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SNA as an Attractor in Emergent Networks of Research Groups

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Abstract

While many progressive enterprises are becoming more network-centric, many research-oriented organisations retain a traditional hierarchy with an ego-centric culture. Paradoxically, network-centrism is associated with technology, innovation and creativity, the hallmarks of cutting-edge research. Using concepts of emergence from complexity theory, this study takes a developmental, action research approach to the application of social network analysis in legitimising a network of research groups in a traditionally managed institution. The results indicate that an emergent network is as valid an organisational structure as an imposed hierarchy for research management. The study also demonstrates the use of social network analysis and similar technological applications in democratising organisational decision-making in respective of group innovation.

Keywords

Social Network Analysis, Research Networks, Complexity Theory, Network-centric Organisation.

INTRODUCTION

Changes resulting from developments in information and communications technologies (ICT) and the growth of the Internet, have contributed to increasing complexity in organisations to a point where hierarchical structures no longer provide a platform for effective and efficient management and operations (Miller & Stuart 2005). Lack of success of traditional management initiatives are revealing the need to take an approach influenced by notions from complexity theory, where a new network-centric paradigm is emerging (Warne et al 2005). As observed by De Vulpian (2005), "we are in the process of moving from a pyramidal, hierarchical society to a single-story society where heterarchical relationships dominate". Supported and enabled by ICT and the Internet, progressive organisations are tending to refocus on supporting teams in community-style networks. This requires a greater understanding of how productive work takes place in network-centric organisations where loosely coupled autonomous teams behave as self-organising organic communities (Alberts et al 2000).

There is a growing body of literature that locates creativity and innovation in informal group activities, (Boland & Tenkasi 1995, Engestrom 1999, Toulmin 1999, Wenger et al 2002). This literature promotes a view of socially-constructed, collective knowledge, at the small team level, as the predominant source of learning, creativity and innovation even in large highly structured business enterprises. For a small team to be innovative and creative, it should be allowed to function either as, or at least within the environment of, a self-determining community. The benefits of such community-oriented teams are so significant that some governments and corporations are seeking ways to encourage their establishment and continued existence (Mentzas et al 2001). As noted by Miller and Stuart (2005), it is a challenge to solicit the creative contributions of group membership in traditional ego-centric organisations, because the results cannot be integrated into the rigid hierarchical structure and, indeed, are often rejected by it.

Studying the dynamic patterns of interactivity among team members, and how they change with time or in response to interventions, requires an ability to look at the entire complex web of relationships and interactions within that team (Scott et al, 2005). There is a large body of literature describing the use of social network analysis (SNA) as a useful tool for observing and analysing interaction among agents in complex social systems. For example, McGrath et al, (2003) spell out how SNA can be used as visualization technique, facilitating understanding complexities in dynamic social networks. Also Scott (2000) describes SNA as a tool which combines the concept of the sociogram (a visual representation of relationships in a social group) with elements of graph theory to analyse patterns of interaction among people in various kinds of networks. This implies that SNA can capture the dynamic patterns of relationships within teams and it would be a useful aid in studies of small teams such as networks of research groups.

This paper is motivated by the proposition that cutting-edge research usually takes place in innovative and creative teams and so should flourish in an ICT enabled network-centric environment. However, organisations

where theoretical or applied research is a major activity are often quite conservative, and may languish in an outmoded, ego-centric culture. Based on this proposition, the study presented here is a proactive endeavour to change the culture of a research organisation, which is managed on the principle that worthwhile research takes place in large, hierarchically-organised institutes and centres to which all recognition and resources are accorded. An ICT-enabled SNA project was undertaken with the objective to legitimise the innovative and creative research that takes place in small groups that form networks of cooperation, but are not viewed as having enough critical mass for large allocation of funds and resources. A developmental, action research approach was adopted, based on concepts from a particular theory of complexity, where the iterative SNA became an attractor that allowed changes in culture to emerge. The outcome of this study provides an example of how notions of emergence from complexity theory may be implanted in practical settings with the appropriate support.

BACKGROUND

This research brings together concepts and techniques from multifaceted areas of network-centrism and complexity theory and applies them to the complicated realm of the conduct and management of research groups. Some background on each is now presented in order to provide a platform for the description and presentation of the study

Network-Centrism

There is no universally accepted definition of the term 'network-centric'. Hasan et al (2005) describe a network-centric structure as one which enables members of an organisation to create and leverage information to increase competitive advantage through the collaboration of small and agile self-directed teams. The capability to do this results from developments of ICT and of the subsequent change from an industrial to an information age. It is however more about people and culture than technology.

The tools of digital democracy provide us with a new flexibility and independence. Email lists, online discussion groups and blogs have altered expectations and have pioneered new models for democratic, flexible, 'network-centric' approaches, but many organizations stick resolutely to traditional 'ego-centric' methods. There's a simmering tension between ego-centric thinking and network-centric thinking – the tension between the institutional power that emanates from an organisation and the transactional power that inheres in its members' daily interactions. Network-centric thinking may, indeed, be counter-intuitive to those who came of age inside traditional civil society organisations. (Miller & Stuart 2005)

A new form of power allows decision-making authority to spread to the edges of an organisation, to membership, which not only generates excitement among supporters, but also opens up a deep well of creativity and expertise. The old power approach keeps this extraordinary knowledge resource untapped. This is described by Allee (2003 p 4) in the following way. "The centre of power is shifting out to the edges. Decisions are moving out from corporate headquarters to individual business units. Business units in turn distribute power and decision-making to self-managed teams and profit centres." This is the basis of the concept of knowledge work where workers have control over their own activities through knowledge acquired in the course of both training and experience.

Emerging heterarchic and networked social structures of social interaction and creative activity are emerging as a part of the digital civil culture. They connect people across traditional boundaries as predicted by early technical innovators. According to Mitchell (1997), "Networks and cyberspace communities connect players in different sectors much as transportation systems and cities on the ground have always done". Alain de Vulpian (2005) has another perspective on these global changes. He writes: "I have reached the conviction that we are in the epicentre of a developmental process of civilisation that is carrying us elsewhere, transforming western culture in depth and possibly preparing the way for a worldwide civilisation. This process is extremely complex. It affects all levels of our social life, from the extreme micro (for example the lives of couples and families, networks of friends) to the macro and the mega (for example, the birth of new organisations, the lives of companies and states, or worldwide regulatory bodies). Simplifying things to the utmost, one could say that an explosion of personal autonomy is feeding into and enriching the social fabric, producing extreme levels of complex interaction through which several technical and technological progresses are selected; and these selections themselves reinforce the levels of individual autonomy and social complexity. These interdependences are bringing to life a new form of society which selects and is selected by new forms of governance."

These new connections and forms of governance provide fertile ground for adaptation, innovation and creative new solutions to entrenched problems. However, research suggests that organisational structures and processes are slower to change (see for example the work of Warne et al 2005), Their research, investigating network centric warfare involving groups of people in rapidly changing situations, also indicates that the quality of interactions and relationships between people is of central importance for effective operational outcomes. There

are efforts to intentionally establish cooperative flexible community cultures from within hierarchical bureaucratic environments, which are, traditionally, rigid and competitive. However, as Trauth (1999) has observed, there are many difficulties in encouraging the necessary level of cooperation in a work culture of individualism.

Complexity Theory

It is our contention that network-centric configurations falls outside the realm of traditional bureaucratic management approaches and is better understood from the perspective of complexity theories where outcomes cannot be planned or predicted. In this context procedures, systems, reward, guidelines etc must be put in place to facilitate the sense-making of self-organising units acting as activity systems (Engeström 1999) which must be trusted to share information and form common objects to act to further the cause of the organisation as a whole.

There is a current interest and growing understanding of how to work with the complex and chaotic socio-technical systems that are now part of the workplace. In recent years, many disciplines have seen the need to complement complete, rational scientific approaches to their understanding of the world with theories that can help to account for the mess and fuzziness of reality. Terms such as 'living on the edge of chaos', 'fuzzy logic', 'small worlds' and so on, have now become part of the language. Recognising that there is not a single cohesive theory of complexity or chaos, we have chosen to base our work on the Cynefin model (Snowden 2002) shown in Figure 1. This is a knowledge space with four domains which set the context for collective knowledge work: two domains of order, the known and the knowable, the domain of complexity and the domain of chaos. Snowden's understanding of the characteristics of self-determination, emergence and organic forms that apply in the Complex quadrant are of particular interest here.

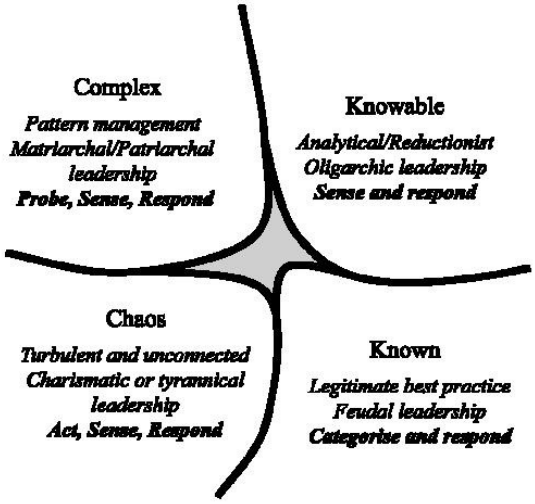

Figure 1 The four perspectives on organisations, knowledge and information systems depicted in the Cynefin framework (Snowden 2002).

Snowden (2002) states that in complex situations it is not possible to predict or determine outcomes in advance, and cause and effect is only seen in hindsight. He describes how meaningful patterns of behaviour emerge that can be encouraged, but not mandated or controlled. According to Snowden, attractors and barriers can be used to enhance the likelihood of desirable outcomes, and indeed innovation and organisational learning. Rather than implying that chaos is the natural outcome of the self-organising capabilities of informal communities, Snowden has faith in the human capability to create order and predictability though collective and individual acts of freewill.

In network-centric organisations connections between central management and other enterprise components are weak so that attempts at control through hierarchical organisational structures often fail. On the other hand connections among constituent components are strong and stable group patterns can emerge and resist change through repeated interaction, mutual goals and experiences (Kurtz and Snowden 2003).

Research Structures and Processes

In Australia, where this research was undertaken, there is now more focus on applied and commercialisable research required for government and industry funding. There is consequently more emphasis on accountability and a corresponding struggle for measurablility of research outcomes and numeric performance indicators. At

the same time there is need for demonstrable quality that is not easily converted to numbers but essential for an international reputation to compete on the global stage. Research reputation has traditional come through an entrenched peer reviewing process of publications, through the ranking of journals, and through the world-wide associations and networks of each discipline. At the same time researchers are subject to the performance indicators, promotion procedure, funding schemes and structures of the institutions within which they work. Most such institutions struggle to find suitable working structures, set performance standards and allocate limited funds across a variety of disciplines in an equitable way in the best interest of the institution. Meanwhile the climate in which all organisations currently function is becoming increasingly competitive, changeable and complex.

Following trends in the United Kingdom (UK), New Zealand (NZ) and elsewhere, the Australian government has begun a process to determine a national Research Quality Framework (RQF) that is intended to promote this quality but also to determine how it provides funds to research institutions. Institutions such as the one used in this study have spent the last few years endeavouring to anticipate and prepare for the changes that the new RQF will impose on them. However, at the time of writing this paper the content of Australian RQF is still not finalised, having been delayed by a change of government minister and confounded by negative feedback from similar undertakings several years earlier in the UK and NZ. The climate of uncertainty is having an unsettling and threatening effect on the participants of the study but it also provides an opportunity in that the results could be an instrument to help them attain a viable and valuable position in the new order.

Research Design

This research uses a variety of complex methods and socio-technical systems to study dynamic, self-organising and diverse communities in accord with the notion of a 'New Scholarship' (McNiff 2000) where there is a new way of knowing that meets the everyday needs of people working in real-life situations. Real-life practices are messy, uncontrolled and unpredictable and are seriously separated from the sanitised world of abstract theorising. McNiff (ibid) proposes that learning from experience, although not highly valued by the academy, can be reinforced through intellectual study and contrasts this to traditional forms of scholarship, which values facts and information and is generated by conventional kinds of research that tests knowledge against standardised criteria and scientific analysis and techniques.

There is a growing realisation of the general research value that can be gained from the use of action research action research, which cooperating between researcher and practitioner in order to endeavour to solve a novel problem (Wood_Harper 1985). We have therefore adopted an approach to our research rooted in reflection-in-action, which implies that the action research will be participatory, evolutionary, contextual, holistic and developmental. The developmental research method involves disciplined investigation conducted in the context of the creation and implementation of a product or process for the purpose of improving either the thing being developed or the developer. This approach is guided by the expanding spiral of learning in the developmental work research approach of Engeström (1987) shown in Figure 2 and the model of quantitative data analysis of Miles and Huberman (1994) depicted in Figure 3. In a spiralling fashion targeted interventions by the participants stimulate activity which is recorded, analysed and displayed as data that informs each subsequent intervention. At some point objectives are realised and conclusions are drawn through interpretation of the situation under investigation.

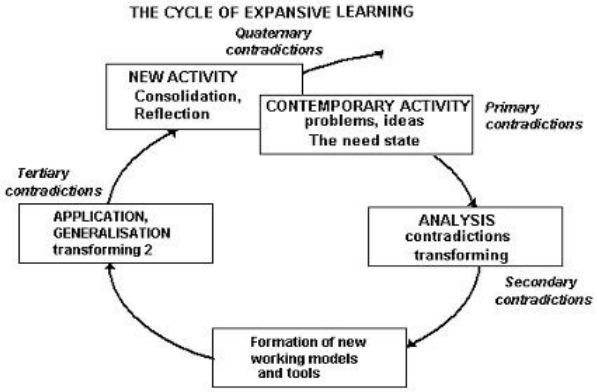

Figure 2: The Developmental Work Research based on the cycle of expansive learning where contradictions are imposed as interventions to stimulate change (Engestrom 1987).

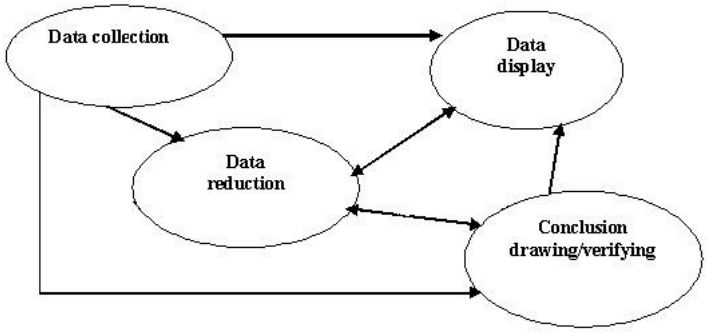

Figure 3: The iterative qualitative data analysis model (Miles & Huberman 1994 p12)

In this study, the site of the investigation is an institution where research, a major part of its business, is substantially government funded and therefore publicly accountable. Internal research structures and resources are mandated and managed centrally, aligned with the institute's reporting responsibilities and four-year strategic plan. The latter identifies areas of strength and researchers in those areas are well supported to form sizeable Centres. Individuals and small groups, not members of these recognised Centres, are supported, but to a much lower level and receive little recognition. This study was commissioned by two clusters of such researchers who were not given Centre status in the current strategic plan because they were not believed to have sufficient focus or critical mass for a Centre.

The aim of the study was to establish a means by which each cluster of self-identified researchers could claim have the focus needed to be a Centre. Meetings of each cluster had worked to put together submissions for funding and recognition to management with limited success. It was then suggested by one cluster that they worked as separate teams, each with its own focus but with interests and activities that connected them to other teams in the cluster. In contrast to the focussed Centre model, they were a loosely coupled yet integrated network in which innovative research was conducted worthy of the same support as that in the big Centres. The objectives of the study were to evolve this concept through identifying, mapping and representing the network as a viable, productive research entity. An evolutionary SNA study seen as a method of doing this, firstly, to consolidate internally a view of the cluster that made sense to its members, and then, secondly, to represent the cluster to management in a meaningful and impressive way. This approach brings together notions of emergence from Complexity Theory (Figure 1), the cycle of expansive learning from the Developmental Work Research (Figure 2) and the importance of data display from the research model of Miles and Huberman (Figure 3).

To conduct the evolutionary SNA study it was advantageous to have SNA software that would enable fast model creation to enable rapid display of revised model to keep participants engaged. Huisman and Van Duijn (2003) have conducted a comprehensive research around different SNA software and their capabilities. This study uses Huisman and Van Duijn (2003) findings as a guideline in order to find the best SNA program. By using that guideline, among different SNA programs such as NetDraw, Pajek, MultiNet and NetMiner II we found NetMiner II more suitable and fit to our study since it is especially designed for the integration of exploratory network analysis and visualization. In fact, the program is a software tool that combines social network analysis and visual exploration techniques, allows users to explore network data visually and interactively, and helps to detect underlying patterns and structures of the network.

As mentioned above the study reported here included proactive projects to identify and represent two separate clusters of small research teams that were under funded and excluded from the mainstream of recognition in the one institution. The SNA of the first cluster, which included researchers with a mainly technical focus, began with a map generated from data currently on the websites of individuals and of small research teams who were candidate members of the cluster. When the resulting map was set around by email to these candidate members, some responded with outrage that websites were out of date, that names had been put there without permission and that some groups were claiming territory belonging to others. While this confirmed the representational power of the SNA map as an interventionist tool in the developmental research method, it almost brought the study to a halt until a second cluster with an organisational studies and social science focus, asked to become part of the study. The following section of the paper describes the study from this point following the evolution of the production of subsequent versions of the SNA map from the second cluster, each fed back to members via email for development until a consensus was agreed that it could go public and be used to define them as a productive network.

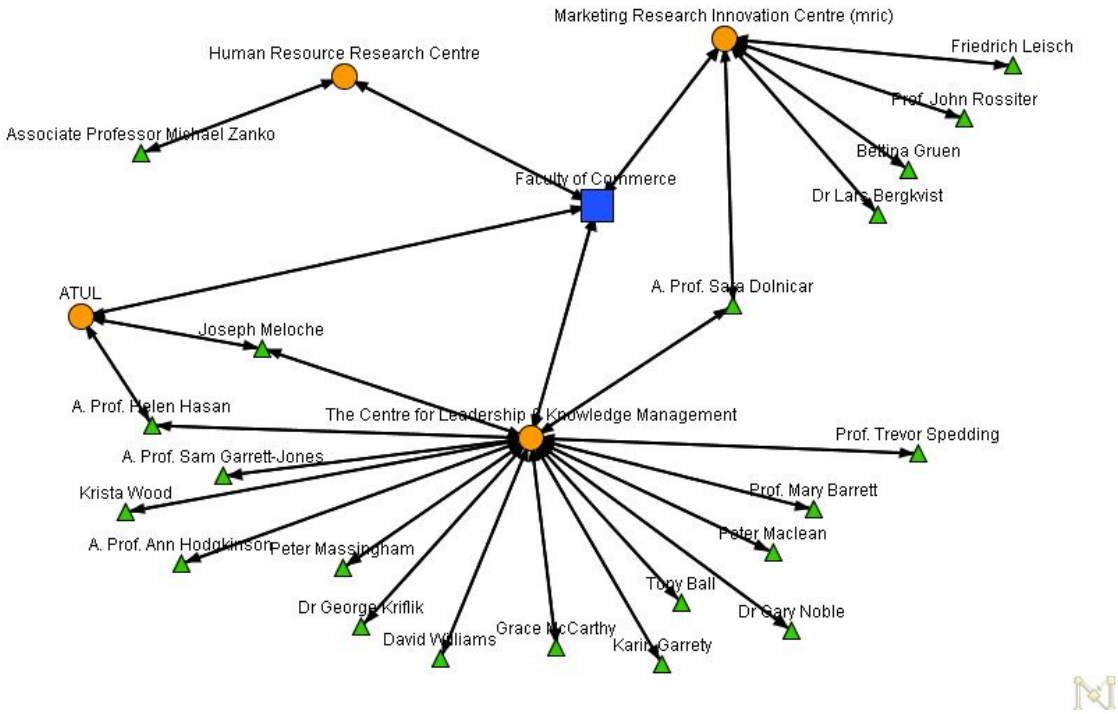

Figure 4 The first SNA map of the second attempt at the study, generated with data on membership of a few research groups as listed on their web-sites. Circles represent teams and groups, triangles represent individual researchers.

RESULTS

As with the first potential cluster, the evolutionary SNA study began with a map generated from data currently on the websites of individuals and of small research teams who were candidate members of the second cluster. This was emailed to all researchers who were deemed to be related to this area of research. The email showed the map itself and asked participants to name any research team or groups to which they belonged and to list he main researchers, internal to the institution with whom they collaborated. These could be within or across the research team of group to which they said they belonged. This time more attention was paid to explaining to participants the potential benefits that could be gained by presenting the results of the study to senior management. The culture of researchers in this cluster was also more conducive to the SNA endeavour being focused more on organisational and social issues rather than technology. They were also more intrigued and engaged by the SNA software which many could also use for their research.

The outcome of the first iteration of the SNA study was positive and encouraging. There was around a 25% response from the emails sent out leading to substantial additions to the map as shown in Figure 5. As responses included collaborations with other colleagues, additions to the map could be made of several non-respondents as well so the improvement was quite substantial. The same process was repeated for a second iteration which produced some corrections to details as well as more groups and individuals to be added to the map as shown in Figure 6. Many of the respondents commented on the positive nature of the exercise and there were none of the negative reactions experienced from the attempt with the first cluster. There were however a few prominent researchers who did not seem to take an interest in the study or its potential benefits and had not yet responded.

The iterative SNA process is continuing and is currently being enhanced to include external collaborators of cluster members and groups. The first version of this map is shown in Figure 7.

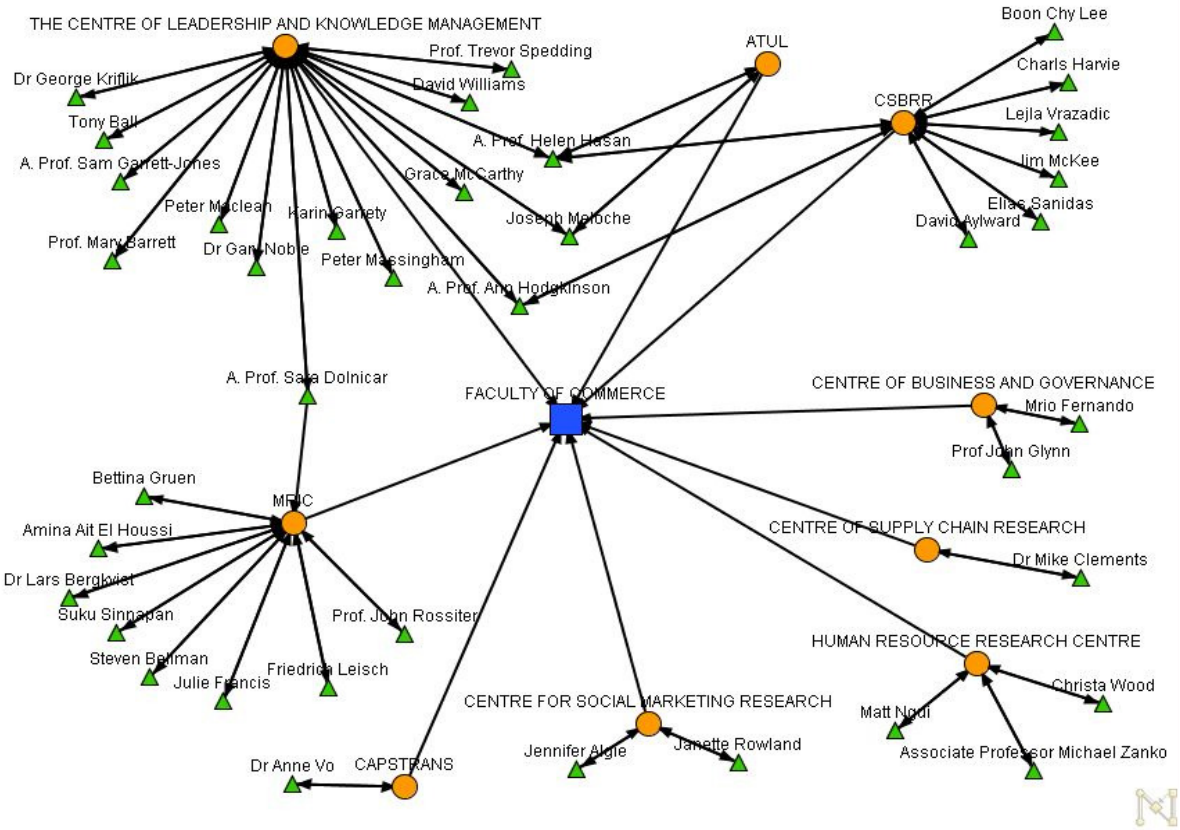

Figure 5 The revised SNA map after the first request for input from potential participants

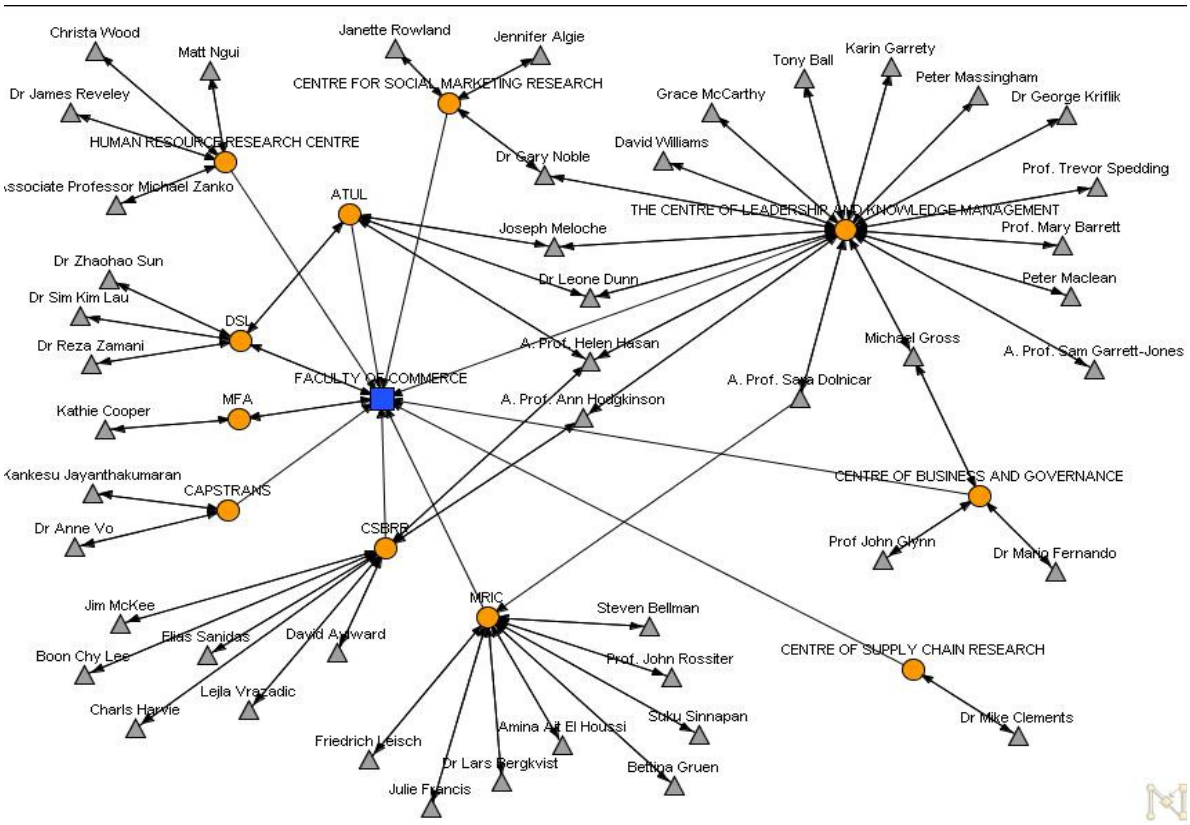

Figure 6 The revised SNA map after the second request for input from potential participants

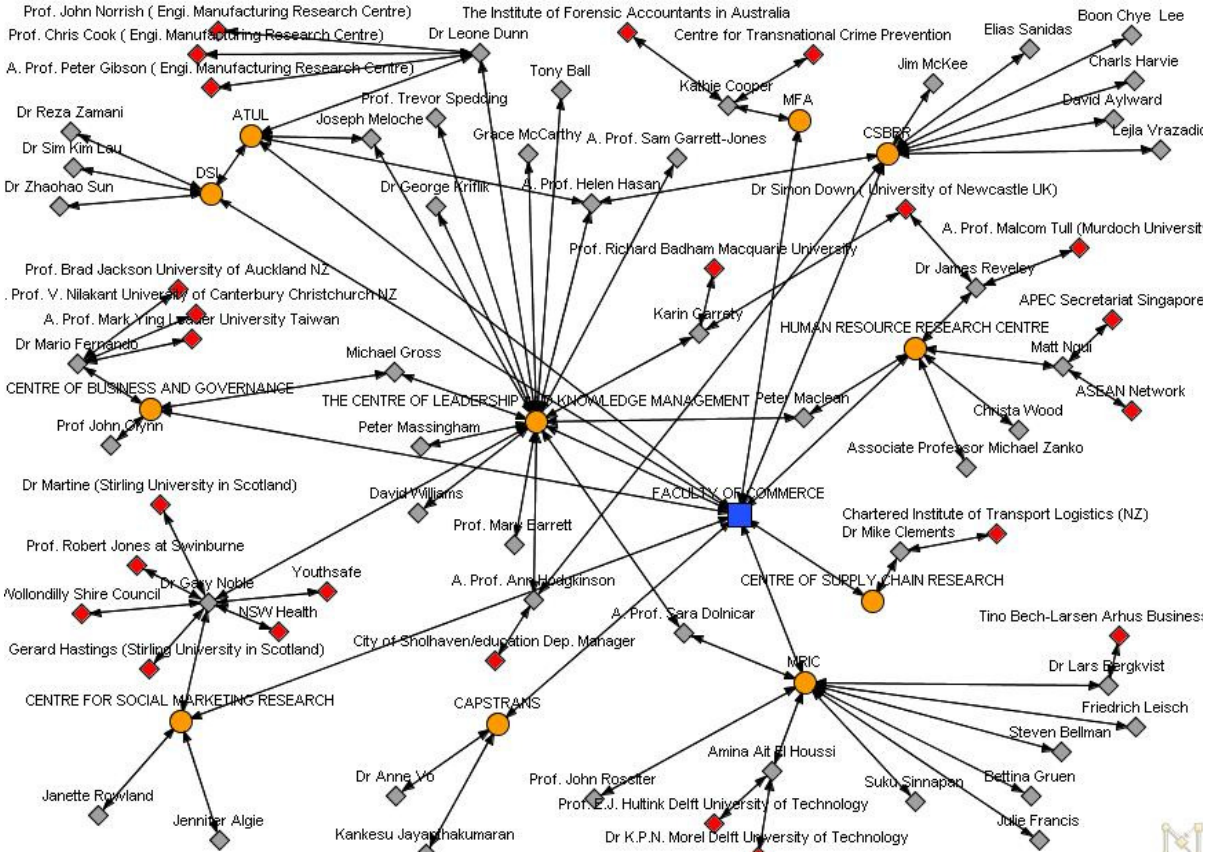

Figure 7 An enhanced SNA map showing some external research collaborators.

Participants now agree that the map, though not yet complete is viable enough to be taken as a representative picture of a viable and substantial research entity which is a network rather than a formal Centre. They were asked permission to show the map to management which has now been done. The response from the senior executive who is research director was extremely positive. She has a science research background and is used to traditionally structured centres. However she said that this solved a problem she had always had in understanding social science research although she had always believed that research in the social science was inherently network-centric. The SNA map was for her an ideal way to represent this reality and she encouraged the SN process to continue while all participants agreed that it represented them. In the next funding cycle this can be used to determine funding and recognition and eventual a Research Network can be put up as just as legitimate and productive research entity and a traditionally structure Research Centre.

DISCUSSION

This study is offered as a legitimate and innovative process of developmental action research with interventions that drive the data collection and the SNA software that supports the analysis and display of the data. The evolutionary approach to repeated distributing the latest version of the map for correction and addition was enabled by the good functionality of the SNA software product and the use of email to distribute and collect data for the timely turn around of each iteration. It was shown by the success of the second cluster study and the failure of the first that this can only work when the culture and environment is right and there is active support from participants.

One of the most pleasing outcomes of the project was the way participants have taken ownership of the SNA map and agreed that it represents and visualises their research network They believe that it defines as significant a research structure as a traditional hierarchically-structured Research Centre. This is the case even though they recognise that it is not yet complete and will never be fixed. In fact they agree that it is more correct to use the SNA map to represent their reality as it is inherently emergent and dynamic with frequent changes of personnel and relationships between them as old project finish and new ones begin. The SNA map clearly represents the complexity of their research world that is meaningful and serves a practical purpose giving the structure a holistic coherence in the same manner as a top down organisational chart of .existing Research Centres.

Even more pleasing was the reaction from the senior research executive who was immediately impressed when shown the SNA map. This is proof of the value of an SNA in the movement towards legitimising network-centric configurations within traditional bureaucratic organisations.

CONCLUSION

This paper began with the proposition that cutting-edge research usually takes place in innovative and creative teams and so should flourish in an ICT enabled network-centric environment. It therefore follows that we would assume that those responsible for managing research organisations would want to understand and foster such an environment. The purpose of the research presented here is to encourage such understanding and demonstrate a way that research organisations can become more network-centric as a valid and recognised configuration that enables good research to occur in small groups.

The approach taken to the study relied on principles of attractors and emergence from complexity theory in evolutionary and participatory action research to intervene and produce a change in organisational culture, behaviour and structure. The data collection, analysis and display was supported by SNA software and administered by email as timely feedback was critical to maintaining support of participants. Indeed the iterative SNA became the attractor that allowed changes in culture to emerge. The outcome of this study provides an example of how a network-centric organisational configuration can be recognised and encouraged within a traditional bureaucracy. It also demonstrates how notions of emergence from complexity theory may be implanted in practical settings with the support of a tool such as SNA.

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