'Belonging' to a Virtual Research Centre: Exploring the Influence of Social Capital Formation Processes on Member Identification in a Virtual Organization

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Identification, a person's sense of belonging, is thought to have positive outcomes because those who identify strongly will be more motivated to achieve organizational goals. This study applies a social capital lens in order to highlight how different social capital formation processes contribute to member identification, with a focus on virtual organizations where dispersed membership may preclude face-to-face interactions. The study provides a rare opportunity to explore variation in identification in a single organizational context. The results highlight how some dimensions of social capital augment each other and affect identification through the four conditions that influence social capital development: time, interdependence, interaction and closure. The study suggests that, while creating interdependence and an array of means for interaction support the development of both social capital and identification, not all members of the organization need to feel equally connected. Partial closure appears beneficial for information flows and 'renewal' of the virtual organization.

Introduction

Although distributed work is not necessarily a new concept (Hinds and Bailey, 2003), the pervasiveness of information and communication technologies has elevated network or virtual organizations as a potential new organizational form worthy of study (Cravens, Piercy and Shipp, 1996; Davidow and Malone, 1992; Powell, 1990). The implications of virtual organizations for organization design and management have been the focus of research attention (e.g. Fiol and O'Conner, 2005; Kasper-Fuehrer and Ashkanasy, 2001; Riemer and Klein, 2008). In such

organizations 'shared meanings, values, beliefs, ideas and symbols become key elements of normative organizational control' (Alvesson and Robertson, 2006, p. 196) and a sense of belonging, or the extent of member identification, is likely to be important for cohesion-building (Fiol and O'Conner, 2005; Wiesenfeld, Raghuram and Garud, 2001).

In this paper we explore the influences on member identification within a virtual organization, specifically a research institute that is both geographically dispersed and largely dependent on electronic communication, the two most common criteria of 'virtuality' (Gibson and Gibbs, 2006). The newly formed institute was a collaborative venture between six organizations and consisted of researchers located at nine different sites. Such centres are becoming common as governments recognize the benefits of collaboration between skilled researchers across multiple organizations.

The MacDiarmid Institute for Advanced Materials and Nanotechnology ('the Institute') was given Centre of Research Excellence (CoRE) status by the New Zealand Government in 2002. Whilst the Institute was endowed right from its inception with considerable financial resources, it started as a loose collective of 45 Principal Investigators (PIs), many of whom had not met or worked together previously.

'Virtual organization' does not constitute an organizational design in the traditional sense but 'embraces a variety of ways of working together, including virtual teams within organizations (intra-organizational) and interorganizational collaboration' (Kasper-Fuehrer and Ashkanasy, 2001, p. 236). We locate our study as being primarily interorganizational. Following Kasper-Fuehrer and Ashkanasy (2001, p. 237), 'such virtual organizations act in all appearances as a single unit' and are defined as a network organization consisting of independent enterprises (organizations, companies, institutions or specialized individuals) that come together to exploit an apparent opportunity.

Given the distributed nature of the Institute, both geographically and organizationally, we were particularly interested in the elements and issues that contributed to a member's 'sense of belonging' (Schoemaker and Jonker, 2005; Weick, 1995) to the Institute community. Unlike other studies that have addressed proximity and identification (e.g. Wilson *et al.*, 2008), our sample provided a rare opportunity to investigate an organization within which all four permutations of member, close/distant proximity and strong/weak identification were present. Because the organization was relatively new when the study started, the research was able to recognize initiatives that appeared to influence the development of member identification.

Organizing in such virtual organizations or networks is often based upon creating a 'bond' between people (Schoemaker and Jonker, 2005), or building social capital. Because of the importance of the interactive features of these Institute efforts, we use a social capital lens, specifically structural, cognitive and relational components, to try to understand the differing contributions of the various social capital formation processes in developing organizational identification. Virtual organizations are a type of social network in that it is the dyadic relational ties between members that underpin the transfer of resources (information and material) and enable the organization to operate. Thus the social capital in the network, defined as 'the aggregate of resources embedded in, available through and derived from the network of relationships' (Inkpen and Tsang, 2005, p. 151), is an especially valuable resource for virtual organizations.

Kramer explored the potential theoretical relationship between identification and social capital and argued that 'a strong prima facie case can be made for the argument that the successful creation of social capital, in turn, enhances collective identification' (2006, p. 39). In this research, we seek to provide empirical evidence for the relationship between social capital and identification. More recently, Riemer and Klein (2008) proposed that virtual organizations need to foster the development of social capital to function effectively. Hence, we seek to bring these two research threads together, and propose that a prime reason for why social capital development is important to virtual organizations is that it fosters member identification when geographic proximity is not a given. Our research hypothesis was that member identification is strongly related to social capital and that therefore building member identification within a virtual organization could be framed as contingent upon, or a useful by-product of, the formation of social capital between the members of the organization.

We make it explicit, though, that some authors include identification as a form of social capital. Nahapiet and Ghoshal (1998) highlight identification as a facet of their relational dimension. They 'recognize, however, that both the dimensions and the several facets of social capital are likely to be interrelated in important and complex ways' (p. 250), specifically citing 'interdependencies between social identification and shared vocabulary and language' (p. 251). Thus, our application of the social capital lens is also aimed at generating a better understanding of how one facet of social capital may be supported or hindered by other facets, an aspect of the nature and dynamics of social capital that has received limited attention to date (Lee, 2009).

After surveying the literature on identification and then proximity, we focus on the relationship between identification and social capital. In the Results section, we report the analysis of a

member's identification with an initial focus on its relationship to proximity. Next, we explore which initiatives influenced a member's sense of belonging through the building of structural, cognitive and relational social capital. Lastly, we outline our conclusions regarding the central role of social capital development in the management of virtual organizations in order to increase member identification, as well as future directions for research.

Organizational identification

'Identification is a person's sense of belonging within a social category' (Fiol and O'Conner, 2005, p. 19) and with respect to an organization 'represents the social and psychological tie binding employees and the organization – a tie that exists even when employees are dispersed' (Wiesenfeld, Raghuram and Garud, 1999, p. 778). While this definition of identification emphasizes a positive relational categorization based in social identity theory, we acknowledge that there are many other theoretical perspectives and typologies of identification that have been proposed in the literature (e.g. Elsbach, 1999; Roccas *et al.*, 2008) indicating the multi-dimensional nature of identification.

A central tenet of social identity theory is that perceived similarity can form a basis for self-categorization and identification (Kramer, 2006) and that diversity may not support organizational identification. Although this diversity is normally about social categories to which individuals belong, it has been noted that task-related differences can go hand-in-hand with organizational identification, 'provided that these differences reflect shared expectations and norms' (Rink and Ellemers, 2007, p. S18).

Given the absence of direct oversight as a means of coordination and control, a central research question for studies of virtual work 'is whether the distance and dispersion it creates will weaken the relationship between virtual employees and their organizations' (Wiesenfeld, Raghuram and Garud, 2001, p. 214). Thus, as Wiesenfeld, Raghuram and Garud (2001, p. 215) suggest, 'our ability to manage the large and growing populations of virtual employees may depend on identifying the factors that predict organizational identification'.

Organizational identification and proximity

One element that has been proposed to influence identification is geographical dispersion, as it has long been conventional wisdom that organizational members that work in close physical proximity will more strongly identify with each other and the organization. Such arguments are a pertinent consideration for virtual organizations where members are distributed across other enterprises. However, with the observed paradoxical situation of physically distant workers feeling close and vice versa, some have suggested that we should question old assumptions about proximity (Wilson *et al.*, 2008). This suggestion may be especially relevant given the plethora of research that has indicated that co-located teams of workers do not necessarily feel close (e.g. Cohen and Bailey, 1997). Thus, if physical proximity is not a good indicator of identification, exploring other aspects of perceived proximity, and the factors affecting it, may contribute to our understanding of identification in virtual organizations.

In their discussion of the paradox of 'close but far', Wilson *et al.* (2008) argue that the differences between geographic proximity and perceptions of proximity have not been adequately explained. They posit that the relationship between perceived proximity and identification stems from the tendency for co-workers to create or discover common identity elements and that by sharing a certain social category they create common ground and reduce uncertainty, all of which reduce the perception of distance created by a lack of physical proximity. Creating the connection between distant members, i.e. building various ways in which individuals can be structurally and cognitively associated with others in the organization, leads us to a consideration of the processes of social capital development.

Social capital

Social capital, the 'features of social life – networks, norms and trust – that enable participants to act together more effectively to pursue shared objectives' (Onyx and Bullen, 2000, p. 24) has become 'a core concept in business, political science, and sociology' (Burt, 2000, p. 345). Organizational social capital is a resource reflect-

ing the character of social relations within the organization and 'is realized through members' levels of collective goal orientation and shared trust' (Leana and Van Buren, 1999, p. 538). Cohen and Prusak state that 'social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind members of human networks and communities and make cooperative action possible' (2001, as cited in Schoemaker and Jonker, 2005, p. 510). Similarly, Fukuyama (1997, p. 378), recognizing the link to identification, proposed that social capital is the existence of a certain set of 'informal values or norms shared among members of a group that permit cooperation among them'.

Even though social capital is often formed as a by-product of other organizational activities, it is integral to the success of collective action. It is jointly owned by the organization as a whole and the individual member, and acts that enhance social capital benefit both the collective and the individual. Social capital potentially solves the problem of coordination in an organization, reduces transaction costs, and facilitates flows of information amongst organizational members (e.g. Bolino, Turnley and Bloodgood, 2002). Of particular relevance to this study of a virtual research organization is Leana and Van Buren's (1999) contention that social capital is positively related to an organization's ability to elicit the commitment of its employees, via enhanced organizational identification (Edwards, 2005).

Nahapiet and Ghoshal's (1998) framework integrated many of the facets that are useful for understanding social capital in an organizational setting. They proposed that there are three dimensions of social capital – structural, cognitive and relational – each with sub-aspects, and interplay between them over time. The *structural* dimension concerns the configuration (density, connectivity, hierarchy and appropriability) of the network of relationships, in this case between organizational members and how they are (or are not) connected. The *cognitive* dimension relates to shared cognition and includes representations, interpretations and systems of meaning as exhibited in common vocabulary and narratives. The *relational* dimension refers to the nature and quality of the relationships that have developed through a history of interaction and plays out in behavioural

attributes such as trustworthiness, shared group norms, obligations and identification.

Social capital is significantly affected by four conditions that influence the evolution of social relationships (Nahapiet and Ghoshal, 1998). The first is *time*, as the network of social relationships becomes 'embedded' and delivers stability and continuity to the organization. Second, the degree of *interdependence* between members is key to building social capital. The third factor is the degree of ongoing *interaction*, as social capital is sustained and increased with use. The final condition is the degree of *closure* of the system; i.e. a strong sense of boundary between members and non-members, whether explicit or implicit, is conducive to the development of higher levels of social capital (Burt, 2005).

Nahapiet and Ghoshal (1998) indicate that the creation and maintenance of social capital, particularly the relational and cognitive aspects, are very costly. The size and complexity of the social structure influences these costs, although technology makes it possible to support a larger structure (Wiesenfeld, Raghuram and Garud, 1999). Even so, 'adding people to the network may serve to reduce certain forms of social capital' (Nahapiet and Ghoshal, 1998, p. 261), because of the added impact of new members on the interdependence, interaction and closure factors. These potential negative consequences imply that achieving a balance between maintaining the extent of social capital within the existing network and refreshing the network with new members may be important.

In summary, social capital is an attribute of collective relationships and is inherently linked to the existence of shared norms and values and the ability to work towards collective goals. The perception of membership of a collective and the sharing of values which characterize social capital are also aligned with definitions of organizational identification suggesting a complementarity with social capital (Kramer, 2006).

Social capital and identification

The impact of social context on individual identity has been canvassed in social identity theory which 'elaborates how individuals through a process of (self-)orientation and (self-)categorising position themselves in society thus choosing

a community or various communities they consider they belong to' (Schoemaker and Jonker, 2005, p. 510). Thus, there appears to be a clear connection between the social interactions (and thus social capital formation) of members of an organization and their identification with the collective.

Identification features in discussions of social capital as being likely to enhance concern for collective processes and outcomes (Nahapiet and Ghoshal, 1998). Ibarra, Kilduff and Tsai (2005, p. 365) noted that 'different individuals perceive very different networks even when looking at the same set of nodes and relationships' and that a member's perception of the organizational network will be affected 'as a result of repeated interaction experience and by the extent to which they occupy a central or peripheral position'. Nahapiet and Ghoshal also state that collectives with dense social capital have 'identities that separate' those that are a part of the collective and those that are not (part of the closure aspect), implying that there is a direct relationship between strength of social capital and strength of identification (1998, p. 258). Thus, within one organizational context, different members may or may not have an equal sense of belonging or identification (Elsbach, 1999).

When a new virtual organization is formed it is likely that both social capital within, and an individual's identification with, that organization will be at a low level and both must be built. It has been observed that 'informal social networks and a sense of shared identity take root among individuals who enter the organization at the same time' (Reagans and Zuckerman, 2001, p. 502). In their study of mergers, Bartels *et al.* (2006, p. S49) suggest that in order to 'obtain a strong identification with the soon-to-be-merged organization, managers should pay extra attention to departments with weaker social bonds as these were expected to identify least with the new organization'. Thus, the link between social capital and identification is implied as particularly important for virtual and new organizations.

To explore the relationship between social capital formation and identification, we consider how various aspects of structural, cognitive and relational components of social capital influence the extent of member identification in a new 'virtual' organization. We ask how the building of social capital makes the members perceive of themselves as belonging to the organization. As network ties between and within some parts of the new virtual organization are likely to be sparse, this elevates the importance of individuals, processes or institutional arrangements that can lead to the formation of structural social capital, a crucial aspect for facilitating access, combination and exchange of intellectual capital (Nahapiet and Ghoshal, 1998).

Some cognitive aspects will probably be at low levels at the point of new virtual organization formation. Shared language and codes will at this stage primarily be generated by those leading the organization because of early decisions that are made around such organizational characteristics as title and branding, organizational structure and strategy etc. However, the way that these then permeate the organization and are repeated and adapted will be indicative of the formation of cognitive social capital between members as they 'buy in' to these characteristics and identify with the organizational goals and values. Where shared language exists, it will be based around characteristics that organization members have in common, so, in a new interorganizational context, the key challenge may be trying to harmonize the differing values and practices that are already ingrained in the pre-existing groups' ways of operating (O'Leary and Mortensen, 2010; Rockman, Pratt and Northcraft, 2007).

The third dimension, the relational aspects, refer to the quality of the relationships, in terms of levels of trust, norms and obligations, but in a new organization the relational dimension, including organizational identification, will also start at low levels (unless there are significant prior ties). Nahapiet and Ghoshal (1998, p. 254) indicated that relational social capital influences the ability to access others in the network as well as creating the motivation to collaborate and anticipation of benefit to be derived from the exchange. Thus, mechanisms that lead to the establishment of norms and obligations will help members to identify with the organization if they perceive that they can fulfil these expectations.

For members of a new virtual organization that do not meet regularly in person, alternative modes of building relational and cognitive social capital must be found, with information communication technology and other modes of communication from their separate locations as primary options (Kasper-Fuehrer and Ashkanasy, 2001).

This summary of the organizational identification and social capital literatures enabled the development of several working hypotheses that guided the research and analysis.

1. Interorganizational virtual organizations create the potential for multiple forms of member identification to coexist.
2. Social capital formation processes will be an important contributor to the building of member identification with an organization, particularly in virtual organizations.
3. Most dimensions of social capital including member identification will exist at low levels at the formation of a new virtual organization.
4. As regular face-to-face interactions are unlikely and costly to initiate/maintain in virtual organizations, other modes of building social capital will take on greater significance in developing member identification.

Identifying which social capital formation processes had the greatest impact on the degree of member identification was thus a primary focus within the data collection and analysis.

The research project

This research is part of a project which had the aim of understanding the Institute from a range of perspectives. Data for this project were gathered through interviews with Institute members and external stakeholders, observation of Institute seminars and meetings, and textual analysis of Institute email communications, meeting minutes and publications. In addition, we performed a bibliometric analysis of the Institute's journal publications to chart evolving collaboration patterns amongst the geographically and organizationally dispersed members since the Institute's formation.

The qualitative data reported here were derived primarily from interviews with each of the Institute's PIs, of which there were 45 at the time this research was conducted.[1] The Institute had experienced limited turnover in PIs, with only

one original PI having moved overseas at the time of data collection. This suggests that all PIs will have experienced identification and social capital building initiatives for a similar timeframe. Initially, the PIs were each assessed according to physical proximity, i.e. whether the PIs were based in either of the Institute's two main centres (the two universities where the Director and Deputy Director and their dedicated administrative support were located) or further away in any of the other seven locations. Then each PI was characterized along a number of dimensions related to possible influences on perceived proximity which will be described in turn in the following sections.

The interviews occurred at the PI's home institution office and lasted 45–60 minutes. Apart from three interviews where detailed written notes were taken, all PIs agreed to digital recording and transcription of the interview. Following some general demographic questions, the interview template contained questions broadly grouped according to the social capital dimensions noted above. While the following sections will indicate how the dimensions described in the literature were operationalized in the research, in brief, questions relating to structural social capital included those that enquired about their perceptions of structure and of former and current collaborations with other members. Such collaboration also reflects relational social capital, with relevant questions inquiring into expectations, norms, obligations and perceived benefits. Questions addressing cognitive social capital asked for views on the Institute's shared values and stories. This categorization of questions, however, is approximate as the social capital dimensions do overlap (Nahapiet and Ghoshal, 1998). Relational and cognitive social capital questions also captured many of the concepts related to identification and self-categorization, such as what would a 'good' member of the Institute be like and what did it mean to 'belong' to the Institute. Some redundancy in the questions was employed to confirm reproducibility of the PIs' perceptions.

All those interviewed were aware that the research was supported by the Institute and that interim and formal reports of findings (with data reported anonymously) would be provided to the Director and Board. The authors acknowledge that perceptions of peripherality may have been

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[1]PI numbers were randomly assigned in order to satisfy the Victoria University of Wellington Human Ethics Committee approval requirements. The report upon which this paper is based has been approved and circulated by the MacDiarmid Institute Governance Board.

Table 1. PI allocation and sample indicative quotations

	Low physical proximity	High physical proximity
Strong identification	*Far but close: 14/45* [The Institute] offers a great network of research collaborators and colleagues. It provides a really good vehicle for staying in touch and increasing what's going on in New Zealand, and finding new research directions. . . . I think it has created an identity and a sense of belonging for the PIs; they have a strong allegiance. . . . [The Institute has] certainly created a sense of being part of something that is greater than the sum of its parts (PI9)	*Close and close: 17/45* I feel that I know everybody. I think I could look at almost all the PIs and know almost exactly what everybody's doing in terms of their research, which is fantastic. So if I want to collaborate with someone doing that, I know who to contact in New Zealand (PI17)
Weak identification	*Far and far: 8/45* [There are] the original two groups who bid for the [Institute], and then there's a few peripheral hangers-on. I'd say there were certain people who control what happens, and other people who peer around the periphery trying to get some benefit from it. . . . I don't feel any great benefit from being part of the [Institute] (PI14)	*Close but far: 6/45* Certainly as far as my research is concerned I can't say that being here has changed things too much unfortunately at the moment (PI19)

slightly decreased by the mere fact that the interview had taken place and may contribute to a small variation in actual categorization (Table 1). Our first interim report was delayed slightly, though, to allow for as many as possible of the interviews to have been completed (43 of the 45) and the two remaining interviewees had not read the report at the time of their interview. While our interviews and questions probably stimulated many of the PIs to think more deeply about the Institute and its values, we used open-ended questions and phrased them so as to limit the extent to which they might lead the respondent to reproduce key values. Their responses appeared to reflect sufficient differences in wording and terminology to suggest that earlier interviews did not affect the responses given by those interviewed later. Undertaking all interviews at a single site in a short period of time should also have limited such effects.

Manual coding of interview statements to social capital dimensions was undertaken separately and independently by the researchers and an experienced research assistant and, given the above, some statements were coded to multiple social capital dimensions. An analysis was conducted with respect to identification, whereby interview data relating to perceptions of membership and benefits, belonging and involvement, increased collaboration and discussion related to Institute goals and values were isolated in the

transcripts. Each PI was then categorized based on whether their belonging and involvement appeared to demonstrate weak or strong identification.[2] Based on this analysis, 31 of 45 PIs (69%) were categorized as exhibiting strong identification overall, with the remaining 14 PIs (31%) weakly identifying with the Institute. In a few cases, the data for a PI contained statements reflecting both weak and strong identification. Collating this assessment with the physical proximity categorization leads to the PI distribution shown in Table 1 which is accompanied by indicative interview data.

Other data collected included those derived from attending the Institute-sponsored major international conferences, joining the mailing list for all PIs, as well as attending Science Executive and selected Board meetings. Given the relatively large number of PI interviews, we were able to augment our qualitative data analysis by coding data across the different concepts of interest quantitatively and running a logistic regression to assess their statistical relationships with our binary coding of each PI's perceived proximity/

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[2]Potentially we could have labelled these as identification and dis-identification, respectively, and the qualitative data may have indicated instances of neutral or schizo identification (Elsbach, 1999), but for the purposes of this study a simple binary strong/weak categorization was employed.

strength of identification. Details of the logit analysis are given in the Appendix.

The research context

Before describing the results, it is useful to briefly explain the context of the Institute's formation and operation. The Institute was formed in 2002 and involved a joint bid for funding by organizations that had traditionally competed for limited available public research funding. Whilst it did not exist as an entity prior to 2002, the Institute started life with a relatively strong brand as it was named after Alan MacDiarmid, a New Zealand-born scientist who won a Nobel prize in chemistry in 2000 for his work on conducting polymers. It was directed by one of New Zealand's most well-respected scientists, Professor (now Sir) Paul Callaghan. The Institute was accredited by the New Zealand government with CoRE status which included considerable capital and operational funding endowments.

The six partner organizations in the Institute were spread geographically across both major islands of New Zealand and were relatively heterogeneous in character. Four of the partner organizations (which employ the PIs separately) were universities. The other two partners were Crown Research Institutes (CRIs), which are government laboratories which operate under a corporate business model (Davenport and Bibby, 2007). CRIs have quite different goals to those of universities in that they rely on contract research and need to maintain financial viability. The remaining three organizations that employed PIs were another non-partner university, another non-partner CRI and a private corporation. The combined CoRE bid included some pre-existing networks of researchers (reflected in the 2002 co-publications, see Figure 1), but it included other PIs because of their strong research records and status within the relatively small local scientific community.

The Institute is governed by a Board, with at least one representative from each partner organization, and also has an International Advisory Board of renowned researchers in the Institute's research fields. The Institute was structured into initially four, but later five, scientific themes that loosely organized a range of research objectives into key topics. PIs,
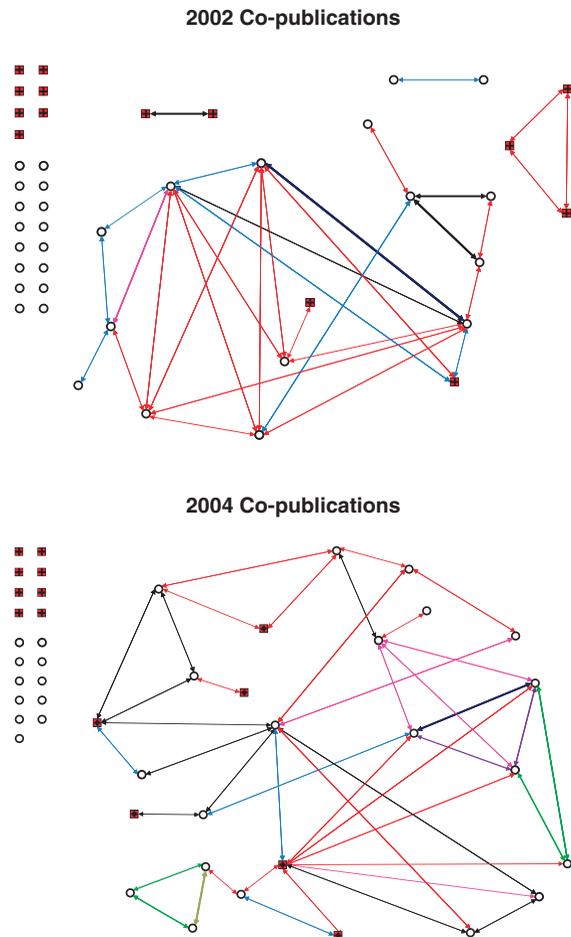

Figure 1. Institute co-publication networks – data from Institute Annual Reports

Note: Each node represents one PI, with unfilled circles indicating PIs who were perceived as central and filled squares those that were peripheral. Unconnected nodes (in the upper left of each diagram) are those PIs with no co-authored publications with other PIs. Higher numbers of co-publications are represented by darker and thicker links between nodes. The number of links between PIs increases from 33 to 44 between 2002 and 2004.

however, chose their own research projects and were able to work within or across themes. A Science Executive, consisting of the Directors and Board Chair, theme leaders and two elected representatives, had oversight of scientific decisions and allocation of contestable funds. A range of activities was undertaken to promote the Institute, such as the purchase of state of the art equipment, a weekly email newsletter (Update) with a lead commentary from either the Director

or Deputy Director, a biennial Advanced Materials and Nanotechnology (AMN) international conference, the biannual *Interface* publication professionally written in magazine format, an annual research profile report, a regular video-linked seminar series with local and international speakers, a major mid-term review of the Institute by prominent international researchers, and the initial distribution of various MacDiarmid-branded items (signs for laboratories and offices, coffee mugs etc). As a result of these activities, the Institute had become very well known in New Zealand and increasingly overseas, despite its short existence. What then gave the PIs a sense of 'belonging' to what was essentially a virtual research centre, especially when each PI also 'belonged' to their home organization?

Identification with Institute goals and values

> The MacDiarmid Institute for Advanced Materials and Nanotechnology is New Zealand's premier research organisation concerned with high quality research and research education in materials science and nanotechnology. The Institute is a collaborative venture encompassing the knowledge and expertise of leading researchers and research facilities. (Institute website[3])

A major argument running through the literature is the fact that sharing goals and values is very important to cognitive components of identification (Edwards, 2005). All data were searched for reflections of the Institute's espoused values and goals as well as the extent to which individuals identified with these. As is partly evident in the excerpt above from the Institute's website, the most commonly expressed values and goals could be distilled into three main themes – excellence, collegiality and fairness.

The fact that the Institute must perform research of very high quality permeated the Institute's communications and discussions as being central to the status of the Institute as a CoRE, and these expectations were very broadly accepted. A stark example of this came from a

Science Executive meeting at which the dilemma of how to deal with differing PI productivity was being addressed. When discussing what a satisfactory level of output was, one member stated, 'satisfactory: meaning excellent of course'. The existence of the Science Executive (which reviewed all proposals for new objectives or new Institute members and hence was seen as the arbiter of excellence), the role of peer review (including the internally initiated review by an international panel of scientists) and ongoing critique were aspects strongly linked to this 'excellence' value.

'Collegiality' was reflected in expectations of collaboration at many levels. It referred to the relationships between the partner organizations and with non-partner organizations, between the PIs and each other as well as between PIs and students, and with the Institute's stakeholders such as the international science community and the local community. Expectations of collaboration in formal research projects was primarily referred to, but collegiality also meant unquestioning participation in other activities deemed important by the Institute, such as its 'outreach' activities to local schools, which was a key expectation of institutes with CoRE status.

'Fairness' also played a significant role in the Institute's identified values. One of the greatest benefits of being a PI in the Institute was the financial resources that came with membership, no matter where in the Institute the PI was located. These resources funded research students and post-doctoral positions, bought equipment and consumables and supported travel. The distribution of these resources had the potential to cause considerable disquiet and political manoeuvring but the Institute intentionally developed a consensus view on appropriate and transparent means of distribution and for open access to Institute members (e.g. to equipment, consumables at cost and each other's library resources).

However, when the interview data regarding goals and values were compared with the identification/proximity data, it became very clear that the ability to espouse the Institute's goals and values was not closely related to whether the PI identified strongly or weakly with the Institute. The quantitative analysis also highlighted that physical proximity (a PI's distance from either the Director or Deputy

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[3]First paragraph on 'The Institute' webpage, http://www.macdiarmid.ac.nz/institute.php.

Table 2. *Institute values and goals and indicative quotations*

	Low physical proximity	High physical proximity
Strong identification	*Far but close* So you need to have an active research group. That research should be plugged into the Institute. It shouldn't be standalone. There should be links to other researchers. I think that's important. ... I think that if you're not being collegial that reflects badly and things will become more difficult for you probably in the Institute (PI35 – collegiality)	*Close and close* [Fairness in] ensuring that there isn't the slightest bit of lack of even-handedness in the allocation of funds or opportunities to speak at meetings or anything like that (PI7 – fairness)
Weak identification	*Far and far* The mantra of excellent research is repeated sufficiently that we aim for it anyway (PI36 – excellence)	*Close but far* [The Institute] was set up to do good science, and the science done there is good science, there's no doubt about that . . . . The Institute really is quite fragmented, although it was supposed to have a lot of collegiality, ... but by and large most people work in their own area and so that area is self-contained (PI15 – excellence and collegiality)

Director) did not appear to have any substantial effect on a PI's organizational identification (see non-significant ln(distance) coefficient in the Appendix). Certainly some of those who more weakly identified with the Institute would question whether particular values and goals were being implemented or whether they were gaining any benefit from them but, nonetheless, they were able to articulate what the key values were. Example quotations for each of the quadrants are given in Table 2 and these themes are also evident in some of the quotations in Table 1.

As a contribution to the understanding of identification within a virtual organization, a clear distinction needs to be made as to whether a member can identify shared goals and values which are espoused by all members from whether they identify *with* them as bringing direct benefit to the member personally.

A social capital lens on identification in a virtual organization

The following sections assess the extent to which structural, relational and cognitive aspects of social capital appeared to be related to identification. We would reiterate, though, that some activities had the potential to affect several social capital dimensions and so we have included them

with the dimension to which they seem to have had the most substantial effect. For each dimension, we start by reporting the findings from the qualitative data and augment them with any associated quantitative analysis. The logistic regressions, though, are restricted to those aspects of social capital that could be readily quantified.

Structural social capital

The formal boundary of the Institute was defined by PI 'membership' and provided the most obvious structural dimension of member identification in terms of who officially 'belonged' and conversely who did not.[4] Being a PI brought certain automatic benefits and these were laid out in a document that each PI was given. Thus, there was no official delineation between PIs at this 'membership' level and it provided little insight for understanding the variation in identification observed in the Institute.

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[4]Several PIs commented that colleagues in their home organization, who were not members of the Institute, were sometimes aggrieved at the status and benefits accorded to Institute members. Although these external colleagues were not part of the data collection, this potentially illustrates Elsbach's (1999) category of 'dis-identification'.

Structural social capital is argued to be present in network ties and configuration (Nahapiet and Ghoshal, 1998) and is represented through a variety of mechanisms connecting organizational members. We examined the following aspects to assess if they were related to member identification: the number of pre-existing research linkages to other PIs prior to the Institute's formation, and any change in the number of linkages over the study period; whether the PI belonged to one or more themes; whether the PI had a significant administrative role such as being a theme leader, a member of the Science Executive, conference convenor or was in charge of a major item of Institute equipment; and structured face-to-face and electronic communication devices.

Pre-existing linkages and changes in collaboration. The extent of a PI's network linkages within the Institute was expected to affect the extent to which they identified with the organization. Those PIs with a greater number of existing research collaborations with other members at the time the Institute was formed would already have more direct connections and closer indirect connections to others. This placed them at a more central position within the social network. To assess this, we undertook a bibliometric analysis of co-publications between researchers based on their CVs and the Institute's annual research report. We generated counts of the number of both joint publications and collaborative links with other PIs up to 2001 as well as for 2002, 2003 and 2004. The number of pre-existing collaborations was most frequently zero, although one PI had publications with 10 other PIs. The logistic regression analysis indicated, as was expected, that the existing links up to 2001 did relate to stronger identification, whereas the relationship with total publication output was less substantial. This suggests that it is the diversity rather than the quantity of links that is important. Therefore the pre-existing links measure reflected whether an individual was more fully connected with a diversity of others rather than just counting repeated instances of the same network tie.

More significantly, those PIs for whom the Institute facilitated new collaborations were less likely to perceive themselves as peripheral. To assess this, we compared the number of linkages

across different years since the Institute's formation. The measure reflecting the closest relationship with perceived proximity, and the most significant explanatory variable overall, was the change in linkages across the 2002–2004 timeframe (ranging from +2 to −2). Those PIs that increased their total collaborations during this timeframe exhibited stronger identification, while those that had fewer collaborations than previously were more likely to perceive of themselves as peripheral. Thus, identification appears to be partly related to the extent that Institute membership facilitated new research opportunities and connections for members. Figure 1, however, demonstrates that the number of PIs categorized as peripheral who were linked through co-publications had increased by 2004.

Institute and theme structure. The knowledge of the Institute structure, i.e. that another PI also 'belonged' to the Institute, provided opportunities for the development of structural social capital by breaking down organizational barriers to collaboration. The following quotations from 'far but close' PIs from two different Institute partner organizations indicates this social capital development.

> Without the Institute there, I would feel like I would be a [University A] staff member going down to the [University B campus] to speak with a [University B] staff member, whereas because [PI$_n$] and I are both part of the Institute, it's just two Institute colleagues having a casual meeting. So I can just go in, knock on the door and say 'Hi [PI$_n$], how's it going?' (PI25, far but close)

> If I hadn't joined the Institute, the chances are I probably wouldn't be collaborating with people in New Zealand. ... Being part of the Institute gives me the confidence that I know I've got access to these facilities and a collaboration can really be meaningful because there can be a long-term structure I can build a collaboration around. (PI44, far but close)

It might be expected that the organization of the Institute into themes would also influence structural social capital formation such that ties would form more readily within the themes, but that they might then constitute barriers to the formation of links between PIs in different themes. However, in four of the five themes, at least one PI was classified in each quadrant of Table 1. While some

themes were less proximate physically at formation, in that a theme accumulated research initiatives across PIs from non-central locations, PIs within these themes did not necessarily perceive of themselves as being peripheral. Furthermore, given that almost 30% of the PIs (13/45) belonged to more than one theme, it might be expected that their social capital and identification would be stronger than those that belong to only one theme. However, the results of the regression analysis indicate that membership in multiple themes was not closely related to a PI's perceptions of belonging. In practice, the themes, which officially gave the perception of a logical research structure, played a very loose organizing role internally and did not detract from the collegiality value. In fact, some PIs could not readily identify the names or numbers of the theme(s) to which they belonged. Geographic spread of PIs meant that theme meetings tended to be infrequent but, when they occurred, did allow links to be formed or improved within themes. Few PIs, though, felt restricted to operate solely within themes and a number of PIs indicated they collaborated across theme boundaries.

> [The Institute's] not going to stop people from doing something because one belongs to one theme and the other belongs to the other. Those are details that are just for the records. But then, what happens in reality is pretty independent of the structure of the Institute. (PI22, close and close)

Administrative roles. Whilst the Institute's theme structure may not influence identification, it would be expected that those that hold an administrative role in the Institute are likely to feel more connected because of the extra opportunities for social capital formation that such roles facilitate. Other than the Director and Deputy Director roles, the administrative role parameter included being a theme leader, membership of the Science Executive, a conference convenor, and/or manager/key contact for a significant piece of Institute equipment.

This last aspect was included given that some of the quotations from the equipment managers suggested that their interactions with the research of others increased their identification with the Institute and other PIs. Even though the equipment was owned by the two university partners, it had been distributed to all of the six partner organizations. The managers of the equipment, therefore, worked with a variety of PIs from around the Institute enabling them to build structural social capital with many others. Several of the early career PIs had been employed with the express purpose of running a piece of equipment or providing a service for the Institute. By doing so, these PIs were rapidly integrated into the Institute by virtue of not only playing an important service role but also being immediately exposed to other PIs.

> I feel that I know everybody. I think I could look at almost all the PIs and know almost exactly what everybody's doing in terms of their research, which is fantastic. So if I want to collaborate with someone doing that, I know who to contact in New Zealand. (PI17, close and close)

> If you're managing a piece of equipment that other Institute users are using then I think that's an important role. A lot of us have different specialties and if you can exploit that by managing a piece of equipment that other people can use then I think that's really good. (PI35, far but close)

The regression analysis indicated little support for an administrative role affecting identification, probably because most of those who had an administrative role already strongly identified with the Institute. We also segmented out those that ran the equipment from the combined administrative role measure, but this measure was also not statistically significant.

Opportunities for visual connection. While opportunities for face-to-face interaction were limited to once a year for theme meetings, two activities were highlighted as fora for PIs to establish ties within the Institute. The first was the international AMN conference, the first of which showcased the Institute two years after its formation. Whilst these conferences certainly were an important part of establishing the Institute's external identity and reputation, they were equally pivotal as internal processes, in that they provided a forum for new connections to be made or strengthened, but also provided a shared sense to the PIs of what constituted the Institute to which they belonged.

> When we get together for our big conferences, you get a very strong sense of identity there as a PI at those conferences. (PI35, far but close)

The conference we have every two years is very good, and brings us all together at the one time, and we are 'the Institute' at that conference. (PI22, close and close)

The regular video conferences and seminars featuring both Institute and international researchers played a similar role in providing opportunities for the distributed PIs to feel connected as well as reinforcing the networked identity of the Institute.

Of course conferences, they've had a very powerful and cohesive effect. Video conferences – you can't always see them but you can sense that they [the other PIs] are out there somewhere! (PI21, close and close)

You're not always operating within that network but it's certainly there ... . I think the regular videoconferencing just reminds you every month. You come back to the videoconference and see all the faces around the country. (PI35, far but close)

Although these opportunities for meeting in person built social capital in the Institute in much the same way as would occur in a traditional organization, it is clear from this research project that these and other communication initiatives (noted below) can be viewed as foci, which 'may actively bring people together or passively constrain them to interact' (Feld, 1981, p. 1018). Once there is a tie between individuals, they will tend to 'develop new foci around which to organize joint activity' (Feld, 1981, p.1019), stimulating them to develop a sense of belonging and community in the network.

Cognitive social capital

Cognitive social capital is said to reside in shared language and narratives (Nahapiet and Ghoshal, 1998). For the Institute, the major aspects of cognitive social capital that were extracted as having an effect on identification were related to differences in disciplinary affiliations, the nature of a PI's home organization, and the impact of two regular textual communications.

Disciplinary affiliation. The Institute included members with backgrounds in both physics and chemistry, although a few identified themselves as physical chemists. The Director of the Institute, Professor Paul Callaghan, was a world renowned physicist whereas 35% of the PIs identified

themselves as chemists. Thus, differences in disciplines had the potential to affect how connected the PIs felt to each other and the Institute. This effect appeared to relate particularly to those who were situated in closer proximity yet perceived of themselves as more peripheral.

I am basically a theoretician, which means I can sit in my room and work by myself. (PI19, close but far)

I don't feel excluded at all [but] have a little difficulty sometimes getting excited about what these people are doing, understanding what they are doing. (PI36, far and far)

Taking a social capital perspective suggests that cognitive differences between the disciplines could generate some lack of identification within the Institute. As Nahapiet and Ghoshal (1998) state, when languages and codes are different, as between the two disciplines, this separates people and restricts their ability to easily form cognitive social capital. Those PIs that perceived of themselves as similar to the Director and to the majority of other PIs based on disciplinary affiliation would be more likely to identify themselves as belonging more strongly to the Institute. Despite the potential for such affiliations to affect identification, this relationship was not statistically significant in the regression analysis and so other cognitive differences probably played a greater role.

Organizational affiliation. Another difference which could contribute to identification was the type of home organization to which the PI belonged. As indicated earlier, the institutional make-up of the home organizations included five universities, one private corporation and three CRIs. Although the background of the researchers may be very similar, the CRIs had very different organizational objectives centred upon commercialization activities, as would a private corporation. Whilst the CRI members worked alongside other university PIs on Institute research, they were often in direct competition when it came to attracting other funding and, apart from a few joint appointments, were physically located away from the universities.

I can't act like anyone. If I have anything to do, it has to be cleared by [the organization] .... If I was

in a university it would have been much more collaborative. (PI26, far and far)

We are commercial and a very IP [intellectual property]-oriented organization. I'm not saying that [the university] is not interested in IP but I think it's a bit more extreme with us. (PI10, far and far)

These quotes suggest that the tension between being a member of two quite different types of organization could have a negative impact on identification (Rockman, Pratt and Northcraft, 2007). The Director and Deputy Director, administrative support and the ownership of the equipment were all located in the universities (a requirement of CoRE status), which appeared to exacerbate the perception of separation and the ability to cognitively identify with the Institute for those not in universities. In contrast to the differences in disciplinary affiliation, the logistic regression results show more support for home organization objectives and imperatives affecting the extent of identification with the Institute.

Textual communication. Two types of textual communication played important roles in social capital formation and identification. The weekly email newsletter 'Update' went to all Institute members with information about events in different centres, various happenings that had occurred, prospective research student enquiries as well as opinion pieces from the Director or Deputy Director on relevant issues. The newsletter exhibited strong cognitive and relational social capital roles, particularly for those who were more geographically isolated, in building a shared language and 'view' about what the Institute, as a collective, thought was important and how the Institute directors interpreted what had been happening.

> I appreciate getting emails once a week from the Director. I think that's excellent and outstanding. (PI2, far and far)

The *Interface* magazine was a professional output that was primarily targeted at external stakeholders. However, it had a very important internal cognitive role in that it produced stories about events and achievements in the Institute, providing organizational narratives of what it means to be a 'successful' Institute member.

I assiduously read everything that comes out of the MacDiarmid, when the reports come out, when the annual report comes out, when the update or the *Interface* come out. I read them. I devour them – to try and find out really what is going on in the Institute. But I don't feel that I'm all that well aware of what's really going on. I don't think that's necessarily a criticism of [the Institute]. It might be more a comment on me. (PI39, close but far)

The *Interface* publications were thus useful for internal social capital formation along the cognitive dimension. Many Institute members had noted who had been 'in' the *Interface* and, occasionally, who had not been profiled. In a sense, one role of the *Interface* was marketing the Institute 'to itself', as a way of building cognitive 'belonging' and identification in much the same way as communities have been observed to do (Lee *et al.*, 2005). Both of these communications, though, served primarily to communicate views, emerging issues and general updates *out* from the Director or Deputy Director, meaning that key values were reinforced in a regular and consistent manner, and stimulated PIs' sense of belonging when they cognitively identified with the content.

Relational social capital

While aspects of structural social capital may also be indicative of relational social capital (e.g. existing research collaborations suggesting the presence of trust), here we consider how other aspects of relational social capital such as norms, obligations and expectations seem to have affected identification. Specifically, we assess the effects of researcher status, the norm of open access to equipment, and leadership roles.

New versus established researchers. While the majority of PIs were established researchers, reflecting the Institute's premier research organization status, seven of 45 were categorized as new researchers. As a result of being at the start of their research careers, it was postulated that their lesser knowledge of, and experience with, the norms and practices of their respective organizations and professions might lead them to feel less connected. However, this did not appear to be the case, with almost all new researchers exhibiting strong identification and this variable

proving to be non-significant in the regression analyses.

> Yes, it definitely does feel like an Institute. . . . [and belonging means] there are certainly the benefits of just sharing ideas, and that does help. (PI33, close and close)

Change in membership status. After the interview data were collected, an internal review of PI performance was conducted during which some PIs were demoted to Associate Investigator (AI) status due to lack of performance, while others (including a couple of PIs that did strongly identify with the Institute) took the opportunity to reduce their commitment/obligation to the Institute, either by becoming an AI or by withdrawing altogether because of other pressures on their time. This factor (Not PI) was significant in predicting weak identification. Further analysis of the transcripts indicated that many of these PIs identified themselves as not performing at an expected standard prior to this review.

> I am at a stage where I think I should withdraw, morally feeling I'm not contributing as I should be contributing. (PI30, close but far)

> I am a fraud really. I shouldn't be in [the Institute] really. I honestly don't do very much. (PI31, far but close)

From a social capital perspective, these PIs were disconnected from the Institute because of their own perceived performance shortcomings which meant that they no longer fulfilled obligations and expectations associated with the Institute's excellence value. While they were being treated fairly and had similar access to the benefits provided by membership, they felt themselves to be peripheral because their less than excellent performance created a misalignment with the Institute's shared values and goals.

Open access to equipment. The interview data suggested that the norm of open access to equipment appeared to break down structural barriers and increase relational social capital for PIs, even for those whose identification with the Institute was not strong.

> The greatest value of the [Institute] was that we could share equipment with essentially no cost, so anyone who wants to use a piece of gear I've got

can, and they don't get charged for it and I feel I can go and ask to use the [X equipment] in [Y organization] and don't feel I have to fork out $200 an hour. I haven't taken much advantage of that but knowing that I can is a great sense of freedom . . . . So it broke down those barriers. (PI14, far and far)

This norm was consistent with the Institute's emphasis on collegiality, which inherently emphasizes collaboration and should promote PIs to identify with the Institute. It also provided a clear and tangible benefit of membership that was not available to colleagues who were not Institute members.

Leadership roles. The Institute had experienced very strong leadership, particularly from its Director, with many PIs noting how he exemplified the Institute's values: 'a lot of that comes down to Paul in the sense of his fairness' (PI37, close and close). However, while the Director had emphasized and exhibited many of the values that were seen as central to the Institute and his actions were perceived to establish organizational norms, we note that he is only one of 45 PIs in the Institute – one with enormous competing demands on his time from inside and outside the organization. Unsurprisingly, then, he was not disproportionately represented in the new collaborations or the formation of social capital and we would resist the tendency to attribute the strong relational and cognitive social capital and their influence on identification primarily to leadership (Meindl, Ehrlich and Dukerich, 1985; cf. Joshi, Lazarova and Liao, 2009). In fact, the leadership roles that appeared most influential were those administrative roles that 'rotated among members, depending on the task to be accomplished' (Jarvenpaa and Leidner, 1999, p. 809) and helped stimulate various dimensions of social capital.

Conditions linking social capital and identification

> You belong as much as you want to belong. (PI3, far but close)

In the sections above we have endeavoured to show how social capital and its formation is important for supporting member identification,

particularly in new virtual organizations. Of particular note is that we investigated a group of people that belonged to the *same* organization, meaning many of the contextual factors were identical, thus enabling a clearer picture to emerge of the factors that appeared to influence the relative strength of identification. In order to further understand the link between social capital formation and identification, we will now discuss the four conditions, namely time, interdependence, interaction and closure (Nahapiet and Ghoshal, 1998), that influence the development of social capital and relate these to the strength of identification.

Although this was not intended to be a longitudinal study, there was evidence for the influence of *time* on social capital formation and identification. Right from its inception, all PIs officially belonged to the Institute. However, as was discussed earlier, social capital is at low levels in new organizations and just because a researcher was a PI did not mean that they would necessarily strongly identify with the Institute. As the quotation below indicates, time has an influence on identification, as 'things happen' and a clearer understanding of what it 'means' to be an Institute member eventuates.

> I think it's more psychology than reality to be honest. It's the same reason that makes a football club 'real'. People just identify with a colour or a theme or a team and then just go for it and they behave collectively as if it were something cut in stone when naturally it's not. . . . But you find that things get done. Things do happen. Equipment appears and studentships appear and people are able to travel abroad and collaborate and the fact that you see the results of belonging to an idea is what makes it real. (PI 22, close and close)

The most tangible example of the influence of time was exposed by our bibliometric analysis. As Murray (2004) observed, one indicator of whether social capital had increased along the structural dimension can be found in co-publication trends. Figure 1 shows the co-authorship in the year of Institute formation (2002) and again after two years of operation (2004). Even with the normal caveats about this type of analysis, such as delays in publishing, the density of linkages had increased markedly over this short time-frame. Not only had there been more publications (Hendy, 2009) but the number of new linkages formed between different Institute members was very clear and this (existing links) measure was found to have the most significant relationship with identification (Appendix).

The time dimension to social capital comes from the fact that it represents 'a form of accumulated history' (Nahapiet and Ghoshal, 1998, p. 257). With repeated interactions over time, PIs form a stronger notion of membership by 'seeing the results of belonging' and, in turn, identification becomes stronger. However, as indicated in many of the quotes of those exhibiting weaker identification, if they do not observe sufficient tangible benefits associated with being a member over the intervening years, then identification will not strengthen for those members and it may even weaken.

The impact of time also arose from the finite time horizon under which the CoREs were initially set up. As funding was committed for six years, there was a clear imperative to deliver a range of tangible outcomes in order to secure the Institute's future. This time horizon provided all PIs in the Institute with a strong incentive to build and leverage social capital, which in turn strengthened identification as opportunities created by the virtual organization led to benefits for Institute members.

The next condition is *interdependence* between members. 'Social capital is eroded by factors that make people less dependent on each other' as 'obligations and expectations are less significant where people have alternative sources of support' (Nahapiet and Ghoshal, 1998, p. 257). Thus increasing interdependence enhances social capital, particularly relational social capital, and Nahapiet and Ghoshal (1998) explicitly argue that creating contexts that enhance interdependence also increases social identification. From our results it can be seen that the funding available, participating in administrative roles and gaining access to capital equipment spread geographically across the Institute all provide examples of increasing interdependence between PIs and enhanced identification. Conversely, those PIs that were also employees of CRIs who did not manage equipment or have involvement in these other factors would primarily see the immediate obligations and expectations of the CRI, and the direct support that their employer provided, as of greater significance to them. This could be exacerbated by a perception of a lack of benefit derived from membership, coalescing to

weaker dependence on the Institute and weaker identification.

The third factor is *interaction*, as social relationships in general increase social capital – although it is recognized that not all interactions accomplish this. Interaction not only develops structural and relational social capital but also facilitates the development of shared codes and language associated with cognitive social capital. Of the factors described previously, those opportunities for physical interaction (such as being involved administratively, attending the conferences, as well as virtual interaction through the video seminars) provide the spaces necessary for the development and maintenance of social capital, particularly as unstructured opportunities for coming together are more limited in virtual organizations. Whilst other communications, such as the email Update, are more passive, they do provide an opportunity for the members to absorb the Institute's shared codes and language and are regular reminders of membership. Such cognitive factors also help to explain the differences between the identification of members from different home organizations, in that a lack of shared language would be a barrier to interaction and thus to social capital formation for those individuals and identification. Our study echoes findings from other research on virtual organizations that argues for creating alternative modes for interactions and manifesting benefits for members in order to ingrain interdependence (Jarvenpaa and Leidner, 1999; Newell, Tansley and Huang, 2004).

Lastly, communities with dense social capital tend to have a very strong sense of sociological boundary which brings us to the *closure* condition. Evidence for the influence of the Institute boundary and the benefits this provided to the members has already been noted in the discussion of structure. However, the cognitive perception of boundaries also affected the strength of identification. As observed in some of the interview data of those PIs exhibiting weaker identification (e.g. Table 1, far and far quadrant), a theme of peripherality pervaded their perception of their relationship with the Institute, even though they were officially an equal Institute member.

> Well, I wouldn't think it was me …. . I do feel it would probably have to be somebody who's on the inside, who's a member of the inner sanctum, the inner circle as it were. But this inner circle, this is a purely mythical thing. (PI39, close but far)

In addition, for a few of those who did perceive of themselves as peripheral, becoming a PI had actually foreclosed other collaborations, so the Institute boundary had a negative impact on their social capital and how they perceived the benefits of being a member.

> Back in the late 1990s I had a collaboration going with [X] at the university but then the MacDiarmid Institute came along and so all those previous interactions for some reason were just cut off and we were left hanging really so it's been a bit difficult since then. (PI1, far and far)

This may also indicate that the amount of bonding that can occur concurrently between members of a research institute has finite capacity, where the development of new linkages may supplant existing ties between PIs or other researchers. Such closure will undoubtedly lead those who lose more links than they gain to feel more peripheral.

The fact that the sense of peripherality and weaker identification was strongly linked to perceptions of benefit (e.g. Table 1, far and far quadrant) is consistent with O'Brien, Phillips and Patsiorkovsky's (2005) proposition that building social capital in a large aggregate of individuals is more difficult without a shared economic interest or personal benefit accruing from being a part of the collective 'inside' the boundary. This finding also relates back to Nahapiet and Ghoshal's (1998) suggestion that the degree of interdependence between members is key to building social capital. When PIs do not perceive that they are receiving benefits from the Institute, their lack of interdependence erodes their propensity to build or access social capital.

A remaining question related to the closure factor, however, is whether it matters for the Institute that there is a delineation between those that are perceived to be 'central' and those that view themselves as more 'peripheral', in that the latter do not identify strongly with the notion of belonging to the Institute. Attempts by virtual organizations to build social capital and identification may suffer if an insufficient number of members perceive themselves as central, and this research suggests that, potentially, some methods for increasing the structural, relational and

cognitive social capital between the peripheral and central PIs (such as by having the peripheral PIs manage equipment) may increase their integration and strength of identification. As Nahapiet and Ghoshal (1998) state, ongoing interaction and increasing interdependence contribute to social capital formation, so any or all of these initiatives might alter the PIs' perception of their own embeddedness in the Institute.

Discussion and conclusions

Our research highlights how the formation of different forms of social capital can affect the extent of identification by members of a virtual organization. This examination has indicated mechanisms through which some dimensions of social capital are interrelated and dynamically reinforce each other, which has been noted as an area where more research is needed (Lee, 2009). By surfacing the Institute's core values, we were able to assess the extent to which individual PIs identified with the organization and their perceptions of belonging. One interesting result that emerged was that the ability to espouse core values did not depend on the strength of identification.

The Institute provided a research setting where the extent of identification and belonging varied across members of the virtual organization. While proximity has at times been proposed to affect the extent of identification (van den Bulte and Moenaert, 1998), our analysis showed that any effects of physical proximity or remoteness were insignificant relative to the key facets of social capital. Many of these mechanisms for developing social capital were undertaken specifically because the Institute was a virtual organization. However, some of these could prove equally useful in traditional organizations to overcome the paradox of 'close but far' (Wilson et al., 2008). For example, through the development of shared language, narratives, norms and obligations, it appears possible to increase member identification. Development and maintenance along multiple social capital dimensions appears useful for both increasing social capital overall and positively influencing other organizational outcomes.

Varying levels of identification found in our study could, though, be perceived as potentially problematic (Hinds and Bailey, 2003; O'Leary and Mortensen, 2010). However, implications derived from the closure aspect of social capital would suggest otherwise. Nahapiet and Ghoshal (1998, p. 260) argued that 'organizations high in social capital may become ossified through their relatively restricted access to diverse sources of ideas and information'. Similarly, Oh, Chung and Labianca (2004) cautioned that extreme levels of social capital can lead to complete closure whereby each member is connected to all other members in strong relationship ties which 'may negatively affect group social capital, and ultimately, group effectiveness' (2004, p. 864). It appears then that moderate amounts of social capital, reflected in moderate levels of homogeneity and closure, may be preferable.

The potential for ossification in organizations results from the likelihood that strongly bonded members will be inwardly focused and less amenable to searching elsewhere for new ideas and information from those who are outside the notional boundary. As Leana and Van Buren state (1999, p. 551) 'the denser and more long-standing the ties among organizational members, the less likely the entry of new information'. Strong norms and specified roles are also indicative of strong social capital and can mean the organization perpetuates the old and becomes very resistant to potentially necessary change, as these norms keep members embedded in current practices rather than adopting new approaches (Leana and Van Buren, 1999).

For virtual organizations like the Institute, which tend to derive much of their advantage from information flow between talented individuals in order to be successful (Davidow and Malone, 1992; Schoemaker and Jonker, 2005), it is suggested that maintaining a balance in the strength of identification across members may be quite important to continually reinvigorating knowledge sources. Relatively unconnected members become a potential knowledge source for those members who have not been linked to them previously, in which case finding ways to improve interaction with potentially useful, but currently peripheral, members would be important. Alternatively, for those members that would still find it difficult to increase their embeddedness no matter what social capital practice is initiated, delivering an easy means of exit without social ramifications is probably a sensible approach. As indicated in our results, those members who more weakly

identify with the organization are likely to remove themselves from membership given the opportunity to do so. New members, who may be more cognitively open to developing a sense of belonging, replace peripheral members who are never likely to identify with the organization. As this is a replacement/renewal strategy rather than a growth strategy, the risks of diluting the interdependence and interaction characteristics that are conducive to social capital formation are also reduced.

While limited to the study of a single virtual organization, our analysis highlighted how a diverse range of social capital formation processes contributes to the extent of member identification. We would argue that a broad set of processes is likely to be necessary at the formation of virtual organizations as there is a primary need to overcome the lack of a sense of place (Brown and Humphreys, 2006). A simple option would have been to designate one partner as the 'head-quarters' – however, as indicated above, this would have gone against several of the core values that emerged in the Institute and may have created a larger periphery within the Institute membership and negatively affected collaboration, collegiality and perceptions of fairness. Instead, by working from the foundation provided by pre-existing structural social capital (such as membership criteria and previous collaborations), the development of other structural, cognitive and relational social capital dimensions was facilitated. These contributed to PIs' understanding of what was expected of them and what it meant to belong to the Institute. Overall, then, a focus on building social capital rather than rectifying the lack of formal organizational structures appeared to serve this virtual organization better.

This research has contributed in other theoretical and practical ways. We have provided rare empirical evidence from one organization within which all four permutations of member close/distant proximity and strong/weak identification were present. This is important as it provides further verification that identification can vary greatly in supposedly uniform groups. As Ibarra, Kilduff and Tsai's (2005) study suggested, different individuals in the same network can experience the network in very different ways which influences the strength of identification. In other settings, many contextual variables are not constant for all members so there is no ability to understand their influence on identification. Here, these variables, including physical proximity, could be investigated individually and collectively. Another specific outcome of our investigation that may shed light on identification theory is that a sense of belonging is not dependent on members being able to identify the shared values and goals of the organization – they must identify with them and a key to this appears to be perceiving of themselves as gaining benefit from membership in the virtual organization.

The consequences of our research for managers of a new organization, particularly one that is virtual or possibly just fragmented in nature, are also clear. Albeit with caveats about the instrumental building of social capital (Willem and Scarborough, 2006), the research results suggest that the way to build strong identification amongst members is to develop and support processes and activities that, whether purposively or unintentionally, build and support social capital formation. Members of a new virtual organization may have a sense of the purpose of the organization and what it is trying to achieve, but are not likely to have a sense of 'belonging' or other core aspects of relational social capital. Cognitive social capital (shared codes and language) may also not be present initially. Since it appears to be the interactions between, and interdependence of, members that will determine when, and the extent to which, strong identification emerges amongst members, initiating a range of processes that communicate norms and values and facilitate interactions across the organization appear to be crucial. The imperative of time can be harnessed if social capital initiatives are developed early as members look for ways to contribute to key organizational outcomes. Being wary of excessive closure within the virtual organization is also noted as important. To facilitate collaboration, interactions and sharing, there is likely to be a strong desire to include only those with similar knowledge, values and networks. Yet, our study suggests that having some members more peripheral can be beneficial as long as they remain connected and ways are found for them interact at key junctures.

Caveats on these insights need to be added, however, as this is an exploratory study of one extremely successful virtual organization where a clear majority of members strongly identified with the organization. Robertson (2007, p. 196) found

'very limited evidence of scientific collaboration', and fragmentation instead, when studying the Genetics Knowledge Parks across England and Wales. Thus, under other circumstances, where perhaps more limited social capital formation processes took place, an organization dominated by weak member identification and a majority of members with perceptions of peripherality might easily have resulted, with possible consequences for organizational performance and survival (Andrews, 2010) given the link between social capital and the ability to generate collective action (Bolino, Turnley and Bloodgood, 2002). Thus, there remains scope for further research into the relationships between different facets of social capital and identification.

Although not explicitly investigated in this study, we were aware that many of the factors highlighted also appeared to influence the collective notion of the Institute's identity. This may be particularly important in virtual organizations where 'shared meanings, values, beliefs, ideas and symbols become key elements of normative organizational control' (Alvesson and Robertson, 2006, p. 196). As Albert, Ashforth and Dutton (2000, p.13) indicate:

> Increasingly, an organization must reside in the heads and hearts of its members. Thus, in the absence of an externalized bureaucratic structure, it becomes more important to have an internalized cognitive structure of what the organization stands for and where it intends to go – in short, a clear sense of the organization's identity.

Albert and Whetten's (1985) definition of identity, as that which members believe to be central, enduring and distinctive about their organization, underpins much of earlier organizational identity research (Corley *et al.*, 2006). However, in line with the rise in new forms of organization, recent writers have viewed identity not as a 'rigid and enduring taxonomic position' but as a more 'mutable, contingent and situationally-determined set of meanings' (Oliver and Burgi, 2005, p. 6; Haslam, Postmes and Ellemers, 2003). Similarly, Scott and Lane (2000, p. 46) proposed that organizational identity construction involves 'the processes, activities, and events through which organization identity becomes specified in the minds of organizational managers and stakeholders'. Hatch and Schultz (1997) also argue that it is the ongoing interactions between

organization members that cause an organizational identity to emerge.

These descriptions make it clear that many of the activities that relate to structural, relational and cognitive social capital formation may also play a role in organizational identity construction. Thus, we see a potential stream of research to investigate identification building processes as collective 'identity work' that contributes to organizational identity construction (Ashforth, Harrison and Corley, 2008). This process would be particularly salient for complex, virtual forms of organization in which social capital formation appears to be a key process for increasing cognitive solidarity for networked members and therefore for developing a shared sense of the identity of the virtual organization. In short, the creation of and identification with such a collective identity are social processes that are ripe for further study.

Appendix

The logistic regression analysis used the categorizations of perceived proximity (central ($= 0$) versus peripheral ($= 1$)) for the 45 PIs. Given the large range of possible explanatory variables, two sets of results are reported. The first model represents a parsimonious set of key variables that leads to a high number of PIs being correctly classified as being either central or peripheral. The second model includes all explanatory variables considered. However, given some high correlations between explanatory variables such as ln(distance) and University vs CRI or Not PI and PI to AI, it is likely that the estimated parameters and standard errors are somewhat affected in the full model. It should also be recognized that the number of explanatory variables is relatively large compared to the sample size, particularly in the full model. Hence, we present these results as an augmentation to the qualitative analysis and not as definitive evidence of statistically significant relationships. Negative significant coefficients (β) indicate factors that affect a PI's perception of being central, while positive coefficients promote perceptions of being peripheral. The first model produced accurate predictions ($38/45 = 84\%$ correct) and a substantial improvement over the maximum likelihood estimated null model.

Model 1

Observed	Predicted		Percentage correct
	Central	Peripheral	
Central	27	4	87.1
Peripheral	3	11	78.6

Models 1 and 2

	Model 1		Model 2	
	β (std error)	Wald statistic	β (std error)	Wald statistic
Pre-existing publ. links	− 0.55 (0.40)	1.88	− 0.87 (0.51)	2.89*
Change in publ. links	− 1.65 (0.83)	3.90**	− 1.97 (0.96)	4.23*
Multiple themes	− 0.71 (0.46)	2.36	− 1.03 (0.62)	2.72*
Administrative roles	− 1.31 (1.07)	1.49	− 0.59 (1.12)	0.28
Disciplinary affiliation	1.31 (0.87)	2.29	1.44 (0.95)	2.31
University vs CRI	1.71 (1.25)	1.89	2.94 (1.82)	2.60*
Not PI after review	1.69 (0.93)	3.25*	5.94 (2.99)	3.93*
Proximity = ln(distance)			− 0.21 (0.21)	0.97
Run equipment			0.33 (1.22)	0.72
PI to AI after review			− 3.54 (2.54)	1.94
New vs established research			− 2.49 (2.15)	1.34

*Significant at $p < 0.10$.
**Significant at $p < 0.05$.

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