected social world", while the developing world will remain underfoot. However, as far as organisations and their multifaceted contributions are concerned, they will continue to exist on the basis of virtually socially connected networks on a multiplex level, while single level face-to-face communication will remain the communication medium for developing countries.

The existence of social networks in an organisation should not be confused with the hierarchy in the organisation. There is however a correlation between hierarchies and the degree of hierarchy with social networks. The central person in the hierarchy does not have a significant standing in the social network and leadership abilities are greatly reduced.

3.   RESEARCHING VIDEOCONFERENCING WITH TELP AT THE EASTERN CAPE TECHNIKON

3.1 Research design

Following the pilot study, the study implemented a multi-step design consisting of the following steps:

- Step 1: The identification of an organisation that utilises videoconferencing on a regular basis, resulting in the formation of social networks and relationships between geographically distributed participants. TELP at the ECT was chosen.
- Step 2: The establishment of an adequate research sample for the quantitative phase (refer to step 4), which was done through discussions with a central person in the social communication network (e.g. the videoconferencing scheduler).
- Step 3: The identification of variables pertaining to the quantitative research process beforehand. This was done through a qualitative phase. The qualitative phase utilised focus groups, generally consisting of four to six individuals. Suitable focus group participants were identified with a person central to the social communication network (videoconferencing scheduler). Focus group sessions were video recorded for the purpose of analysis.
- Step 4: The construction and distribution of a quantitative questionnaire for the individuals identified during step 2. The questionnaire consisted of demographic variables, social network data and descriptive data collected through Likert-type questions. The construction of the quantitative questionnaire was solely possible due to the precluded step 3, the qualitative focus groups.

3.2 Research methods

The research methods included focus group discussions and a quantitative questionnaire that included demographic, social network matrixes as well as Likert-scale type questions.

3.2.1   Focus groups
A face-to-face focus group was held in South Africa and video recorded (for analysis purposes), while an interactive videoconference focus group was held by the researcher in South Africa with the group at Texas Southern University. The practice of video recording focus groups for later analysis is said to make the work of the researcher easier (Mwanga & Mugashe, 1998:707), while the use of videoconferencing for focus groups can be dated as far back as 1994 (Heather, 1994:6).

A focus group is defined by Nucifora (2000:66) as "a round-table discussion session, typically involving four to ten individuals who are recruited to come to a central research facility for two hours or so, where they discuss a topic of interest, led by a moderator or facilitator who guides the discussion into predetermined area". It furthermore indicates that focus groups are an appropriate means for assisting in the identification of variables for questionnaires.

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3.2.2   Questionnaires as a research method
The questionnaires consisted of three major sections:

• Demographic section
• Network analysis section
• Likert-scale type question section

The construction of the quantitative questionnaire was solely possible due to the qualitative focus groups, which provided information required for the construction of the questionnaires. The questionnaires were filled by means of personal interviews with the respondents conducted by the researcher in East London. A suitable individual (research experience at PhD level) with ample research experience duplicated the process (following a suitable briefing) at Texas Southern University, since the researcher was unable to travel due to financial constraints.

Since the information collected was highly sensitive in nature and the researchers were known to the respondents in a working capacity, this method of data collection seemed most appropriate for achieving the specific research aims.

Demographic data was requested in the form of seven questions pertaining to physical location, name, surname, gender, age, home language and length of use. For ease of use, the questions pertaining to gender, age, home language and length of use were distributed in categories established during the pilot study.

Network analysis data was collected through social matrixes. The concept of social matrixes was explained and the respondents were asked to consider all the possible relations. The existence of a significant tie was indicated with a "1" and no tie with a "0".

Likert-scale type questions were simply read by the respondents and they were asked for a response ranging between "strongly agree", "agree", "neutral", "disagree" and "strongly disagree". For the purposes of validity, the respondents were shown the completed questionnaire afterwards for their approval.

3.3 Data analysis

Data analysis includes a discussion on the focus group analysis of video-recorded data and various methods employed to analyse the data in the questionnaire.

3.3.1   Video recording of focus groups
The practice of the audio and video recording of focus groups has been well documented (Buseh & McElmurry, 2002:176). Gordon and Langmaid (in Catterall & Maclaran, 1997:2) describe two methods of analysing video-recorded information. One of these methods suggests categorising segments of information under themes and headings identified prior to conducting focus groups. These categories and headings should be identified in conjunction with the client (in the case of market research) or with an opinion leader on the subject.

The focus groups held were therefore video recorded for the purpose of analysis. The video recordings were played back and analysed through the observation of both verbal and non-verbal data. Before engaging in the focus group analyses, a meeting was held with the videoconferencing scheduler for the development of categories (as described by Catterall & Maclaran, 1997:2) for the analysis of the information gathered.

These categories were as follows:

- Verbal reactions to the questions posed
- Non-verbal reactions to the questions posed
- General social communication network functioning utilising the videoconferencing system
- Identification of key management variables required for the quantitative phase of the research
- The effect of the videoconferencing system itself on the communication process

Following the abovementioned steps, general notes were compiled (as described by Catterall & Maclaran, 1997:2) for the purpose of writing interpretative thoughts on the subject. The observations were therefore aimed at:

- Determining the general feeling exhibited by the participants with regard to the quality of communication practices and communication management performance
- Determining the communication policies and practices applied by management to regulate videoconferencing communication practices with reference to social network practices
- Gaining an understanding of the perceptions of the communication network members of the organisation's policies and practices applied by management and the extent to which they have an influence on the output of the social network
- Identifying key management issues required to answer the research question pertaining to the perceived effectiveness of the management of the quality of communication within the respective social networks as per key management issue

During the focus group sessions, it emerged clearly that a distinction should be drawn between TELP Management and the Critical Friends Group (CFG) throughout all the levels of analysis (focus groups, questionnaires and network analysis) methods. This enabled the researcher to distinguish between management (and the perception they have of themselves as well as the CFG) and the rest of the group (and the perception they have of themselves as well as the CFG). Furthermore, this enabled a level of analysis for cross-comparison purposes, especially where perceptions regarding organisational policies and practices are relevant.

3.3.2   Questionnaires: data analysis methods
The questionnaire consisted of the following sections:

- Demographic section for the identification of descriptive statistics
- Network analysis section for analysis with UCINET with reference to system, clique and individual levels of analysis
- Likert-scale type questions section for the purposes of frequency tables and cross-tabulations

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An analysis of these three sets of data will now be discussed in turn:

The demographic data included physical location, gender, age, home language and length of use. The data collected was furthermore cross-tabulated with data collected from the Likert-scale type questions.

The network analysis data, collected in the format of social matrixes, was entered into a microcomputer program called UCINET. The purpose of entering the data into a computer program like UCINET is described below:

Relationships can be displayed visually through sociograms, or socio-network diagrams, which display graphically the relationships that exist between social network members (Parker et al., 2001:27). Such relationships can be illustrated qualitatively by drawing the relationships between the individuals by hand, based on the results of the centrality variables obtained (De Wet, 1991:182) or quantitatively by using a computer program that uses the data directly obtained through a social network analysis program (e.g. UCINET), such as Krackplot (Haythornwaite, 2001:218).

The following drawings illustrate these relationships visually and vary naturally through the multivariate conditions in which they exist (see Figure 3).
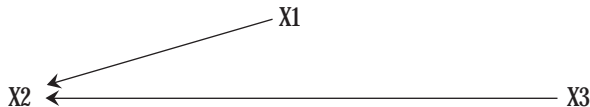

Figure 1: Directional representation of relationships perceived by X1 and X3

Once the social matrixes were entered into UCINET, the program was used to analyse the data on three levels:

- Individual level of analysis
- Clique level of analysis
- System level of analysis

On an individual level, social network analysis allows us to understand relationships between people. It highlights the central individuals in a network, those playing important information-brokering roles or acting as boundary spanners and the peripheral, unused members (Parker et al., 2001:25).

There are various variables that could be used to identify these individuals in a specific social network. In this study, an analysis of centrality variables was done.

Centrality examines the overall patterns of relations in the network (Durrington et al., 2000:16), and high centrality would mean that the actor of a network would have a large number of connections with individuals in their immediate environment (Scott, 1991:37).

Centrality is further defined as (MacEvoy & Freeman, 1987:49):

"Centrality calculates a whole set of grap-theory based properties of actors, actor pairs, and networks, including measures of actor distance, degree, betweenness and closeness, and network indices of density and centrality".

Centrality can, at the individual level of analysis, be measured through the following variables (Freeman, 1979:120):

- Point in point out degrees are derived from the term degree, simply referring to the number of employees with which an individual is directly connected, with point in or point out acting as an indicator of the direction of connectedness (Freeman in Burkhardt & Brass, 1990:113, Ahuja et al., 1999:18, Scott, 1991:86). Degree is calculated by selecting the number of times an individual is nominated by fellow employees on the matrix in a specific direction, i.e. in or out, in referring to the number of times others have nominated the individual, and out referring to the number of times the individual has nominated others. Individual point in/out scores can be approximated to calculate the average point in/out score. In other words, an individual with a point out score of 16 and point in score of 14 would have an average point in/out score of 15 (=16+14/2). This results in a single score that makes the different scores between the actors comparable.
- Betweenness is used to measure the prevalence of structural holes or to indicate unconnected social groups (Mehra in Pappas & Wooldridge, 2002:2). Betweenness is defined by De Wet (1995:8) as "the control of information flow within a network", and in terms of the description from Scott (1991:90), "… betweenness proportion of a point Y for a particular set of points X and Z is defined as the proportion of geodesics connecting that pair that pass through Y, it measures the extent to which Y is between X and Z…". Mathematically speaking, betweenness is a function of pair-dependency (Freeman, 1979:587), and calculates the sum of the ordered and unordered pairs (Freeman, 1979:591).
- Closeness examines how near an individual is to others in the social network (Durrington et al., 2000:19) or strong social connectivity (Pappas & Wooldridge, 2002:2). Knoke and Kulinski (in Pappas & Wooldridge, 2002:2) further define closeness as follows: " … that typifies actors' involvement in the social network and is expressed in terms of network density, distance and social proximity". On an individual level of analysis, the closeness score reflects distance and proximity and, over and above considering the structural relationships that it has with betweenness, it is defined by De Wet (1995:9) as the degree of independence an actor has in relation to all other actors. Burkhardt and Brass (1990:113) state that, the "closeness measure of centrality accounts for both direct and indirect links and conceptually represents ease of access to others" and De Wet (1991:160) points out that the lower the closeness score, the "more independent an actor, and potentially speaking, the more efficiently

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communication messages can be transmitted to another actor". It should be noted that the closeness measure, as with betweenness, is a function of pair-dependency (Freeman, 1980:591). It should however be noted that closeness calculates the number of intermediate points connecting a geodesic, as opposed to betweenness, which is merely the sum of the ordered and unordered pairs (Freeman, 1980:591).

On the second level, clique level of analysis, Rogers & Kinciad (in De Wet, 1991:115) regard a clique as a subsystem, whose members interact with one another more frequently than others in a communication system. This definition is added to by Burt (in Contractor & Eisenberg 1990:153) as follows: "the structural equivalence of a clique is the extent to which a group of members share a similar pattern of communication with others in the network".

Clique level of analysis implies the identification and reconstruction of cliques using the CONCOR (convergence of iterated relations) program provided in the UCINET package. Cliques were identified by using block and matrix densities.

Density is defined by Haythronwaite (2001:219) as "the number of pairs connected relative to the maximum possible connections".

Where block values revealed a value greater than the calculated matrix density, the existence of a strong and significant tie can be assumed (De Wet, 1995:9). Groups of individuals revealing a similar score in specific strong ties are identified as cliques, also known as block modelling.

At the third level of analysis, system level of analysis takes place ipso facto the clique level of analysis. Once all the significant cliques in a network have been revealed by using matrix and clique density, the "image" of the system emerges and all the possible relations between the different network members would have been revealed and studied and the system as a whole examined.

Network data was collected in the form of social matrixes. The use of social networks for analysis purposes is discussed below:

Social networks, derived from social matrixes, are based on the notion that individual behaviours are embedded within networks of interpersonal relations (Granovetter in Pappas & Woolridge, 2002:2), and have been formally defined by Corman & Scott (in Daniels et al., 1997:113), stressing the perceived network perspective as:

"The network is a structure of perceived communication relationships. It is a kind of latent knowledge that guides members' manifest communication behaviour. We believe that members' reports of communication reflect this knowledge, and not their recollections of specific communication episodes".

Mathematically, Doreian (2001:81) defines it as:

"The most straightforward definition of a social network is G=(V,R) where V is a set of social actors and R is a social relation defined over the elements of V. Each element of R is a pair of elements from V with R subset VxV, the Cartesian product of V with itself. Put differently, for i,j epsilon V, iRj means (I,j) epsilon R. The relational ties are binary (0,1) or have magnitude."

Both the information and systems theories supply the conceptual underpinning for using networks as the basic units of analysis to define and explain patterns of information flow in the organisation (Heath & Bryant, 1992:239). The tradition of viewing organisations as systems has a long intellectual history (Katz & Kahn 1966:11), and has recently been categorised as "the complex systems theory" (Morel & Ramanujam, 1999:278). Morel and Ramanujam (1999:278) state that social network analysis is "compelling for studying complex systems theory in organisations" due to the fact that it can illustrate "self-organisation" and compare it to hierarchical organisation in the organisation.

Social matrixes are required for the quantitative measuring of social networks. A social matrix is described by Scott (1991:39) as:

"At its simplest, a data matrix comprises a table of figures, a pattern of rows and columns, drawn on paper. … Whatever the physical form taken, the logical structure of a data matrix is that of a table. In variable analysis, attribute data can be organised in a case-by-variable matrix. Each case studied is represented by a row in the matrix, whilst the column refers to the variables on which their attributes are measured…"

Kretschmer (2002:476) states mathematically that "if all the possible relations are recorded from the point of view of every individual person (with X) to all the other persons (with Y) then a symmetrical matrix of Z_{xy} is obtained."

Refer to Table 1 for an illustration of a symmetrical data matrix.

	X_1	X_2	X_3
X_1	–		
X_2		–	
X_3			–

Table 1: Symmetrical data matrix

Firstly, it should be realised that it is accepted that an actor cannot have a relationship with him/herself. Therefore X_1 will never be equal to X_1. Before explaining all the possible arising relationships from such a data matrix, it should be noted that all relationships are considered reciprocal. In other words, X_1 may perceive that a strong relationship exists with X_2 (=1), while X_2 may not perceive that he/she has a strong relationship with X_1 (=0). If X_1 is viewed as an actor keeping in mind all the possible reciprocated relationships, all the possible relationships with X_n are as follows:

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- X_1 and X_2
- X_1 and X_3

and reciprocally:
- X_2 and X_1
- X_2 and X_1

and reciprocally:
- X_3 and X_1
- X_3 and X_2

As an example, we presuppose that there are only relationships between X1 and X2 as well as X3 and X_2, non-reciprocated. If the social matrix is plotted whereby 1=relationship and 0=no relationship, the example illustrated is reflected in Table 2:

	X_1	X_2	X_3
X_1	-	0	0
X_2	1	-	1
X_3	0	0	-

Table 2: Symmetrical matrix: relations between X1 and X2 as well as X3 and X2

These matrixes can be extended to have X_n number of relationships.

Note that it was deemed necessary by the videoconferencing scheduler to assign abbreviations to the names of individuals since the privacy of the individuals should be respected.

Likert-scale data-analysis type questions included the analysis of ordinary frequency tables (describing mean, median, standard deviation, minimum and maximum). These frequency tables were also cross-tabulated by site, age, gender and length of use. Percentage frequency distribution bar charts were used to display the results of selected questions for the visual interpretation of central tendencies.

While cross-tabulations do not provide the same analysis of multivariate situations as factorial design (Trochum, 2002:2), they allow the researcher to examine the effect of two variables. In this way various variables could be examined, allowing for the identification of dependent and independent variables.

Cross-tabulations have been proven to be essential in studies that combine qualitative and quantitative techniques in social network settings (Bengsston-Tops & Hansson, 2001:67), which increase the validity and reliability of the study by comparing and cross-referencing the data with network analysis data.

3.4 Data interpretation and findings

3.4.1   Likert-scale data
The results of the Likert-scale data revealed that:

- Respondents were not of the opinion that a strong clear management policy regarding videoconferencing utilisation existed.
- Respondents felt that more information was shared utilising videoconferencing technology than what would have been otherwise possible.
- Respondents felt that it was a consideration as an alternative to flying.
- Respondents felt that it was more cost-effective than flying.
- Respondents agreed that new relationships were forged by using the system.
- Respondents felt that the work groups were effective.
- Respondents felt that the system lent itself to the improvement of quality of communication.
- Respondents felt that it contributed to the effectiveness of the management of the TELP project.
- Respondents felt that the system made a significant contribution to the TELP training project and the Critical Friends Group that emerged due to the implementation of the system.

3.4.2   Network analysis data and findings

Individual level of analysis

With regard to the average point in/out degree, the following observations were made:

- The individuals concerned scored satisfactorily with regard to their frequency of communication in relation to their level of management.
- The most senior level managers at TSU and ECT respectively are, as the data suggests, figureheads to the project due to lower scores than other management members. These two individuals form an isolated dyad.
- The individuals recently appointed to management scored lower than the individuals in management over a longer period.
- Individual C1 emerged as a network hub between ECT and TSU.
- CFG individuals in general scored lower than members of management.
- TELP trainers yielded a similar score with a slightly lower score for the trainer based at a neighbouring technikon.

With regard to betweenness and centrality, the following observations were made:

- Individual network roles are clearly identifiable, allowing for triangulating a qualitative observation in the individual level of analysis with quantitative data in the clique level of analysis.
- The individual level of analysis with regard to betweenness clearly confirmed the social network positions as identified with the average point in/out degree measure.

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- Individual E1 plays a significant role in terms of acting as a link between the two institutions.
- Significant differences in management styles between individuals E2 and E3 are clearly definable.

With regard to closeness and centrality, the following observations were made:

- Individual network roles are clearly identifiable, allowing for triangulating a qualitative observation in the individual level of analysis with quantitative data in the clique level of analysis.
- The individual level of analysis with regard to closeness clearly confirmed the social network positions as identified with the average point in/out degree and betweenness measures.
- Individual E2, as identified with the betweenness measure having a distinct management style, revealed that the person has low leadership qualities and low control over the flow of information but, however indirectly, influences the way in which information is perceived. The above is displayed graphically in figure 2.
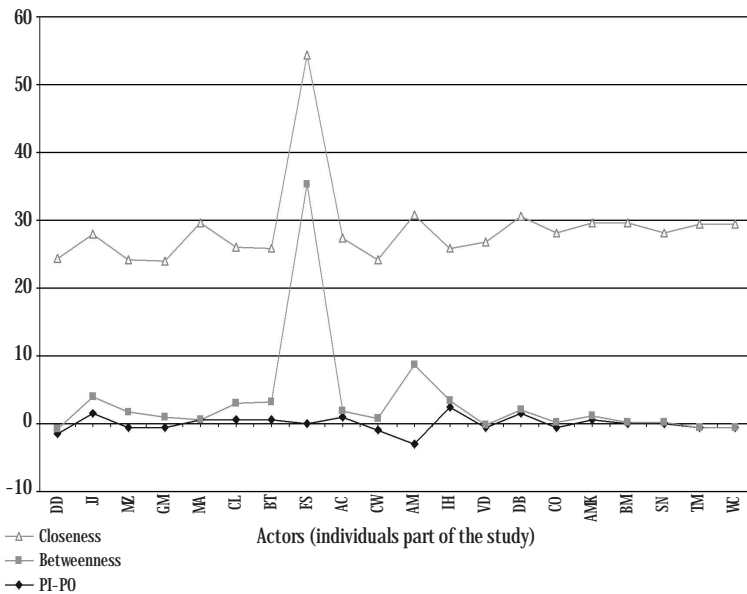
Figure 2: Individual level of analysis scores with regard to betweenness, closeness and average point in/out scores

Clique and system level of analysis

Clique reconstruction was done qualitatively and based on the opinions of perceived network roles of different layers. Refer to figure 3 for a sociogramme based on observations taking the following variables into account:

- Average point in/point out
- Betweenness
- Closeness

If figure 3 is examined, it can be stated that the following perceived network roles of the following actors are evident:

- Actor C1 fulfils the role of an opinion leader as well as gatekeeper. Actor C1 is the most vital link in the linkage project. Actor C1 is the TELP project co-ordinator in South Africa. Actor C1 would be perceived by receivers of TELP training as an opinion leader, whereas senior levels of management would purely view the person as a vital link in the flow of information.
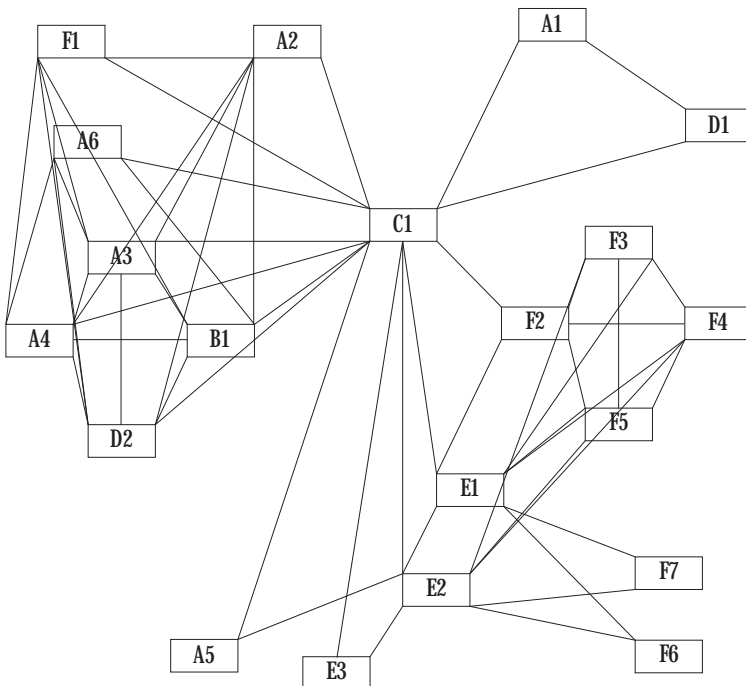

Figure 3: Qualitatively reconstructed sociogramme of the TELP social network at ECT

- Actors A1 and D1 are an isolated dyad. Actors A1 and D1 are both the most senior levels of management of the ECT and TSU involved in the linkage project respectively.
- Cliques F2, F3, F4 and F5 are all receivers of TELP training and all members of the Engineering Faculty. It should further be noted that these members are tied by a stronger tie to the rest of the network through individual F2, who plays the role of gatekeeper between C1 and E1, the individuals with whom he is most closely tied. The clique also receives training from individuals E1 and E2 on a clique basis.
- Individuals F6 and F7 are virtual isolates, mainly due to their physical location and roles in the TELP project. Individual F6 is based in Queenstown and F7 in Butterworth. These two individuals would receive TELP training from E1 and E2.
- Individual E3 is an isolated TELP trainer due to the fact that the individual is based at a neighbouring technikon. Individual E3 is linked to the network through association with C1 and E2 only.
- Individual A5 (from TSU) is an isolate to the project, mainly due to the fact that the individual was appointed recently in the position.
- Cliques A3, A4, B1 and D2 are individuals at senior management level from both institutions. This clique is loosely linked to individuals A2, F1 and A6 due to the administrative tasks that they fulfil for management.

The implications of the above analysis for the study are as follows:

- Individual C1 is a critical central person for TELP. This person links all the various groupings. High reliance of one person in this manner, from a strategic point of view, should rather be avoided. If the central person could rather be a dyad, a triad, or even a small clique, the TELP programme would be less reliant on this person.
- Management only communicates through the central person, instead of being visible at all levels.
- The various cliques exist due to their functionality in other organisational and institutional factors, instead of TELP-specific objectives and outcomes.

4. SUMMARY OF MAJOR RESEARCH FINDINGS

The findings of the research demonstrate the following:

- There is a need for a strong, clear management policy on videoconferencing utilisation.
- Videoconferencing is not an alternative in all contexts for substituting personal contact.
- The system creates new relationships, adds to the effectiveness of the workgroups, and improves the quality of communication and the output of the workgroups.
- A central person is essential for the coordination of videoconferencing activities.
- Management "must have" a strong, clear, well-defined videoconferencing management, and a utilisation policy needs to be developed,
- A system is ideal for use in highly cliqued, high density environments.

5.   SYNTHESIS AND CONCLUSION

Organisational communication networks are revealed naturally, purely through the nature of individuals in association with one another. The value of such personal networks is described as "invaluable, not only for my professional growth and education ..." (Barnier, 2000:7). It should also be noted that "the network is a structure of perceived communication relationships..." (Daniels et al., 1997:113).

Videoconferencing specifically places another communication medium into the myriad of communication tools available to individuals in organisations, and can facilitate "more extensive communication and broader network participation" (Monge & Fulk, 1999:86). Assumptions of individuals associating or not associating due to the presence or absence of new communication technology should not be relevant in a well-managed communication environment. Research as early as 1994 (Kydd & Ferry, 1994:374) established that videoconferencing should be managed to create a communication climate that would increase productivity, and that the medium is only effective under certain circumstances. Therefore, videoconferencing facilitates organisational communication networks on the precondition that the communication networks and the communication environment are well managed. The nature of social networks reveals that it will always exist if human interaction is relevant. However, communication management strategies are indeed required to ensure that the quality of information disseminated over the social network contributes to sound managerial outcomes.

The fact that many recommendations can be made (PicturePhone, 1996:1) for videoconferencing implementation to contribute to communication patterns in organisations does not necessarily signify that management policies are required for a system to be effective. Some organisations have policies regarding the use of simple technologies like telephones, others do not, and there is no real sound managerial rule regarding this.

While it is recognised that videoconferencing could be used as a group decision support system (Kelsey, 2002:37), the above proposition would be true only if an organisation utilised videoconferencing for making decisions only. It is known that videoconferencing could be used for other applications as well (VTEL, 1997:2).

Therefore, communication management and policies do not necessarily affect individuals' experiences of videoconferencing. However, as a communication management tool, videoconferencing must be guided by effective communication management policies and practices for the group to be effective, but not necessarily as a group decision support system, since the group might not use videoconferencing for the purpose of making decisions.

Verwey et al. (2002:170) are of the opinion that "a new social architecture emerges" with the implementation of new communication technology, thereby restructuring social relationships. Since social networks are the "interaction with one another in sociometric patterns" (Rogers & Argawala-Rogers, 1978:296) and network analysis is a method for

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social network identification (Ahuja & Carley, 1998:23), communication managers could manage social relationships over videoconferencing systems more effectively if they had knowledge of the social network.

Therefore, managerial videoconferencing policies and practices as a communication tool must incorporate social network identification. Social networks are often similar to hierarchical networks, but the nature of social networks allows for opinion leaders to exist without the incorporation of the individual into the hierarchical structure.

These social network structures should be related to individual, clique and system levels of analysis to ensure that managerial policies and practices of a videoconferencing system could make a level of contribution at every level.

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