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A Taxonomy of modes of knowledge sharing between disparate groups

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A TAXONOMY OF MODES OF KNOWLEDGE SHARING BETWEEN DISPARATE GROUPS

Authors

Abstract

While there is an abundance of literature on knowledge sharing within teams, there is a scarcity of literature on the transfer of knowledge between disparate groups where communication and coordination are difficult due to the diversity of attributes such as culture, language and priorities. The inspiration for this work comes from a project on the use of the web to enhance communication between clinicians and the families of patients in intensive care units. The paper also draws from relevant research on topics such as cross-functional teams, shared situational awareness, jointness, interagency cooperation and inter-organisational boundary- spanning. This investigation is grounded in concepts from Complexity Theory and Activity Theory and has resulted in the taxonomy of modes of knowledge sharing between disparate groups that is presented and discussed in this paper. There are five items in the taxonomy, namely Ad hoc, Spokesperson, Mediator, Embedded, Boundary Spanner. Each is described and discussed based on the research experience and an analysis of relevant literature. The motivation in presenting this taxonomy is to provide a useful tool for understanding and to stimulate a deeper and broader appreciation of this topic.

Keywords: knowledge sharing, disparate groups, taxonomy, cooperative activity

1. INTRODUCTION

Socially-constructed knowledge is a significant source of learning, creativity and innovation in many kinds of human enterprises, from community settings to multinational businesses (Crawford et al 2009). In formal enterprises, knowledge can be considered at three levels, namely individual, organisational, and an intermediate level (the team/group/unit) (Linger & Warne 2001). The smaller entities at the intermediate level are often informal yet quite cohesive and it is within them that the potential of collective activities for innovation is most apparent and the sharing of knowledge among members is so critical (Boland & Tenkasi 1995, Engestrom 1999, Toulmin 1999, Wenger et al 2002). There is, therefore, an extensive body of contemporary literature on information and knowledge transfer within teams and work units. In the field of Information Systems (IS) there is particular focus on information and communications technology (ICT) support for knowledge sharing within virtual teams. In contrast, there is a scarcity of literature on the subject of this paper, namely the transfer of knowledge between disparate groups where communication and coordination difficulties are evident due to the diversity of group attributes such as culture, language and priorities. The paper draws from some relevant findings from research on topics such as cross-functional teams, shared situational awareness, jointness, interagency cooperation and inter-organisational-boundary spanning, particularly along supply chains. However, the main evidence for the taxonomy of modes of knowledge sharing between disparate groups, presented in this paper, comes from observed instances of knowledge sharing between such entities in practice.

The inspiration for this work comes from a research consultancy project aimed at assessing the use of the web to enhance communication between clinicians and the families of patients in intensive care units (ICU) (*references to this work have been removed for the blind review process*). As this project unfolded the challenge of enabling knowledge sharing between these two disparate groups was encountered. In the ICU situation the patient usually does not have the capacity to contribute to their healthcare choices so that decisions have to be made on their behalf using the combined knowledge of the clinicians and the patient's family. The situation is made more difficult by the ad hoc communication between ICU staff and family members who happened to be present when time-critical decisions have to be made at all hours of the day and night. As a spin off from the main project, the potential for alternative modes of knowledge sharing between the two groups was investigated by re-examining interview data in the project and searching for solutions to this problem in other contexts where similar challenges are encountered. This investigation is grounded in concepts from Complexity Theory and Activity Theory as will be described in the paper. The result of this process is the taxonomy of modes of knowledge sharing between groups that is presented and discussed in the paper. The items in the taxonomy encompass all modes that our search has uncovered but there is no guarantee that there may not be others to add to the list. The intention is to provide a useful tool for understanding and to stimulate a deeper and broader appreciation of this topic.

2. BACKGROUND

2.1. Clarification of Terms

Two key terms in the title of this paper, those of 'group' and 'knowledge sharing', are deliberately chosen to encompass as wide a focus as possible and thus give the resulting taxonomy broad application. The rationale for each term is now given.

The term 'knowledge sharing' was chosen to encompass a whole set of other concepts that could be used in the context of inter-group activity. These would include communication, collaboration, cooperation, coordination and information flows. The intention is to use the term 'knowledge sharing' to cover the notion of two-way information transfer leading to mutual understanding, common sense and insight providing the capability for collective decision-making and action. This distinguishes knowledge from information in that knowledge is information made actionable as indicated in the following three definitions of knowledge: (i) knowledge is a body of understanding and skills that is constructed by people and is increased through interaction with information (AS 5037 2005); (ii)

knowledge is information with belief (Callioni 2003) and that (iii) knowledge is created through a sense-making process and acts as an interpretant to turn data into information (Callahan 2007).

The term 'group' is used to represent any relatively small collection of people engaged in a reasonably long-term activity with a common purposeful object, as understood by Activity Theory as described below. This would include formal or informal work units and teams but also other entities such as families and community groups. The groups can be real, virtual or a combination of these. It is assumed that groups tend to function either as, or at least within, the environment of a self-determining community and so be innovative and relatively independent (Mentzas et al 2001). It is also assumed that there are strong ties within a group and a sense of identity often with its own culture, language, assumptions and objectives. The phrase 'between disparate groups' in the paper title refers to two or more groups that could be independent, part of the same larger organisation or from different agencies. For the purpose of this paper, the groups would need to have some reason to interact and share knowledge. However, there are likely to be differences in culture, language, assumptions and/or motives between disparate groups and ties between groups would be weaker than those within the groups. It is this 'between group' interaction that is the focus of this paper and its importance has emerged from studies of complex network-centric organisational configurations (Crawford et al 2009).

A network-centric configuration is 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 (Hasan & Pousti 2006). 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 network centric paradigm thus recognises the value of human relationships, commitment, engagement and purpose, as critical to the success of shared endeavours (Crawford et al 2009). One of the most challenging aspects of the network-centric paradigm is the need support loosely-coupled, self-managed teams to make cooperative decisions through the sharing of knowledge. In such a model the different histories, capabilities, needs and purposes of participants and the quality of their relationships and shared interaction define the scope and possibilities for effective shared activity. This is aligned with in the 'complex domain' of the Cynefin model of collective knowledge creation, sharing and utilisation (Snowden 2002). In complex situations the relationship between cause and effect can only be perceived in retrospect, but not in advance. The most appropriate way to treat problems in this domain is to *Probe - Sense - Respond* (PSR) and then allow *emergent* practice (Kurtz & Snowden 2003). A reliance on the detection and leveraging of emergent patterns, rather than pre-planning and design, have guided the approach to taxonomy development used in this paper.

2.2. Groups as Collective Activity

As mentioned above, the lens of the Cultural-Historical Activity Theory is used to understand group activity and inter-group cooperation, as it provides a solid theoretical basis for understanding collective human experience. Activity Theory is a social-psychological theory that has its roots in the work of the Russian psychologist Vygotsky during the first half of the 20th century (Vygotsky 1997). Vygotsky defined human activity as a dialectic relationship between subject and object, or more simply a person, or more often a group of people, working at something. He also proposed that all human activity is purposeful, is carried out through the use of tools and is essentially social. Vygotsky believed that tools play a mediating role in all human activities and mental processes. Activity Theory can therefore be quite a practical and holistic way of analysing a complex situation as seems to be the case in this study. Activity, i.e. what people do, is the basic unit of analysis, and is mediated through the use of tools.

To be able to analyse complex interactions and relationships, Engeström (1987) proposed a research framework with an activity system as the unit of analysis. This is represented in the triangle shown in Figure (2) which has been widely used in social science research over the last two decades. Following the original Vygotskian theory, the core of an activity is a dialectic relationship between *subject* (human) and *object* (purpose) where the subject can be individual or collective, as in a group or team working on a common project. The *subject* could be an individual or a small group involved in a collective activity. The subject-object relationship, which defines the activity, is mediated by tools

and community. Tools which mediate activities can be physical, i.e. technical or psychological such as language, ideas and models. This is a two-way concept of mediation where the capability and availability of tools mediates what is able to be done and tools, in turn, evolve to hold the historical knowledge of how the communities behaves and is organised.

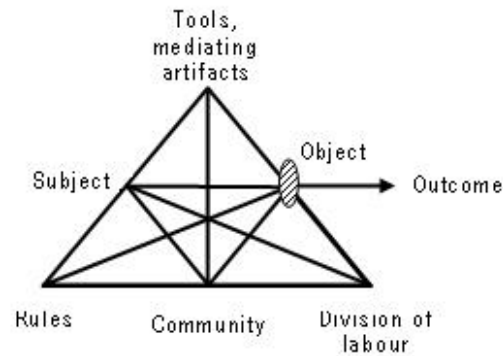


Figure 1. Engestrom's (1987) representation of an activity depicting the core relationship between subject and object across the centre of the triangle surrounded by mediating elements

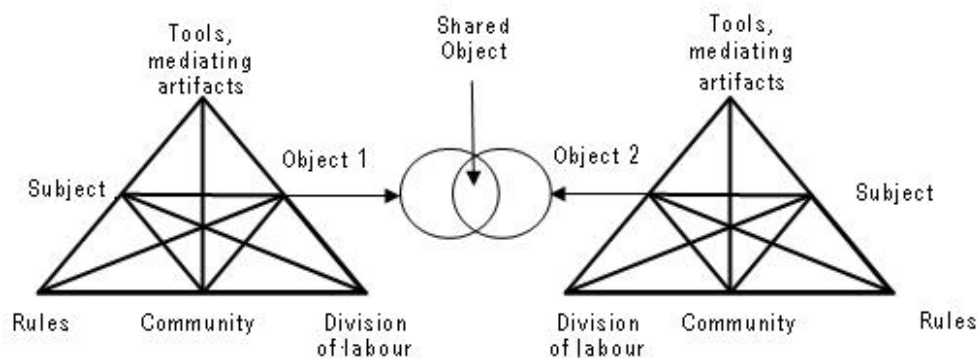


Figure 2. Engestrom's triangles are used to depict two activities with partially shared objects. .

Figure 2 uses the representation of Figure 1 to depict the case of interacting activities, keeping in mind that it is the object of an activity that incorporates its focus and purpose. Two related activities can either share a common object, have overlapping objects or at least objects that are aligned or complementary. When the subject of each activity is collective (ie a group) this model underpins the situation of interest to this paper where related but disparate (loosely coupled) groups need to share knowledge in some joint endeavour.

3. RELEVANT CONCEPTS FROM THE LITERATURE

As mentioned in the Introduction, there is only a small body of literature specifically on knowledge sharing between groups (Lertpittayapoom et al 2007). One example is the work of Hansen (1999) showing that weak inter-unit ties (ie ones with relationships that are infrequent and distant) help a project team search for useful knowledge in other subunits but impede the transfer of complex knowledge, which tends to require a strong tie between the two parties to a transfer. Thus having weak inter-unit ties speeds up projects when knowledge is not complex but slows projects down when the knowledge to be transferred is highly complex. The research of Cummings (2004) deals with external knowledge sharing between project teams and customers, organisational experts and others. The findings show that the value of external knowledge sharing increases with the structural diversity of group by virtue of different affiliations, roles or positions that can expose the group to unique sources of knowledge. The need to match the diversity of knowledge within a group with the diverse challenges of the environment is consistent with the Law of Requisite Variety (Ashby 1957), which states that, with the support of logical reasoning and empirical evidence, only variety can master

variety. Despite the lack of specific literature, the topic of inter-group knowledge sharing is informed by the following related instances of collective activity.

Cross-functional teams: This literature includes research on communication (Patrashkova & McComb. 2004) as well as leadership and trust (Webber 2002) among diverse team members. Cross functional teams have similar cross-cultural and cross-disciplinary knowledge sharing problems to those experienced between groups.

Jointness: There is a body of literature from the military of knowledge barriers encountered in joint operations, ie those involving personnel from different services. Problems encountered due to diversity are similar to those encountered in cross-functional teams. Diversity of leadership styles between different military services is one issue that is often reported as causing friction in cross-service teams (see eg HDoFW Research Team 2007).

Inter-agency cooperation: Emergency and crisis situations usually involve the formation of temporary multi-agency enterprises. Problems of inter-agency communication and coordination have been addressed in the literature (see eg Pousti et al 2005). Similar challenges are encountered in the temporary alliances of building projects (Beckett & Hasan 2006) and in the making of movies in the film industries (Jones 2006).

Organisational boundary-spanning: There is a body of literature highlighting the problems of inter-organisational information and knowledge sharing, particularly along supply chains. Several researchers in talking about the bullwhip effect in supply chains discuss the potential to reduce supply chain deficiencies by addressing managerial needs for information along the supply chain (Lee et al. 2000; Zhao et al. 2002; Dejonckheere et al. 2004). Lertpittayapoom et al (2007) also describe the differences in organisational culture, knowledge domains and other critical factors that pose a major challenge for inter-organisational knowledge sharing.

Shared situational awareness: Situational awareness (SA) is generally described as knowing and understanding what is going on around you and predicting how things will change.. According to Endsley (Endsley et al, 2003 p. 197) shared situational awareness (SSA) is defined as the degree to which team members have the same SA on shared SA requirements, although rarely would a team require exactly the same SA in all members. Endsley (1995) defined SA, and implicitly shared situational awareness (SSA), as having three levels: Level 1, perception of elements, which requires information sharing among team members supported by a physical tool. Level 2, comprehension of the current situation, which requires knowledge sharing through co-created mental models of the state of play so that knowledge is understood as 'information made actionable'. Level 3, projection of future status, which takes knowledge into the realm of the 'big-picture' with understanding, insight and wisdom needed. Baber et al (2006) define SSA as a systems level perspective of a situation that can be determined through the input of relevant information and the words and behaviour of team members.

In each of the areas above, participants face challenges of carrying out a complex collective activity where there is a need for shared situational awareness but often different perceptions of the object of the activity. Knowledge must be shared among people with diverse views and experience and across cultural boundaries.

4. METHODOLOGY

As mentioned in the Introduction, the work of this paper is a spin-off from research in which data was gathered from three sets of stakeholders in an ICU, namely staff in the ICU of several state hospitals, the general public concerned with ICU patients and managers of the state government ICU website (*references to this work have been removed for the blind review process*). Qualitative data was collected using different techniques suited to the context of the stakeholders including interview, observations, Q-method and usability testing of the website. The results of the data analysis were fed into an evolutionary System Dynamics modelling process, which both integrates the data and literature, and also dynamically visualises the information flows between the different stakeholders. The resulting model was then qualitatively reinterpreted using concepts and frameworks from Activity Theory in order to provide deeper insights into the relationships within the system. The project studied

information flows in ICUs between one group, the clinicians and another, the family of the patient who is usually incapacitated in an ICU. Knowledge sharing between these two groups was essential to making good healthcare decisions on the patient's behalf and the managers of the ICU website wanted to know how to better use a public website to improve public ICU knowledge. The situation in the ICU was modelled as two collective activities (see Figure 3) with a common object or purpose, namely the welfare of the patient, but with very different subjects. On one hand were the clinicians familiar with the ICU environment, having medical knowledge and skills, using a technical and professional language and, on the other hand, the family who were distressed, upset and bewildered by the need to understand what was happening in the ICU.

Results of the original study revealed that encounters between the two groups were mostly serendipitous so that discussions on critical aspects of the patient's condition took place between various members of each group who happened to be present at the time and at all hours of the day and night. The quality of knowledge sharing therefore was variable both between the two groups and among member of each group, especially the family. Many clinicians did not have great skills in communicating with the public and tended to avoid contact with the family. Family members often made unrealistic demands on the time of busy ICU staff.

For the purpose of this paper the qualitative data has been re-examined to investigate alternative modes of knowledge sharing between the two groups and solutions to this problem are also sought in other contexts where similar challenges were encountered. Similar challenges in inter-group knowledge sharing were found in other research projects that we had conducted in commercial and military organisations. In addition we have conducted experiments on communication between student groups and groups engaged in an online game (*references to this work have been removed for the blind review process*). As a result, a set of five generic types of knowledge sharing have been identified. These are described in the following section of the paper and then analysed for their suitability and implications in different situations. Guided by the set of concept described above, examples from our research are used to illustrate the five types. It is important to note that most cases of inter-group interaction in practice will probably involve mixtures of the generic types.

5. THE TAXONOMY

The proposed taxonomy is composed of five types of inter-group knowledge sharing which, as described above, includes information flows and inter-personal communication on which decisions are based leading to action. Groups are engaged in interrelated activities so that between group coordination is required and where there are weak ties between groups and strong ties within groups. In the ICU study for example, the clinicians had a common professional expertise and medical language, and the ICU team in each hospital had bonded through working together in crisis situations over an extended period of time. As expected, family ties were also strong and long standing but of a different nature to those within the ICU team. Each type in the taxonomy is described and illustrated by the case where two small groups interact. The two groups are designed as X and Y with members $\{x_1, x_2, \dots, x_i\}$ and $\{y_1, y_2, \dots, y_i\}$ respectively. However the same styles could apply where more than two groups are involved and where the groups are larger.

Mode 1. Ad hoc: In ad hoc knowledge sharing each member of X (the x_i) has access to each member of Y (the y_i) as depicted in Figure 3 and interaction depends on individual communication often by chance meeting which could be infrequent and difficult. This mode of knowledge sharing was observed as the most common style of interaction between clinicians and families in the ICU study and is typical of informal proximally located groups, for example community organisations. Three problems observed in the ICU with this mode is, firstly, that there is often no record of who has spoken to whom, secondly, contradictory information may be passed between groups by difference inter-group encounters, and, thirdly, knowledge received by one group member may not be shared among group members even though ties between them are strong. On the other hand, we have seen in the workplace and in the military, that there is value in encouraging informal social interactions between members of different teams and units. This builds morale, broadens social learning, and helps develop positive attitudes to activities that span team and unit boundaries. Ad hoc inter-group

relationships and networks can be a source of new ideas and innovations and provide an informal alternative means of communication in situations when formal channels breakdown.

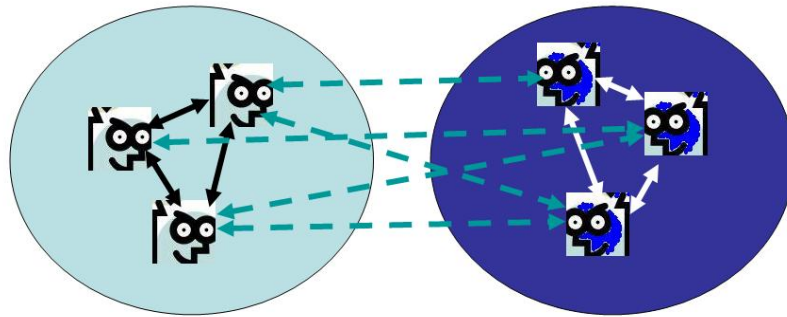


Figure 3. *The ad hoc mode of interaction where there are weak ties between each x_i and each y_i and strong ties with groups X (left – light blue) and Y (right – dark blue)..*

By its nature the ad hoc mode often happens naturally and is the default when no other mode is set up. However, if team members realise that it is not a very efficient mode of knowledge sharing and can be the cause of fragmentation of information and decision making. The ad hoc mode is often of value as a supplement to other modes to build informal networks in a traditional formal bureaucratic organisation. This phenomenon occurs in the Complex quadrant of the Cynefin model of collective knowledge creation, sharing and utilisation.

There was a time when ad hoc meetings between members of disparate groups would only occur if the groups were co-located so that face to face encounters were possible. Now it is increasingly likely that people meet online as there many places on the Internet where ad hoc encounters can and do occur (eg social systems such as Facebook, Myspace, Twitter). Thus distance is becoming less of a barrier to the ad hoc mode of knowledge sharing.

Mode 2. Spokesperson: In this mode each group has one member (say x_s and y_s) through whom all knowledge sharing is channelled as depicted in Figure 5. The spokesperson could be the group leader or a representative who could be assigned, elected or even just emerges in a self-organisation group. In the ICU the obvious spokesperson for the family would be the next of kin or guardian who can make decisions on behalf of the patient. This mode is the common official mode in many work and military situations eg meeting of team or unit leaders, and has obvious advantages of efficiency over the ad hoc style when there are formal decisions to be made and where there are many groups who must co-ordinate efforts. However, group, team or unit members can feel marginalised in this process. Our research into team games has revealed that often a team leader or spokes person can emerge as they become more cohesive but this does not always need to be the case.

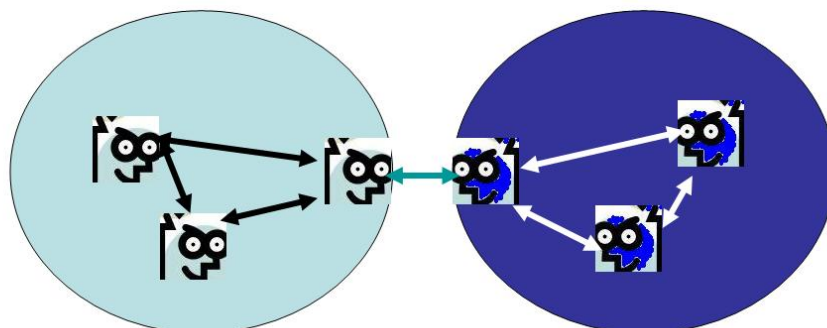


Figure 4. *The Spokesperson mode of interaction where X and Y each have a spokesperson x_s and y_s who can develop quite strong ties together with the strong ties within X and Y.*

Selecting a spokesperson to interact with another group is often a solution to the recognition of problems with the ad hoc mode. Efficiencies come from faster consensus in decision-making but actual knowledge sharing may be slower and reduced as the spokesperson acts as a filter. The spokesperson can thus have a position of power and other members of the group may not have the same influence. There can be political implications on choice of spokesperson.

Mode 3. Mediator: In this mode, an external person M, ideally with relationship management or negotiating skills, performs the role of mediator and provides the channel for knowledge sharing. M could interact with all members of the group, as to each x_i in Figure 5 or and to a group spokesperson, as to y_s in Figure 5. This mode of knowledge sharing is prevalent when there is tension or antagonism between groups or a break down of knowledge sharing using one of the other modes. Possible mediators suggested in the ICU study were could be translators for families with limited English, social workers or lawyers. In the work environment union officials often act as mediators between worker groups and management. Negotiators also often act as mediators in hostage situations in law enforcement and military operations. Situations involving mediators usually have a level of stress and complexity on top of the other difficulties encountered in knowledge sharing between disparate groups. There is more likely to be a larger variety of motives between the activities of the groups involve that need to be resolved before they can work towards the common object that brings them together (see Figure 2).

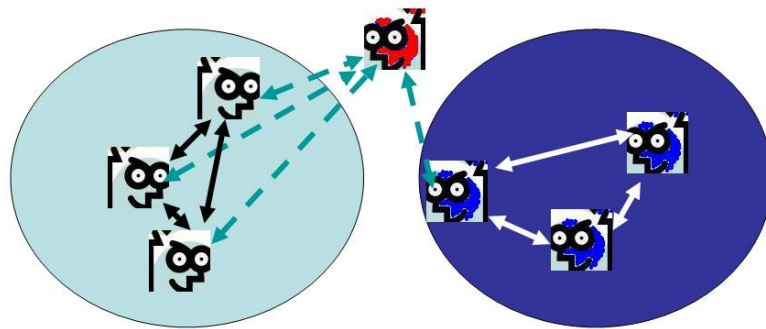


Figure 5. *The Mediator mode of interaction where knowledge sharing goes through a neutral external person M (who can then interact with each group in either the ad hoc mode (X light blue group on the left) or a spokesperson (Y dark blue group on the right))*

Calling in a mediator is often a solution to a breakdown in inter-group co-ordination using one or more of the other modes of interaction. There are usually difficult issues and problems to deal with so that a professional or experienced negotiator is needed. Trust and respect for the mediator, as well as his or her skills and suitability is critical to success. This mode is often used when much is at stake so that failure could have dire consequences.

Mode 4. Embedded: In this mode, as shown in Figure 6, one member of one team, say y_e from team Y, joins the other team, in this case X, either as an observer or even as a participant, and y_i can then report back to the rest of team Y from an insider's perspective. An example of this in the ICU would be if one family member attended ICU team meetings and had open access to their knowledge as appropriate. In the study we did not hear of any instances of this and, when questioned, ICU staff were quite negative to this possibility. This mode is more common in other organisations, where various representatives sit on committees of other parts of the organisation, student representatives sit on university boards, etc. A particularly interesting recent instance of embedding is that of war-correspondents joining active battle units in covering events for news media. This mode of interaction between disparate groups gives deeper contextual understanding to the knowledge shared leading to improved outcomes of the joint activity. There are, however, obvious challenges to this mode due to issues of confidentiality, misinterpretation and even danger as the embedded person is exposed to the real activities of the other group for which they are not trained. In addition there are the issues of trust and acceptance by the receiving group of the embedded person.

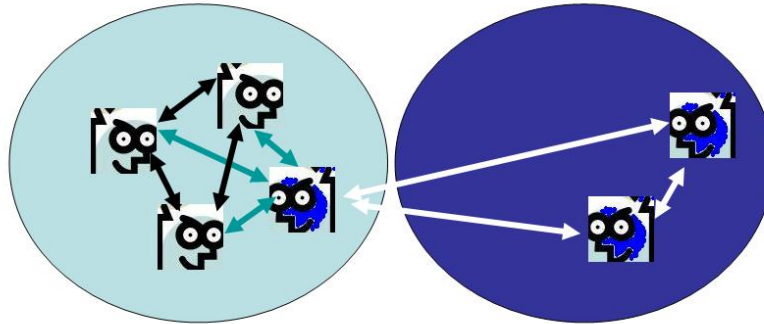


Figure 6 *The Embedded mode of interaction where a member y_e of team Y joins team X.*

Mode 5. Boundary Spanner: In this mode, the boundary spanner has a legitimate claim for membership of both groups, and so is someone who is both an x_i and a y_i . In the ICU study there were several cases, particularly in the small regional health services where someone who worked at the hospital had a family member in ICU. Boundary spanners exist in a wide range of inter-group situations. Most such arrangements are serendipitous but provide an opportunity for quality knowledge sharing that should be exploited. The military for example can benefit from members of their own forces who have a cultural or language background of the enemy or of the countries where they are serving on peace-keeping duties.

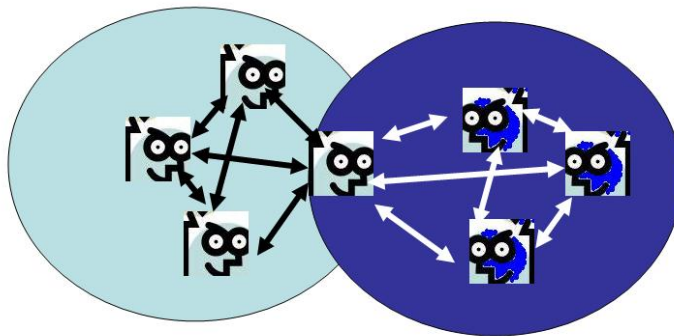


Figure 7 *The Boundary Spanning mode where someone is a member of both teams.*

In reality interaction between groups results in a mixture of these modes of knowledge sharing. For example in Figure 8 the light blue team, X, has a spokesperson the other relies on the ad hoc mode. Similarly in Figure 5 in the mediated mode members of team X have ad hoc interaction with the external mediator while team Y use a spokesperson.

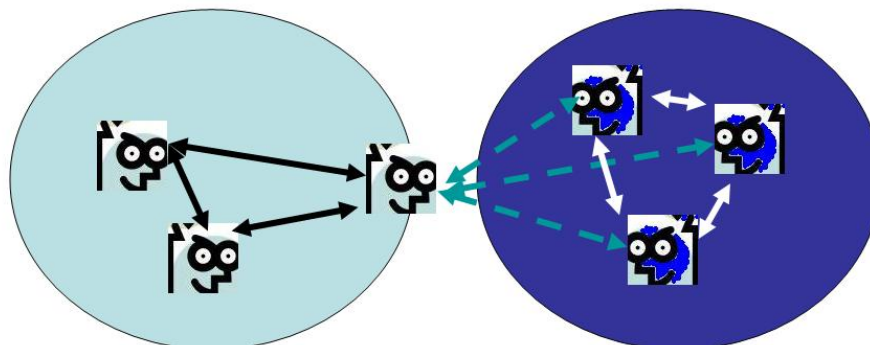


Figure 8 *An example of a mixed mode of interaction where the light is blue team X operates in spokesperson mode and the dark-blue team Y has an ad hoc knowledge sharing mode/*

It would also be possible for two or more modes operate in parallel particularly as most modern organisations have complex hybrid structures consisting of both hierarchies and networks (Hasan et al

2007). The hierarchical part of the organisation would set up formal arrangements, such as the spokesperson and mediator modes, to coordinate the work of teams and unit where as the less formal networks would more likely use ad hoc or boundary spanner modes.

6. DISCUSSION

Knowledge sharing is difficult across boundaries as seen from literature cited in this paper on topics related to that of knowledge sharing between disparate groups, namely cross-functional teams, jointness in the military, boundary-spanning along supply chains and interagency cooperation. Issues raised include the challenges in shared situational awareness, communication, leadership and trust across differences in culture and ways of working. These are cases of activities where collective subjects need to know and understand what is going on around them, enabling cooperative action towards common objects. Successful outcomes of activities require the sharing of complex knowledge between individuals and groups.

The groups relevant to the taxonomy presented here are likely to have strong internal ties with relative homogeneity of their perception of the object of the joint activity. However the disparity between the groups will usually mean that ties between them are weak with less shared situation awareness and diverse interpretations of the common object of the joint activity. The literature on cooperative activities of disparate groups indicates that the lack of strong ties between them often impedes the sharing of complex knowledge. However, the potential value of knowledge sharing between groups engaged in cooperative activities with each other increases with the diversity of the groups by virtue of different and unique sources of knowledge. The Law of Requisite Variety points to the need to match the diversity of knowledge within a group, and by extension within a coalition of groups working towards a common object, to that outside it in order to meet the diverse challenges of the environment. The taxonomy of relationships between groups can be used to understand and improve the inter-group knowledge sharing and thereby increase the chances of successful outcomes of their joint activity.

Instances where disparate groups engage in collective activities are numerous and varied. This research began with the example of the two groups in an ICU, the clinicians and the family working together for the wellbeing of the patient. It may be extended to small business clusters, myriads of networks such as those we have for research, supply chains, client/vendor partnerships, and temporary organisations such as those for construction and movie making. Of critical importance are the communications among coalitions of groups rapidly formed in emergency situations. These may include teams of police, military, medical, rescue services and local civilian community groups. Critical sharing knowledge can be severely constrained by the breakdown in normal modes of communication as has been evident in the events of 9/11, the Asian Tsunami, the cyclone in New Orleans and the bush fires in Australia. Rehearsal of interagency patterns of information gathering and exchange, as well as responsibility for action, need to take into account different ways response teams can be organised to optimise knowledge sharing for co-ordinated decision and action. Kapucu (2006) emphasises the importance of developing a strong communication system with other agencies before a disaster occurs to establish appropriate modes of communication in which effective interagency coordination will take place at the time of a disaster. It is suggested that the taxonomy presented here may be a useful tool in this exercise as multiple modes of interaction will inevitably be needed to suit the different cultures and ways of working of each agency.

Table 1 is a summary of the taxonomy of alternative modes knowledge sharing between disparate groups who must coordinate actions in activities, in which they participate, that share a common object. This taxonomy is set up to be useful for research, understanding and for practical application. As identified in this paper, disparate groups have different ways of knowing and working posing difficulties for inter-group knowledge sharing. This taxonomy provides an understanding and a language for the different modes of knowledge sharing that could be applied as appropriate in any particular inter-group activity.

Mode	Summary Description
Ad hoc	Each member of X (x_i) has access to each member of Y (y_i) and interaction depends on individual chance meetings.
Spokesperson	Each group has one member (x_s, y_s) through whom all knowledge is channelled.
Mediator	An external person M performs the role of mediator and interacts with all members of the group, ie each x_i or to a group spokesperson, y_s .
Embedded	One member of one team, say y_e from team Y, joins the other team, in this case X, either as an observer or even as a participant, and y_i can then report back to the rest of team Y from an insider's perspective.
Boundary Spanner	With a legitimate claim for membership of both groups, the boundary spanner is both an x_i and a y_i .

Table 12. A Summary of the Taxonomy of modes of knowledge sharing.

The taxonomy emerged from the critical and stressful situation that exist in an ICU when difficulties were encountered when two different groups, teams of clinicians and families of patients strive together for the good health outcomes under pressure in an uncertain crisis situation.. Concepts from Complexity Theory and Activity Theory were found useful in making sense of the problems faced in coming to a common understanding so that the right decisions are made on behalf of the patient. As discussed above there are many other similar activities where disparate groups have an urgent requirement for effective knowledge sharing.

The taxonomy is not intended to be a simple solution to a complex problem but rather one tool that could be found useful in providing some guidelines as to which mode suits which group engaged in any particular joint activity. In reality, complex interaction between groups will usually involve a mixture of these modes of knowledge sharing. The choice of mode may depend of the size and number of groups; the length and strength of ties within and between groups; the level of trust based on previous of the groups interaction; the critical nature of the communication; time pressures and constraints. Here the modes have been described when there were only two groups involved whereas many joint activities involve multiple groups, making the picture more complicated, although still a combination of the five modes described here. The reader may have encountered other modes of interaction and the taxonomy could be extended accordingly. In future research, it is hoped that the usefulness of the taxonomy will be verified and the basic concept found to be widely applicable.

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