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COALITION COMMAND AND CONTROL IN THE NETWORKED ERA

Using Organisational Networks to inform the design of a new HQ

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ABSTRACT

In early 2001 several of the authors were approached to provide advice to the Australian Defence Force (ADF) regarding the proposed collocation of five geographically separated HQ. These HQ had common responsibilities in terms of meeting operational goals and, although they worked in different domains, were required to work collaboratively.

The collaborative nature of these inter-organisational relationships had prompted decision makers within the ADF to consider the concept of a new collocated environment where all of the HQ would be located with minimal physical separation. At the time of our work limited consideration had been given to reconfiguring the organisational structure to best take advantage of the potentials of increased proximity.

Previous work identified the importance of human-to-human links within the organisational networks that existed within and between these HQ. This study employed social/organisational network analysis techniques to provide an understanding of relative interdependencies between groups and the global structure of collaboration across the enterprise. The analysis examined organisational networks at multiple levels of abstraction (enterprise, organisational, functional and individual levels). Additional analyses were undertaken, aimed at exploring implications of these networks in terms of physical placement of personnel within the new HQ building. Whilst not explicitly an aim of this study, it was also planned to use the outcomes of these analyses to gain insights into the suitability of alternative organisational structures.

This paper provides an outline of the approach used as well as illustrative results that arose from the analyses that were conducted.

1. Introduction

This paper provides an overview of the methods used and illustrative results from analyses of social and organisational network data collected across five geographically separated HQ. The data were analysed in order to provide inputs into the decision making process for a new HQ (henceforth the New HQ) which would arise from the collocation of the five geographically separated HQ into a single new location. This New HQ would bring together, for the first time, these five HQ which, whilst having common responsibilities and a need to work together collaboratively, all specialise in unique and different domains. Three of these HQ were located in separate buildings at the one site, the fourth HQ was approximately 15 minutes away by car and the final HQ was over 60 minutes away by car. The New HQ is to be located at a new site in a different city. To further complicate the process, the decision was also made that certain development responsibilities currently undertaken within each of the HQ would not be performed in the New HQ and that these development functions would be performed at another site. Thus, each of the HQ would need to split and relocate only those staff involved in the core operational functions of the HQ (referred to as collocating staff); those staff engaged in the support functions were to be left behind (referred to as the non-collocating staff).

This project was aimed at providing improvements in organisational performance through increased organisational awareness and enhanced inputs to assist in the decision making process of senior executives. For the purposes of this paper, the five HQ are referred to as HQ-A, HQ-B, HQ-C, HQ-D and HQ-E.

1.1 Previous work

Previous work in support of this project had involved analysts from the Defence Science and Technology Organisation (DSTO) undertaking a study to provide analytical support to develop the concept for the New HQ with a particular focus on the Communal Facility (CF) within the New HQ. The CF was designed to house elements from all five of the current HQ and can be seen as the core of the New HQ that supports all HQ and their activities. The CF was designed to provide an environment in which common resources needed by all five HQ could be shared. Because of cost factors, there was a limit as to how many people could be permanently located within the CF. Further details regarding this work are available from the authors.

1.2 Collocation and synergy

The genesis for this study came from a project paper, which stated the following two fold focus for collocation: 1) to provide enhanced organisational structures, and 2) enabling of administrative and organisational synergies and effectiveness. For the analysts the key element of these statements was the 'enabling of operational synergies'. Synergy here was understood to be 'the means of combined action'. Hence,

in the context of the collocation project, synergy is the combined actions of the collocating entities to deliver a combined capability. Understanding the degree of synergy within a HQ requires understanding the nature of the linkages between HQ elements. Building from this understanding, the synergy of the enterprise could then be considered as being reflected in the nature and structure of the linkages within and between the five HQ.

The analysts recognised that when combining the various collocating entities there was the possibility that synergies which currently exist could be diminished (for instance it was possible that not all elements of a HQ would be moving to the New HQ, thus synergistic relationships that may exist now could be diminished). Therefore, the goal of this study was to describe and explore synergetic HQ structures that built on the current synergy. The work empirically examined the patterns of information/knowledge exchange within and between the five HQ in order to inform decisions regarding physical placement of the various HQ elements in the New HQ. Informing such decisions would help to: 1) avoid damage to current communication and collaboration networks during the transition to the New HQ, and 2) identify ways of placing people that reduce strain due to distance.

1.3 Network view of organisations

The concept for the collocation project is based on the idea that the network between HQ groups is significant in terms of performance of the system at the enterprise level. But the significance of networks in organisations extends much deeper than this, having critical importance not just between larger HQ groupings, but also within HQ themselves, their constituent functional groups, and the individuals within them.

When the structures and networks of dependencies in an organisation are considered, generally the first thing thought of is the administrative groupings and reporting structure (Figure 1). Further probing may bring to mind groupings within the organisation based on an hierarchical decomposition of tasks, and dependencies in the form of flows of material or information between elements responsible for components of tasks (Figure 2). These conceptualisations, while useful, tend to be only abstract and incomplete representations of the network of interdependencies and elements that underlie successful functioning of an organisation or enterprise.

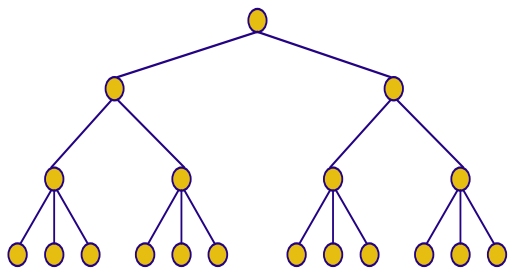

Figure 1: Hypothetical reporting network

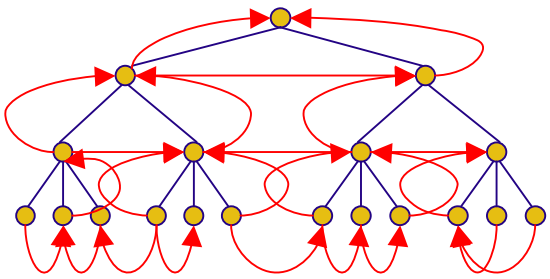

Figure 2: Hypothetical formal/prescribed organisational network

In many work environments, the nature of the problems which need to be addressed are much more complex. In these situations, it is very difficult to 'design' an organisation in the sense that McDonalds restaurants design an organisation within their fast food outlets. Because the problems faced are complex, and hence unpredictable, it is impossible to prescribe every process a priori because one has no way of knowing what issues one will confront and hence how organisational elements will need to react. The end result is an emergent network of informal links (Figure 3) that are often unrecognised, if not actively ignored by managers. However, as there is a move toward flatter, decentralised, networked, adaptive learning organisations that deal with more complex, dynamic, and unstable problem environments, these networks become more and more significant in relation to organisational outcomes.

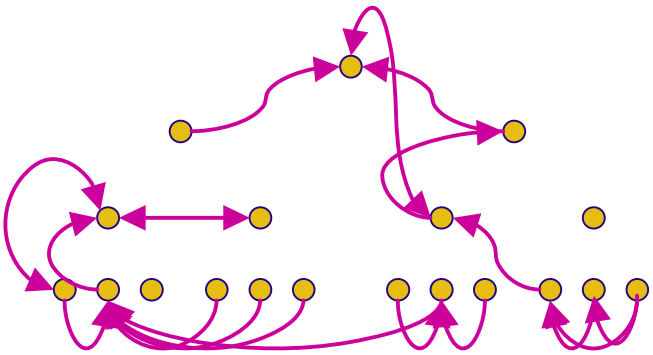

Figure 3: Hypothetical informal network structure

It is the authors' contention that all three network types (reporting, formal and informal networks) must be considered, at least to some degree, in order to successfully understand and influence organisational outcomes. This synthesised view is illustrated in Figure 4 and is what might be called a *multiplex* organisational network, representing all links that have a significant effect on outcomes of interest.

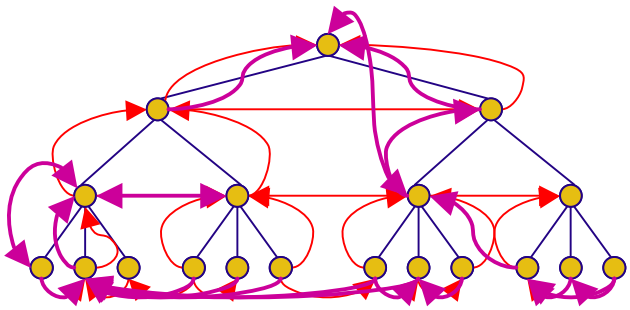

Figure 4: Hypothetical Multiplex Network

For this study, the analysts explicitly defined the boundaries of the network as being a 'reliance' network – in essence any link, whether formally prescribed or informal, that organisational members felt had an influence on their work outcomes.

1.3.1 The value of the network approach

Numerous authors have demonstrated the significance of insights gained through understanding social systems from a network perspective (see Miles et al, 1997 for a review) and the gains that can be achieved through explicitly harnessing these insights to achieve organisational outcomes (e.g. Cross et al, 2003; Cross & Parker 2004; Kilduff & Tsai, 2003; Monge & Contractor, 2003; and Tichy, 1981). Research in this area has shown that understanding social/organisational networks can help us to understand a variety of performance issues. Some examples include: information flow, innovation, common awareness, decision outcomes and quality, satisfaction, promotion, influence, power, control, cohesion, and cultural evolution. The network approach is particularly useful when the product of the organisation under study is good robust decisions, where much of the resources exchanged are intangible knowledge (in the minds of people) or information (contextualised data). This situation is highly characteristic of HQ within a defence environment. The network approach is crucial to this study, particularly for understanding the impact of staff placement decisions within the New HQ.

1.4 Information richness, communication media and proximity in a networked organisation

The very concept of collocation acknowledges that inter-HQ networks are important. But what do networks have to do with decisions about physical placement of people in our modern wired world – does distance really matter anymore? It seems to be a commonly accepted perspective that modern technology's support for cheap and instant mediated communication such as email, telephones, and video conference has removed the significance of physical distance or proximity between people as a factor in performance. Research has indicated, however, that while new technologies have had a positive impact on the ease and success of communication over distance, there are some compelling reasons for taking account of proximity when considering outcomes within a knowledge transfer environment (Monge & Contractor, 2003). These reasons typically revolve around differences in outcomes related to the use of mediated communication technologies compared to face-to-face communication, and the varied appropriateness of each type for different types of communication. According to Daft and Lengel (1984, cited in Daft & Lengel, 1986), the ability of a given form of media to convey rich information decreases in the following order, from: 1) face-to-face, 2) telephone, 3) personal documents such as letters or memos, 4) impersonal written documents, and 5) numeric documents. They stress that one should match the choice of media to the richness of the information which is to be exchanged.

The concept of richness is mirrored in the distinction between the concepts of *tacit* knowledge and *explicit* knowledge. *Explicit* knowledge is information or knowledge that needs little interpretation and can therefore be communicated quickly and easily, often through electronic means. *Tacit* knowledge is knowledge or information that requires a high degree of interpretation and thus cannot be transferred quickly and

easily. The exchange of tacit information and knowledge is best achieved through personal face-to-face contact.

Proximity, which is a key enabler of face-to-face communications, can also influence the frequency, method, and content of people's communication networks, potentially leading to variations in the outcomes of information transfer within an organisation. Research suggests (Monge & Contractor, 2003) that there are potentially additional positive effects for increasing the proximity of individuals within an organisation. Examples of such effects include:

- *A greater chance for face-to-face interactions*, which is one of the 'richest' communication channels available. It is easier and faster to spontaneously organise a meeting with someone who is just next door as opposed to several suburbs or even hours drive away. Face-to-face in personal communication is also much richer. Both sender and receiver can communicate many more nonverbal cues, both as a part of the direct message and as a feedback mechanism. This can lead to clearer, more comprehensive knowledge transfer.
- *An increased chance for serendipitous information gathering*. There is more chance of 'non-scheduled' interaction (bumping into each other) and more frequent information exchanges are likely if people are located close to one another.
- *Decreased turnaround time* brought about by faster information processing as a result of easier access to colleagues.
- *A greater ability to maintain interactions with a greater number of others*, thus producing a denser network for information flow. The greater the density of the network, the shorter the distance across it and so the faster the information diffusion throughout the network.

From this discussion it can be deduced that the way an organisation is linked (i.e. the networks in place within an organisation), significantly affects the way in which the elements of the organisation perform. A well crafted network can substantially improve an organisation's ability to transfer knowledge and information among units, teams and other work groups. Further, the transfer of complex information or knowledge is best achieved through effective human-based organisational networks.

1.5 The role of organisational network analysis

A large body of literature over the last 50 years has highlighted the usefulness of Organisational Network Analysis (ONA) as an approach for examining the structure of social systems and their relationships to outcomes at a group and individual level[1]. Projects in the area have examined a range of informal network types (e.g. advice, friendship, kinship, collaboration), key structural and network characteristics (centrality, network structural holes, social capital, information diffusion, and

[1] See Cross & Parker (2004), Kilduff & Tsai (2003), Monge & Contractor (2003), Nohria & Eccles (1992), and Wasserman & Faust (1994).

dynamics of flow and change etc.), and outcomes (performance, satisfaction etc.). ONA uses the rigour of systems analysis to reveal the behaviour inside and between organisations. Networks are mapped that uncover interactions within and across the boundaries of the organisation. ONA combines many disciplines including social network theory, organisational behaviour, interpersonal communications, chaos theory, complex adaptive systems, and a branch of mathematics called graph theory.

One of the key advantages of this type of network analysis, compared to the more traditional process or hierarchy based representations of information networks, is that they capture the informal as well as formal links in an organisation, and are able to provide a much richer (and often more up-to-date) picture of an organisation than is provided by traditional approaches. The result is a clearer picture of what Cross and Parker (2004) see as the *real* or *hidden organisation*, and what Stacey (2001) terms the *shadow organisation*. Many of these 'hidden links' are the backbone through which the organisation's tacit information flows, and thus are ignored with peril by organisational designers.

The basic premise behind ONA research is that the structure of networks provides constraints and opportunities to individuals in the network, depending on their state of 'embeddedness'. This in turn can have a wide range of effects on effectiveness and performance at the individual, group, and organisational levels. These structures, however, are often quite unrelated to formal design of the organisation as envisaged by management, and are likely to either be unrecognised or ignored as salient factors in organisational outcomes. ONA approaches come to the fore in organisational systems which are characterised by: unstable environments; sensitive to informal communication and collaboration structures; complex and unpredictable problems; the predominance of 'knowledge work', rather than manual labour in the workforce; and a focus on decisions rather than 'products' as the primary output.

1.6 How to place people in the New HQ – project rationale

At the time of this study, the predominant paradigm for how elements should be placed spatially within the new HQ building (both within and outside the CF) was the 'organisational method of grouping', where elements would be placed according to the HQ to which they currently answered. This means people are likely to be clustered according to the reporting hierarchy, with people in the same section very close together, sections within the same branch clustered together, and branches from the same HQ clustered together. If, however, it is accepted that the New HQ will be a predominantly information processing organisation, then it could be postulated that the 'best' way of placing elements (either individuals or groups) within the New HQ is one which minimises the strain on communication, and which maximises the facilitation of important communication. In other words, proximity should be linked to the nature and effects of the links between two elements, rather than simply being dictated on the basis of administrative and reporting affiliations. Moreover, decision makers need to be able to recognise and support the more informal network structures

that play a critical enabling role for the core functions of the organisation to be achieved, but often are invisible and unrecognised by management.

The basic message is that understanding the patterns of connection between elements in an organisational network can assist us in exploring possible implications of changes in physical location in a rigorous scientific way, providing more robust and reliable assistance to decision making. This will be achieved through the application of ONA methods.

1.7 Study goals

The study reported in this paper aimed to map the network of work links within and across five HQ in order to address the following research questions, from a systems-of-systems perspective:

1) What is the current level of strain on the organisational networks between HQ, and to what extent could this be reduced by bringing these HQ to a single site?
2) What are some heuristics, or rules of thumb, that could be applied to guide decision making about placement of personnel in the New HQ such that strain would generally be reduced?
3) How strong are the connections between functional groups in the entire enterprise, and what can this tell us about how to place groups such that the risk of strain is reduced?
4) What are the specific individual level links and people that would be at risk under proposed allocations of personnel to geographical positions in the New HQ?

2. Method

2.1 Participants and data collection

Self-report data was collected, using an electronic survey application, over a six-week period. The analysts decided to take a predefined *sample based* approach, which targeted 360 elements that had been predetermined as being a representative sample of the entire enterprise. A summary of the final participant population sampled is presented in Table 1.

Table 1: Summary of respondent population

Source	Proportion of collective HQ population accounted for by each HQ	Percentage of HQ population sampled*	Percentage of desired sample population actually interviewed
HQ-A	20.32%	50.0%	78.4%
HQ-B	23.40%	24.6%	67.8%
HQ-C	20.05%	42.6%	78.1%
HQ-D	28.88%	32.9%	80.5%
HQ-E	7.35%	52.7%	80.6%
Total	100%	37.7%	77.3%

** Figure calculated on the basis of complete contact lists supplied by HQ personnel.*

As can be gleaned from Table 1, just under 80% of the targeted population could be interviewed. This was due mainly to operational constraints and general staff unavailability at times of data collection.

A thorough outline of the methodology used in the study, including participant selection, types of data collected, instruments used, methodological framework and data analysis tools, is provided in Appendix A.

2.2 Data analysis

2.2.1 Multiple levels of analysis

Whilst the sample data were collected at the individual level for greatest granularity and validity, it was necessary to analyse the data at numerous levels of abstraction, both for ease of interpretation by decision makers, and because the different levels of analysis provide different insights (i.e. what is 'best' for the individual is not always 'best' for the group or the organisation, and vice versa). The levels investigated in the present work included the enterprise or the collective (all five) HQ level, the organisational or individual HQ level, the functional group classification level, and the individual level.

2.2.1.1 Enterprise level

At the *enterprise level* the analytical focus was on the collective HQ population, namely the five HQ combined. The focus of the analysis at this level was six fold:

1) Understanding the relationships and interactions between the enterprise and the external environment. Specifically what other agencies or external HQ does the enterprise interact with and to what degree?

2) Gaining a snapshot of what an 'average' person's network looked like. For example, how many connections does the average person have? How frequent and important are these interactions?
3) Examining the characteristics of links across the sampled network at the enterprise level to give insights into the nature and significance of network links.
4) Investigating the extent to which basic traditional measures of strength (i.e. Importance and Frequency) allow us to predict Desired Closeness between individuals.
5) Investigating the issues of network distance and degrees of separation within the collective HQ network.
6) Comparing the nature of interactions occurring within each HQ compared with the interactions occurring between HQ.

2.2.1.2 Organisational level

At the *organisational level* interest was focussed on each component HQ separately, with individual responses from organisational members being combined to provide measures representing each organisation's links. At this level the analyses were on the networks of interaction between the organisational level nodes (HQ), as well as differences and similarities between the behaviours of the individual *members* of each organisational group.

2.2.1.3 Functional level

At the *functional level* the focus was on the smaller groupings of personnel and positions representing functional groups (such as human resources, finance, or legal). At this level the network of interactions between the functional level nodes, as well as differences and similarities between the behaviours of the individual *members* of each functional group, can be examined.

2.2.1.4 Individual level

At the *individual level* the focus was on individual people, positions, or links. At this level detailed risk analyses of placement options can be conducted. Using the empirical network data provided by each person, together with information about proposed placement plans provided by client organisations, the aim was to identify both strained *links* and strained *people.* Strained links are defined as those in which two people are further apart than they should be. Strained people are those who shoulder a relatively higher degree of strain than others in the network. They can be identified in two primary ways: 1) those who have the highest *number* of strained links, and 2) those who have the highest *proportion* of their links strained.

2.2.2 Exploring network implications - approaches to analysis

Network implications can be explored using two main thrusts of analysis, descriptive analyses and risk analyses.

Descriptive analyses involve examination of characteristics of the network and potential implications for placement of personnel. This might include issues such as the direction, range and strength of connections to guide placement, as well as similarities and differences between groups, or network based characteristics such as centrality or influence. These analyses can be conducted at various levels of abstraction.

At the individual level the data can also be used to conduct risk analyses to identify people or links which are strained or which span boundaries. Strain, in this context, is defined as the potential for reduced performance due to excessive distance between interacting parties. Strain can be conceptualised in terms of both strained *links* and strained *people* as discussed above. Boundary spanners are people or positions characterised by being more connected to more distant areas compared to their local environment. This might suggest that the person has not been placed in the most appropriate location and that the allocation may benefit from review. In a sense, boundary spanners indicate potential for strain because the majority of the people to whom they are linked are not located with them. This perspective on strain is of use in examining particular physical boundaries, such as the boundary between the New HQ and alternative sites, or the boundary between the CF space and other areas within the New HQ.

2.3 Caveats and limitations

There are a number of caveats and limitations that need to be taken into account when interpreting the results presented in this paper. First, it was not possible to collect data from every member of the organisational population. Given the size of the population, the resources required for data collection, and practical issues of availability, this is unlikely to ever be realistically achievable. Secondly, the data only provide a snapshot at a point in time. While there are likely to be some patterns that will remain consistent over time, the network will undoubtedly change to some degree in response to variations in tasks, environment, people, and processes. Finally, a limited grouping methodology (the nomination of a group as a contact, as opposed to individual members of that group) was employed in some cases to facilitate faster response times. In these cases participants with very large networks felt that they interacted *in the same way* with all members of a particular group and were, therefore, reluctant to complete the survey for every individual contact. The use of this form of grouping methodology is non-preferred, as the characteristics of relations with any group of people are almost certainly *never* the same. However, in cases where minimising disruption is critical, and the risk of the respondent ceasing to participate due to time constraints being significant, a compromise solution like the one above may be considered justified.

3. Results and discussion

Due to space restrictions, the following section presents an overview of the key results and discussion only. For more details please contact the authors.

3.1 Overview of the network map

283 respondents from the five HQ were surveyed, and this resulted in a network map that was comprised of 9158 network links. Of this, 7602 (80%) links went to 658 HQ personnel and there were 1556 (20%) links to external organisations. Based on the data collected during this study it became clear that as an enterprise the collective HQ are strongly embedded within a wider network of information sharing and collaboration. Links to external agencies therefore should be considered in the move to the New HQ to ensure that critical stakeholder links are supported.

3.2 Addressing the goals of the study

An overview of results pertaining to each of the study goals is briefly discussed below.

3.2.1 Current connectedness and strain between headquarters and the related benefits of collocation

One of the key high level findings was that there were significant 'cross HQ' interactions that spanned multiple sites (approx 25% of all links within the enterprise were between different HQ). The figure below shows the network of links between the five HQ (the thickness of the line represents the total number of links).

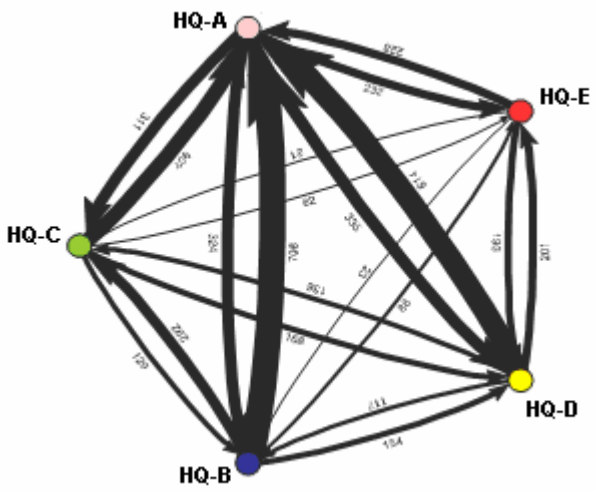

Figure 5: The network of 'cross HQ' links

About half of the 'cross HQ' interactions identified were strained by distance. On its own this would appear to be strong support of the collocation concept. However, when the problem is considered from a network perspective the argument becomes even stronger because, in a network, people are interdependent and what affects one's neighbour can affect oneself. If 10% of a network's links are detrimentally affected by being on separate sites, then what of the secondary effects on all the links connected to these? It is likely that even links within a HQ will be dependent in some way upon strained cross-site links, and hence at risk of a secondary effect from the strain on the first link. In other words, if 10% of links are directly affected by site related strain, then a larger proportion are probably affected indirectly. Thus damage or improvement to one part of network can have far reaching implications for other parts of the network!

Overall, the study demonstrated that collocation has the potential to reduce strain on existing relations, and facilitate *additional* beneficial interactions. This is expected to result in greater efficiency and effectiveness for the New HQ. Consideration, however, should still be given to the potential for new strains to be created between staff that are collocating and those that are not.

3.2.2 Heuristics for placement of individuals

The second goal for the study was to develop general heuristics that can be used to inform the development of population options for the New HQ. The following heuristics were identified during this study.

- Given that responses for the Desired Closeness[2] score indicated that distance does matter, it is going to be important to pay attention to where people are placed within the New HQ in terms of enabling them to fulfil their work outcomes.
- Using the Desired Closeness scores as a measure for determining how to physically populate the New HQ, staff from all HQ wanted to be on the same floor as other staff of their own HQ; staff from all HQ wanted to be in the same building as HQ-A staff; and all HQ staff wanted to be on the same site as the other HQ (one exception was HQ-D, who did not exhibit any need to be on the same site as HQ-C). The cells in Table 2 provide a representation of the ultrametric[3] category that would satisfy 50% of the members of the source HQ. The categories are represented using the following codes: SF (Same Floor) - green; SW/SB (same wing or same building) - blue; SS (same site) - orange; and DS (different site) - purple.

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[2] The Desired Closeness score consisted of a five-item scale assessing the effects of proximity on the network link from the respondent's perspective. See Appendix A for more details.

[3] In this study a metric scale for distance was deemed inappropriate for a variety of reasons (see Bergin, Rogers & Heyer, 2005). Interaction distances were "operationalised" on an ordinal scale representing what Pattison (2002) termed an "ultrametric" scale. Such a scale incorporates the idea of hierarchically nested distances in terms of using concepts of 'workspaces', 'floors', 'wings or buildings' and 'sites'.

Table 2: Corresponding ultrametric distance categories of the median Desired Closeness scores of 'within' and 'cross HQ' links.

		Target Headquarter				
		HQ-C	**HQ-A**	**HQ-E**	**HQ-D**	**HQ-B**
Source Headquarter	**HQ-C**	SF	SW/SB	SS	SS	SS
	HQ-A	SS	SF	SW/SB	SS	SW/SB
	HQ-E	SS	SW/SB	SF	SS	SW/SB
	HQ-D	DS	SW/SB	SS	SF	SS
	HQ-B	SS	SW/SB	SS	SS	SF

- People were more connected to other people in their own HQ. Within their own HQ they were more likely to be connected to people in their own branch and so on. This suggests support for initially grouping people based on organisational structures.
- If two people were connected in the network they were likely to want to be at least in the same building.
- 'Within HQ' links when compared to 'cross HQ' links were found to be characterised as being more important, more frequent, utilising a higher degree of face-to-face communication and having a significantly higher need to be physically close. The 'cross HQ' links were characterised as having a greater tendency to use video conferencing, telephone and email communications.

3.2.3 Functional group affiliations and implications for placement of groups

The third goal for the study was to examine connections at the functional group level and identify the implications of these affiliations on population options for the New HQ.

One of the interesting findings illustrated by the functional level analyses was that the networks 'within HQ' were very dense, with the majority of groups being linked to the majority of their peer groups. In dense networks information tends to diffuse quickly and groups are more likely to have common perspectives on issues than in more sparse networks. One might suggest that in a denser network, with greater feedback and interdependency between groups, organisational functioning will be more complex than a system where the network is sparse and characterised by linear sequences of connections between groups. The implications of this high level of density are that functional groups cannot be considered in isolation; rather a holistic view of the system is required when making decisions about placement. Figure 6 provides an example of a 'within HQ' network map generated from the results which shows HQ-A Branch 2's network to the 14 other branches of their HQ (the thickness of line represents the total number of links).

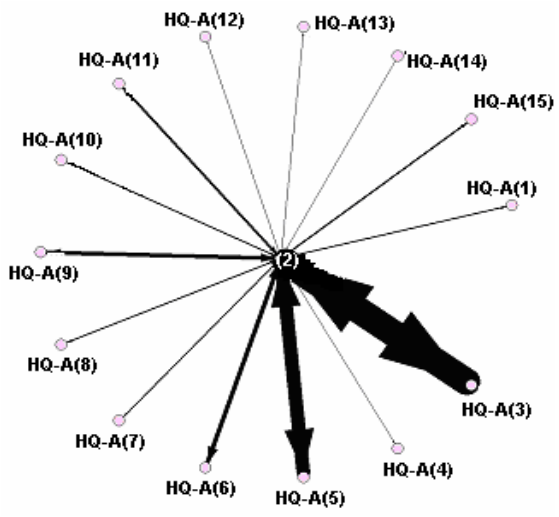


Figure 6: HQ-A Branch 2 Network Map ('within HQ' network)

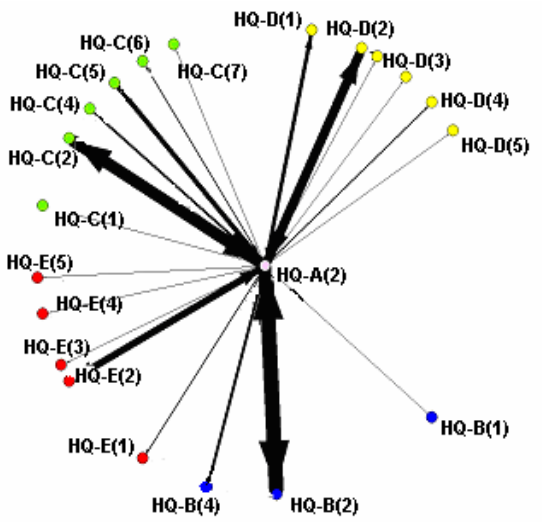


Figure 7: HQ-A Branch 2 Network Map ('cross HQ')

In terms of 'cross HQ' links it was also noted that there was a fairly high density of links and a strong tendency for functional groups to link to complementary functional groups in other HQ. As an example of this, the Commanders' offices all formed dense cross-organisational networks between HQ. Whilst not necessarily surprising, it is a good indication of the organisations working together to harness each other's resources and also provides general support to the concept of collocation. Figure 7 provides an example of a 'cross HQ' network map generated from the results which shows HQ-A Branch 2's network to a number of other branches within the other four HQ (the thickness of line represents the total number of links).

Generally speaking, the results also suggested that there was significant potential for problems with 'cross HQ' links, and an important area for future examination could be looking for the synergies between HQ, to ensure these are captured and fostered in the New HQ environment. In other words, determining population options for the New HQ at a functional group level should not just focus on how the HQ would best physically organise themselves (i.e. minimising internal strain for each HQ) but also focus on how the HQ could best be physically organised to support *each other* (i.e. minimise 'cross HQ' strain) to better realise the goals of increased synergy that explicitly underlie the New HQ project.

3.2.4 Individual links and personnel at risk

The fourth goal for the study was to examine individual level links and personnel that could be at risk under proposed allocations of personnel to geographical positions in the New HQ. Figure 8 shows an illustration of the links between all personnel in the collective HQ enterprise. Figure 9 shows the same personnel but only displays links which would be strained by distance if people were assigned to physical locations on

the basis of the information provided by HQ representatives. These figures are meant to be illustrative only, but reveal that a significant number of strained links exist, affecting many people.

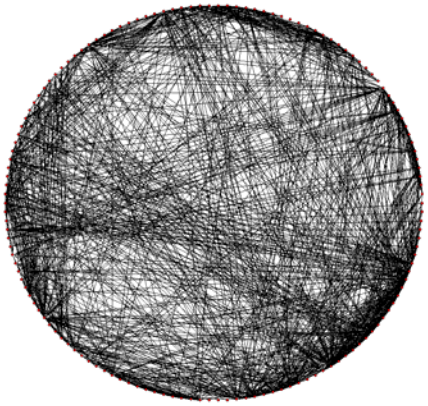


Figure 8: Individual links between HQ

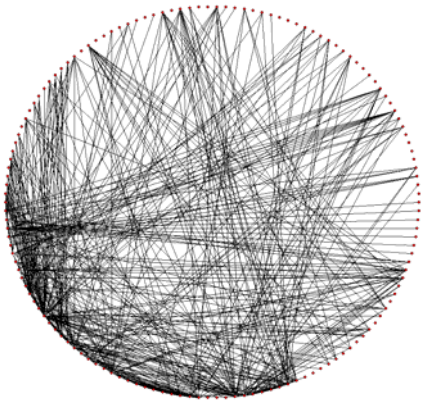
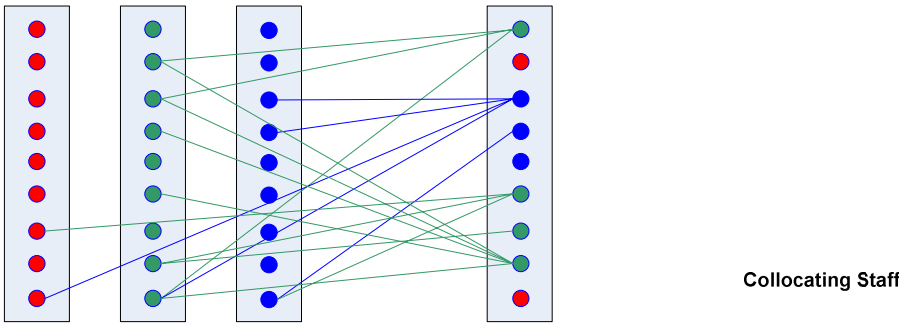


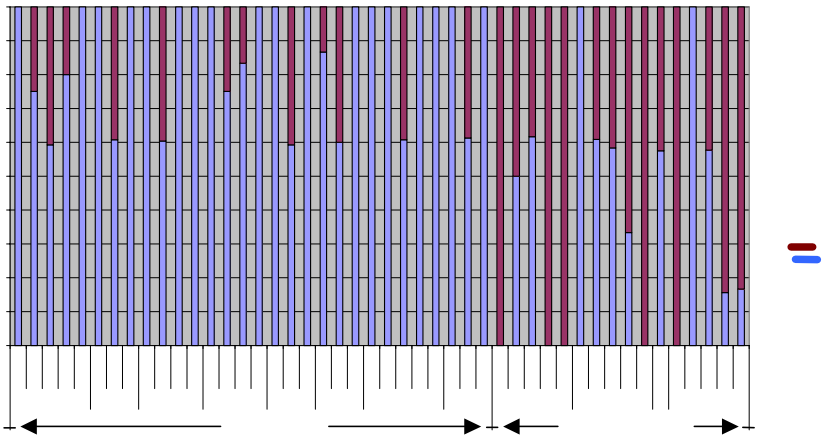
Figure 9: Individual links strained by distance across the HQ according to placement projections in late 2003

The degree of interdependency between strained parts of the network means that determining ways of both identifying and minimising strain is not straight forward; it requires a more fine tuned analysis. In order to achieve this, the study analysed the incoming and outgoing links of every individual position identified with a focus on both *specific strained links* and *specific strained people*, as well as those *boundary spanners* who were, for instance, to be placed within the CF, but had more links to people outside the CF. Whilst some preliminary results, shared with clients, were valuable in informing placement decisions immediately after the analyses were completed, natural degradations in data validity mean that the results are now illustrative only and too lengthy to report here.

Figure 10 provides examples of how strains across sites and boundary spanning strain within the organisational network can be represented. In the top portion of the figure, nodes in the right hand column represent staff who will not be collocating (and colour coded according to HQ) and displays their links to staff within the collocating HQ (in this example just HQ-A, HQ-B and HQ-C). In this way individuals likely to suffer organisational strain between sites can be identified and further investigations pursued. The lower portion of the diagram shows for individuals in HQ-A the percentage of their links to others that maybe inside or outside the CF. Thus, in an ideal world one would hope to see staff outside of the CF having the majority of the links to others outside the CF (i.e. a predominance of blue bars) and nodes inside the CF having the majority of their links to others inside the CF (i.e. a predominance of red bars).



Example of strain across sites



Example of boundary spanner strain

HQ-A HQ-B HQ-C

Figure 10: Examples of how to represent strain across sites and also boundary spanner strain within the organisational networks of the collective HQ

In general terms, the study demonstrated a novel and scientifically based method for achieving the goal of evaluating individual links and personnel at risk. It is recommended that the process be repeated closer to transition to the New HQ.

3.3 The impact of network variation

Since this study was commenced there have been significant changes to the organisational networks of the HQ. The network explored in the present study was of the collective HQ population at a single snapshot in time. It is not necessarily an image of the way the population is *all* the time, or even the way it *should* be. It is expected that variations in tasks, environment, the personalities of staff, and the very act of collocation may all cause some degree of variation in the interaction patterns, even

though the general structure of the network is expected to remain similar. Thus while changes will naturally occur, and improvements can possibly be made to the structure of the collective HQ networks, the real challenge for collocation is to avoid strain on current important interactions, and to maximise the opportunity for useful new links to be forged and facilitated.

In addition, the current network structure is the 'status quo'. While it is very important to keep this network in mind to avoid damage to the collective HQ network during collocation, it is also important to consider if any significant improvements can be made to the way the network is structured. It may be that significant structural holes exist in the communication web that would benefit from being addressed through some form of intervention. For example, perhaps it would be beneficial to encourage more interaction between complementary functional groups in different component HQ to facilitate a sharing of resources, knowledge, and skills.

A further point worthy of consideration is the nature of the network that was considered in this study. The current study looked at human-to-human links and informed requirements for certain staff to be close together, based on these needs. The study did not assess requirements to be close together based on other needs, such as a common resource dependency (e.g. the need for access to high security areas, or access to a common machine) nor did it account for the particular nature and characteristics of the interaction (e.g. from a theoretical perspective maybe a command relationship should be considered to be more important than a collaborative one in terms of the outcomes of the collective HQ enterprise). Other factors that influence a given pair's need to be physically close should be explored and considered in conjunction with the current results.

4. Summary and recommendations

The present work has shown empirical support for collocation and presented some insights into how one might go about making and evaluating decisions about physical placement of personnel in the New HQ. While this work can help to guide general principles, the greatest value in terms of supporting detailed optimisation will be provided as the process is repeated closer to the instantiation date. This would be achieved in light of the most up to date decisions about the physical space of the New HQ site and proposed allocations of personnel within this space. Consequently it is recommended that this process be repeated approximately six to eight months prior to transition to the New HQ. Additionally, it is recommended that the process also be repeated upon transition to the new site to assist in fine tuning placement of personnel post-collocation.

Future efforts undertaken prior to collocation could provide guidance to staggered transition of staff from the old sites to the new collocated site. Analysis methods aimed at identifying emergent clusters of personnel (and the extent to which these groups are connected) could provide a basis for selecting clusters of personnel to move in steps such that the number of links crossing sites at each transition step is minimised.

5. Concluding comments

In the current information age ongoing technology advances continue to promise faster, more efficient communication media with the implication that distance does not matter. From this perspective, humans in an organisation are being seen more and more as decision making agents in a vast network of flowing knowledge. Technology is seen as having the role of providing the medium for storage and transmission of this information. The human components of the system are ideally supposed to be able to access and retrieve information as needed from the technological servants.

In a perfect system like this, distance should not matter, since technology serves as the 'butler' of the organisational castle, relieving the human masters from the burden of having to retain and transport the knowledge around the organisation. The development of organisational awareness is not supported by technology only; it involves the transfer of both tacit and explicit knowledge. To successfully deal with this tacit knowledge, it is essential to realise that humans in the system are the medium through which knowledge is transferred. For this to occur effectively, a certain amount of face-to-face contact between elements will be required. Collocation has the potential to better facilitate effective and efficient face-to-face communication, and hence transmission of tacit information, providing a greater level of operational awareness to the collective HQ population.

According to the results of this study, staff within each HQ communicate mainly amongst themselves, but still have a fairly large proportion of their interactions with people in other HQ (around 25%). So what might the future look like compared to this picture? Upon collocation it could be expected that there will be greater interaction between these HQ due to their increased proximity. Such increased interaction is likely to lead to greater information sharing, and cross fertilisation of values and culture between the HQ. This may well lead to the emergence of an improved culture. HQ are likely to build a greater understanding for each others skills and approaches, a greater understanding of where their own strengths and weaknesses lie, and how they might complement each other.

In the long run, each of the HQ is likely to co-evolve interdependently with each other, renegotiating their roles and responsibilities in light of changes in each of their partner organisations, and in shared perceptions of the enterprise as a whole. In light of this it should be recognised that a large part of the future shape of the New HQ (and

whatever organisation(s) inhabit it) will be the result of emergent processes, rather than any deliberately designed and engineered solution.

To date, most of the focus on the New HQ project has been on trying to assess, foresee and document the explicit requirements that each HQ is predicted to have within the New HQ environment. These requirements have been based on thinking primarily within the box of how business is currently done, (i.e. predominantly independently) and have adopted a primarily traditional engineering paradigm. This paradigm focuses on collecting as much information as possible about the system, and making some rigorous predictions about decision outcomes. Unfortunately, this approach can only prepare us for scenarios we expect, in which the stakeholder's organisational boundaries, roles and responsibilities are comparable to what is in existence today. While these traditional engineering approaches may provide highly detailed and accurate predictions within a stable environment, they are less useful if the basic makeup of the system we are working with changes so much that it is nearly unrecognisable.

Given that the future shape of the New HQ is likely to be the result of emergent processes, many of them rooted in increased interaction due to increased proximity, we are unlikely to be able to envisage many of the possible (even probable) instantiations of the New HQ and its elements in the future. Thus alternate approaches to traditional engineering may be valuable to employ, with the aim of harnessing the positive aspects of complexity, rather than trying to control complexity through explicit and detailed design. In other words, rather than investing all of our efforts in trying to predict what should be done to create the 'best New HQ' on the basis of what we know or can find out now (engineering approach), we should invest in positioning and enabling the organisation(s) involved in the New HQ to become a learning organisation. These approaches focus more on the goal of fostering the capability of the organisation to sense and respond (and adapt/evolve) appropriately in the face of opportunities and threats once collocation occurs.

Aside from direct support to placement choices, this study demonstrated the additional value of taking a holistic network perspective to military organisational systems, which recognises elements as being enmeshed in a web of interdependencies, rather than simply independent elements with independent requirements. It is the understanding of these network-based social and organisational interdependencies, and the adoption of the associated network paradigm that will be the basis of future Network Centric Warfare success as much as any technological developments. As John Arquilla and David Ronfeldt from RAND state in their book *Networks and Netwars*, "***whoever masters the network form first will gain major advantages***" (p.15).

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Appendix A: Method

This Appendix provides details on the method employed for the study.

A.1. Timing

Self-report data was collected over a six-week period.

A.2. Instrument

Data was predominantly collected through the use of an electronic survey application specifically designed for the purpose, although some manual data collection was undertaken where operational constraints precluded the use of the computer systems.

A.3. Methodological framework and analysis tools

ONA methods were chosen as the most appropriate methodological framework to approach the problem space in order to ensure that all forms of information and knowledge exchanges were captured. A large body of literature over the last 50 years has highlighted the usefulness of ONA as an approach for examining the structure of social systems and their relationships to outcomes at a group and individual level[4].

The very idea of collocation is based on the idea that the network between HQ groups is significant in terms of performance of the enterprise level system. But the significance of networks in organisations extends much deeper than this, having critical importance not just between larger HQ groupings, but also within HQ themselves, their constituent functional groups, and the individuals within them. Understanding the patterns of connection between elements in an organisational network, through the application of ONA methods, can assist the analysts in exploring possible implications of changes in physical location in a rigorous scientific way, providing more robust and reliable assistance to decision making.

Data analyses were conducted using a range of spreadsheet, statistical and network analysis tools including Microsoft Excel, the Statistical Package for Social Sciences (SPSS), Pajek, Netdraw, Netminer, and UCINET 6.

A.4. Data collected

There were two main types of data collected: organisational architecture data, and "self reported" social/organisational network data.

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[4] See Cross & Parker (2004), Kilduff & Tsai (2003), Monge & Contractor (2003), Nohria & Eccles (1992) and Wasserman & Faust (1994).

A.4.1 Organisational architecture data

Organisational architecture data refers to data about the formal design architectures in the organisation, including reporting chains, functional and administrative groupings, position listings, contact lists, and information about the physical location of people and groups. This data was collected from two primary sources: the respective websites for each HQ and directly from nominated representatives.

A.4.2 Self-report social/organisational network data

Demographic data was collected from respondents about their history/experience in the collective HQ network, and their typical usage of classified information.

Assessment of history/experience includes asking about:

1. Time in role (in months)
2. Year started in Service

Assessment of the respondents classified information access profile involved asking respondents to indicate the proportion of time spent by each respondent in each of a number of security classification categories.

A.4.3 Qualitative data on respondent roles, activities, and functional duties

Respondents were also asked to give details about their roles and activities. This response was in the form of a variable number of text descriptions generated by the participants. In addition, respondents were asked to indicate which of a list of 15 functional areas they engaged in as part of their role.

A.4.4 Respondent ego-networks

Each respondent's local ego network (the 'personal network' which centres on the respondent) was elicited by presenting the following text:

> For the following questions, please think about all the significant people whom you interact with to do your job. This should include people you *need* to interact with, as well as people who it is *useful* to interact with.
> Please include all significant ongoing *formal* <u>*and*</u> *informal* interactions involving.
> - supervision
> - working together on a common task
> - information exchange
> - advice
>
> Do not include interactions that do not have a direct impact on your work output (For example cleaners you regularly see, or people who work in the canteen etc.)

Respondents were then asked to:

…list all the people that you interact with where this interaction contributes to you achieving your goals/objectives.

A.4.5 Selection method

Respondents' contacts were elicited through the use of combined recall and recognition methods. This composite method was chosen since straight recall was seen to be too cognitively taxing on respondents, and would be open to a variety of memory biases (eg. recency effects, or influences of frequency of interaction or affect between elements) which would affect the elicited network. On the other hand, the sheer number of elements in the collective HQ enterprise meant that the results from use of a complete serialised contact list for recognition based nomination would suffer at the hands of respondent fatigue. Thus a compromise position was developed.

Respondents were presented with a list of people in the collective HQ enterprise, developed in conjunction with HQ representatives and preloaded into the computerised data collection instrument. Respondents were able to search, sort, and filter this list according to the following categories:

1. Name
2. Headquarters
3. Organisational Designator

Thus respondents could quickly and simply navigate to a known person by name or position, or alternately could browse through lists sorted by the above-mentioned categories, and select elements that they recognised. The smaller lists resulting from screening the larger list on the basis of search criteria meant that respondents were presented with a number of smaller lists that could be easily scanned. Additionally, the use of explicit categories for limiting searches had the additional benefit of acting as a primer to encourage people to consider elements across the collective HQ enterprise.

A.4.6 Types of contact

There were two types of contacts that each person was asked to nominate, which were classified as *internal* or *external.*

Internal Contacts:
Internal contacts were those that were "within the collective HQ". For the purpose of the study this was defined as all elements in the five HQ, as well as some subgroups. Details about internal contacts were all pre-loaded into the contact list database.

Generally it was intended that all internal contacts should refer to a single person and position, although limited scope was included to refer to 'nameless' positions/roles in cases where multiple persons filled the same position. It is also worth noting that a handful of elements in the internal list were actually groups, rather than individual people or positions.

External Contacts:
External contacts were any contact that was not included in the "within the collective HQ" definition. As these were outside the predictable population limits, contacts were only identified through selection of a 'service' category, and a free text label input by the respondent. It is important to note that the majority of detailed data on respondent's network links was only collected for internal relationships, since these were the ones most centrally affected by collocation activities. For external links, only information on the identity of the external element, and the perceived importance of the relationship, was collected.

A.4.7 Details about the characteristics of 'internal' interactions

For each internal interaction, respondents were asked to indicate details about the characteristics of the reported interaction. The following section details the items that were addressed:

Formal Reporting nature of the relationship
Respondents were asked to indicate whether:

- they were a supervisor of the nominee,
- they were supervised by the nominee, or
- the respondent and nominee were peers (i.e. no reporting relationship).

Importance
Respondents were asked to indicate the importance of the interaction by being presented with the following text, and being asked to select one of five categories on the following ordinal scale[5]:

> How important is interaction with this person to you carrying out your roles and duties successfully?
> 1. Crucial – without this interaction I could not successfully do my job at all.
> 2. Very important

[5] The reader should note that the order of these categories was reversed in later analyses, to ensure higher numbers represented more important values.

3. Moderately important
4. Slightly important
5. Not important – if I could not interact with this person it would not have any significant effect on me doing my job

Frequency
Respondents were asked to indicate the frequency of the interaction by being presented with the following text, and being asked to select one of seven categories on the following ordinal scale[6]:

> *Think back over the last year - on average*, how often have you and this person/element interacted?
> 1. Hourly
> 2. Daily
> 3. Several times a week
> 4. About once a week
> 5. About once a fortnight
> 6. About once a month
> 7. Less than once a month

Medium
Respondents were asked to indicate the proportion of time that they utilised the following medium for the nominated interaction:

> Approximately what percentage of your total number of communications (with this person) would occur through the following channels?
> - Face-to-face in person (includes meetings and briefings)
> - Vid Con
> - Telephone
> - Email/message/signal
> - Other (e.g. fax, documents, databases, internet and intranet etc.)

A.4.8 Proximity data

For each interaction, participants were asked to indicate information about the proximity of themselves to each nominee. Information was collected about:

- *The current distance* between the respondent and nominee.
- *The effects of variations* in relative site and floor location on the interaction outcomes.
- *The least separation* distance from the nominee at which the respondent felt that they needed to be in order to successfully carry out their interaction.

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[6] The reader should note that the order of these categories was reversed in later analyses, to ensure higher numbers represented more important values.

It should be noted that for the sake of speed, distance effects questions were *not* asked for relations that were indicated as being in the lowest two categories of importance i.e. those classified as *Not Important* or *Slightly Important*. However, participants were still asked about the current location and the least distance for these links.

Current distance
Current distance was assessed by asking the respondent to indicate which one of seven categories best described the distance between themselves and the nominee.

- Adjacent workspaces (i.e. very close proximity, and fast and easy physical access)
- Same floor, close and easily accessible.
- Same floor, but not close, or separated by significant physical barrier (eg. security door), or in separate wings etc)
- Same building – different floors
- Same site different buildings
- Different Sites within approx 15km
- Different Sites within approx 100km
- Sites greater than 100km apart

A.4.9 The Desired Closeness scale

Instead of trying to assess one or more of the three items (importance, frequency, and required face-to-face) likely to feed into the effects of distance, a completely new measure was designed to more directly assess the effects of distance from the respondents' perspective. To the authors knowledge this had not previously been attempted.[7]

This new measure, called Desired Closeness, consisted of a five-item scale assessing the effects of proximity on the interaction from the respondents' perspective. For each cited contact, participants were asked to indicate information about the effects of distance.

Effects of distance
Effects of distance were examined through four items in the survey which looked at the perceived effects of relocating the two elements (respondent and nominee) at varying anchored distances. These distance categories included:

- Variation in relative site location
- Variation in relative floor location

[7] Appendix B of Bergin, Rogers & Heyer (2005) discusses some of the testing conducted on the validity of the Desired Closeness scale, and section A.4.10 of this paper briefly touches on the reliability analyses of this scale that were conducted.

To prime the respondents, they were presented with the following text:

> For all of the following questions about this person, please imagine that both you and the other person are having your offices relocated. For each question, think about the alternatives presented, and how they would affect the success of *your* outcomes from your interactions with this person. This may include such factors as:
>
> - the impact upon your ability to receive/exchange information
> - the efficiency of your interactions
> - any other difficulties or advantages which may arise from being further or closer from one another

Site location

Impact of site location variation was assessed first, on a two-item scale examining usefulness and need. Respondents were presented with the following:

> Consider that both of you are having your offices relocated. To maximise your outcomes from your interactions with this person, *how* ***useful*** *would it be* for you to be on the same site as each other?
>
> - Extremely useful – the benefits of such collocation on what I get out of our interaction would be of an order such that they should definitely be on the same floor as me.
> - Highly Useful
> - Moderately useful
> - Slightly useful
> - No real usefulness – it wouldn't significantly improve the outcomes for me
>
> Consider that both of you are having your offices relocated. To satisfy your basic requirements from your interaction with this person, *how high is your* ***need*** to be on the same site as each other?
>
> - Extremely high need – it is absolutely crucial that we be on the same site in order for me to achieve what I need from our interaction
> - High need
> - Moderate need
> - Slight need
> - No significant need – being on different sites wouldn't impact negatively on the outcomes of this interaction for me

Floor location

The effects of floor location were then assessed through the use of a two-item scale examining usefulness and need. Firstly, respondents were presented with the following priming text:

Imagine now that it has been decided that you *will* be relocated to the same site, and that the choice now is whether you should be located on the same floor.

Following this the floor effect items were presented:

> Consider that *both of you are going to be relocated to the same site*. To maximise your outcomes from your interactions with this person, *how **useful** would it be* for you to be on the same floor as each other, in close and easily accessible positions?
> - Extremely useful – the benefits of such collocation on what I get out of our interaction would be of an order such that they should definitely be on the same floor as me.
> - Highly Useful
> - Moderately useful
> - Slightly useful
> - No real usefulness – it wouldn't significantly improve the outcomes for me
>
> Consider that *both of you are going to be relocated to the same site*. To satisfy your basic requirements from your interaction with this person, *how high is your **need*** to be on the same floor, in close and easily accessible positions?
> - Extremely high need – it is absolutely crucial that we be on the same site in order for me to achieve what I need from our interaction
> - High need
> - Moderate need
> - Slight need
> - No significant need – being on different sites wouldn't impact negatively on the outcomes of this interaction for me

Least distance

Least Distance was assessed by asking the respondent to indicate which one of seven categories best described the minimum distance from the nominee they felt they needed to be. The following text was presented:

> What is the *furthest apart* that you and this person could be located for you to still do your job effectively?
> - Adjacent workspaces (i.e. very close proximity, and fast and easy physical access)
> - Same floor, close and easily accessible
> - Same floor, any area
> - Same building, any floor
> - Same site (any building)
> - Sites within approximately 15km
> - Sites within approximately 100km
> - Doesn't matter

A.4.10 Reliability Analyses of the Desired Closeness Scale

The five survey items relating to Desired Closeness were correlated for each network link. Not surprisingly, responses to these five items were closely related. Bivariate correlations among the five items ranged from a low of 0.549 to a high of 0.918. A single principal component represented 77% of the total variance in the five items with approximately equal loadings for all questions. The correlation between this component and a unit-weighted total score on the five items was a very high 0.998, as was the internal consistency of the total score with an alpha of 0.91.