Abstract

Product development (PD) can be described as the process that identifies a market opportunity and transforms it into a product available for sale (Krishnan and Ulrich, 2001). It cuts across every aspect of an organisation and involves the functional skills of many people who must work together effectively. Many organisations have attempted to alter their formal structures to improve PD performance by focussing on the integration of different functional skills, knowledge and expertise and adopting a multi-functional project team approach (Cusumano and Nobeoka 1998). While considerable resource has been expended in restructuring organisations to optimise performance, Henderson’s research (1994) suggests
the search for an optimal organisational form is a fruitless exercise: much of the real work in organisations happens despite the formal structure.

The informal organisational network is used for resource exchange and cutting across formal boundaries, and comes into play for transmitting the social support and social norms related to the organisation (Pagel, Erdly et al. 1987; Podolny and Baron, 1997). Nevertheless, this same mechanism can also be used to block communication, obstruct innovation, foster negativity and delay, or even halt change. We postulate that learning to harness the positive aspects of the informal organisation while managing the negative to improve relationships may be the way to improving performance: effectively, adding value to technical expertise to increase profitability.

Recent fieldwork has established that the relationships of successful networkers are more than just business contacts (Cross, Davenport et al. 2003). Our research activities informed the development of a tool that allows organisations to improve performance by improving communication flows through enhanced relationships between teams, departments, organisations and strategic alliances. The tool utilises Social Network Analysis techniques within a standardised structure to facilitate comparative analysis of industrial partners. Structured/semi-structured questionnaires are also employed, together with interviews, workshops, focus groups and stage reviews.

This paper will set the research context and present the results of our action research in a number of industrial settings. Our working tool has been able to manipulate the informal organisation by enabling visualisation of networks, by generating discussion, and by supplying focus for individuals and teams to manage relationships more effectively and hence improve performance. Implications for further use of the tool will be reported, together with an outline of its potential for improving performance in other organisational areas.
**Key terms:** product development performance, adding value, social network analysis

**Introduction**

In the latter part of the last century considerable effort and resources were expended in restructuring organisations to optimise product development performance (Drucker 1997). Research by Henderson (1994) suggests that the search for an optimal organisational form is a fruitless exercise. She emphasises that “success is not a function of a particular organizational choice”. Much of the real work in organisations happens despite the formal organisational structure. Krackhardt and Hanson (1993) call upon biological metaphor to illustrate:

“If the formal organization is the skeleton of a company, the informal is the central nervous system driving the collective thought processes, actions, and reactions of its business units”.

Smart found that the social or informal organisational network of interrelationships is used, amongst other things, for resource exchange, cutting across formal boundaries, and avoiding barriers and lengthy delays generated by the prescriptive processes of the formal structure, particularly in times of change (Smart, Brookes et al. 2000). Alongside the work-related sources of technical advice, for example, the informal network also comes into play for transmitting the social support and social norms related to the organisation (Pagel, Erdly et al. 1987; Podolny and Baron 1997).

Much of the previous attention centred on the social exchange networks in the workplace – the informal organisation network – has focussed on awareness and recognition. Our research seeks to establish whether the informal network can actually be manipulated to improve project or product development performance.

The value of informal communication in project and product development is widely recognised. Concurrent Engineering, for example, often collocates project team members to
facilitate a positive environment for more rapid exchange of ideas and information (Jo, Parsaei et al. 1991; Syan 1994; Backhouse and Brookes 1996). However, the expertise that made project team members attractive in the first place can be diluted over lengthy periods of collocation. Moreover, team members also have varying degrees of skill in informal communication and may not address the importance of developing personal networks of relationships.

Research suggests that organisations should not only recognise the informal network but also know how to identify and direct it. “Learning how to map these social links can help managers harness the real power in their companies and revamp their formal organisation to let the informal ones thrive” (Krackhardt and Hanson 1993). The informal network can traverse functions and divisions to facilitate more rapid outcomes. Nevertheless, this same mechanism can also be used to block communication, obstruct innovation, foster negativity and delay, or even halt change.

A growing body of management theory and research on the informal organisational network supports the idea of interrelationships that enhance or constrain access to valued resources (Brass 1984; Krackhardt 1993; Ibarra 1993; Bouty 2000). Smart suggests that successfully managing project or product design and development activities may mean providing individuals with the skills and opportunities to enhance their own networks of relationships in different directions across the formal organisational chart (Smart, Brookes et al. 2001).

Our empirical research activities have informed the development of a managerial tool that allows organisations to obtain a boundary-based view of product development. The tool concept embraces the importance of collaboration to forming and maintaining productive relationships in any organisation and will improve product development performance by improving communication flows between product developers. Such a tool will help
organisations, and the individuals within them, to identify appropriate strategies for developing effective intra- and inter-organisational networks.

**Case Study Research**

In recent decades organisations in the aerospace industry, amongst others, have experienced change in terms of formal reorganisation, often utilising the implementation of strategies such as Design For Manufacture and Business Process Reengineering, for example. Company A is one of a number of industrial partners collaborating in the current research and is part of a large organisation in the aerospace industry, designing systems and equipment for major civil and military programmes of the western world. Engineers from five of Company A’s project teams have participated in the research to date, with involvement from further teams planned for the future.

Key issues on the organisational agenda encompass a) ensuring a profitable organisation, b) improving customer service, and c) increasing added value to customers. Collaboration in the research activity aims to address these issues, at least in part. An integral part of Company A’s process for achieving sustainable competitive advantage, this research is expected to assist in providing answers to the following questions:

- Why do some engineers outperform others?
- How does the organisation sell the value that engineering expertise brings?
- How does the organisation take the process-wise expertise and add an understanding of the above issues in order to lead the market?

**Research Methodology**

Research activities were conducted using Social Network Analysis (SNA) techniques within a standardised structure to facilitate comparison within and between the collaborating
organisations and the project teams therein. The SNA approach analyses and measures how interactions and communications occur between individuals and groups (Krebs 2002). It has been used successfully with reference to, amongst others:

- the brewing industry (Simpson and Mayo 1997)
- satisfaction issues (Flap and Volker 2001)
- information exchange (Haythornthwaite 1996)
- healthcare (Cattell 2001)
- issues of salary discrimination (Seidel, Polzer et al. Mar 2000)
- project management (Mead Dec 2001)

Initial data collection within Company A involved a series of individual interviews and group workshop sessions to engage subjects in a general discussion about their social network patterns. Subjects were subsequently surveyed by questionnaire to collect additional data about each of the relationships listed in their personal networks. Questionnaires were emailed as attached files for subjects to choose either on-screen completion and electronic return, or hardcopy print and postal return.

The initial data collection activities subsequently evolved to facilitate in-situ listing of contacts in personal networks, and to gain perceived levels of trust and success for each contact listed. Refinements to the data collection activities formed an iterative process and are included in the research findings.

Personal network data is collected as a matrix of relationship dyads, where a dyad is the unit of construct resulting from the interrelationship or link between two persons or points in a network (Lipnack and Stamps 1986). Morton et al speculate that “informal relationships are strengthened by trust, together with common experiences and a social context” (Morton,
Smart et al. 2002). Smart, Backhouse et al (2000) conclude that such relationships are strengthened by a range of dyadic properties that includes:

- trust - the degree of trust felt for the other person in each dyad
- respect - the degree of respect felt for the other person
- loyalty - the degree of loyalty felt for the other person
- strength - the strength of the relationship with the other person
- success - the extent to which interactions with the other person achieves a successful outcome

The concept of trust in relationships is the subject of a substantial body of research and does not lend itself easily to measurement (Lewis and Weigert 1985; Lyon 2000; Newton 2001). Nevertheless, trust can be measured through the analysis of resource sharing, added value and cost reductions, for instance, and is considered a key factor in effective supply chain management (Landry 1998).

The work of Jarvenpaa is of particular relevance in its investigation of trust in the context of a boundaryless network (Jarvenpaa, Knoll et al. 1998). So too is Nooteboom’s analysis of trust in teams or ‘communities of practice’ (Nooteboom and Six 2003), together with the growing body of research on ‘swift trust’ exemplified by that of Meyerson, Weick et al.(1996); Jarvenpaa and Leidner (1999); Hardt and Brynteson (1999); and Jarvenpaa and Staples (2001), amongst others.

Developed to explain behaviours in face-to-face temporary teams with no time to develop trust in gradual/cumulative fashion (Markus, 1994), ‘swift trust’ exhibits less emphasis on feeling, commitment and/or exchange and more emphasis on action, where action strengthens, and is both an important antecedent and outcome of, trust. Mayer et al (1995) predict that lack of action may be interpreted as lack of goodwill (benevolence), ability (to
communicate) and/or reliability & honesty (integrity). Jarvenpaa further forecasts that high levels of interaction will reduce ambiguity and uncertainty and strengthen trust in temporary teams (Jarvenpaa, Knoll et al. 1998). Moreover, McKenzie (2001) suggests that lack of interactive communication between employees, and between employees and the supply chain, inhibits the development of trust in relationships.

Measures of trust levels, together with other measures such as those for respect and strength for example, are construed as the properties of a network and aggregate to the social capital of the interrelationships within the network. Dess and Shaw (2001) conceptualise social capital as the network structure and social resources therein, while Nahapiet construes it as “the sum of actual and potential resources embedded within, available through, and derived from the network of relationships possessed by a social unit” (Nahapiet and Ghoshal 1998). Cohen and Prusak go further in their explanation and define social capital as “the stock of active connections among people: the trust, mutual understanding, and shared values and behaviors that bind the members of human networks and communities and make cooperative action possible” (Cohen and Prusak 2001).

Recent research observed that increasing trust/success in relationships was matched by a corresponding increase for success with other factors – eg duration of relationship, commonalties, method of contact used, social contact - with similar trends also in evidence for the properties of respect, loyalty and strength (Morton, Smart et al. 2002).

Our case study subjects were asked to catalogue the contacts utilised for work related activities and to give further details for each contact. Such details as, for example, the type of information exchanged, length of time known, location (internal/external to own organisation), frequency of contact, usual means of communication, and who generally initiates the contact. Subjects were also asked to provide perceived measures for the dyadic properties outlined earlier, contextual information for some of which is shown in table 1
below. Subjects’ perceptions of ‘success’ and ‘trust’, for example, were invited on a 4-point rating scale from 1 (no success/trust at all) to 4 (very much success/trust).

<table>
<thead>
<tr>
<th>Trust</th>
<th>How much is the person trusted to carry out what is expected in the relationship?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loyalty</td>
<td>Based on shared interactions, to what extent are feelings of loyalty held for the person?</td>
</tr>
<tr>
<td>Success</td>
<td>In terms of achieving effective results, how successful is the relationship?</td>
</tr>
<tr>
<td>Respect</td>
<td>In terms of role performed in relation to own role, how much respect is held for person’s knowledge &amp; experience?</td>
</tr>
</tbody>
</table>

Table 1. Properties of relationship dyads in context

Soft systems theory advocates incorporation of user participation and feedback loops into models/mechanisms to ensure end-user acceptance (Checkland 1988; Edge 1988). Our research activities also included conducting interim reviews with Company A’s senior managers, and with individual subjects and individual project teams at appropriate points during the research, together with an overall ‘summary review’ to which all those who had been involved in the research were invited.

Research Findings

Case study experiences were modelled as network topologies that depict individual measures of success and trust, utilising network attribute terms derived from the social network analysis and network theory research fields (Ibarra, Sackley et al. 1998; Burt 2000; Nohria and Eccles, 1992; and Scott 1991). For the purposes of this research a network hub – a central coordinating node for the ebb and flow of information and resources (Mintzberg and Van der Heyden 1999) – is defined as a node in the network cited by three or more of the respondents.
The most successful/most trusting relationships were observed to have the following characteristics:

- daily/weekly contact in relationships
- initial method of contact - face to face/telephone, although subsequent interaction may be via email
- contacts meet outside work by arrangement
- network owners share some commonalities with contacts
- length of relationship - 5 years or more

It was further observed that the least successful relationships use email as the main method of maintaining contact, with little or no evidence of prior face-to-face interaction.

Further findings from the case study research are summarised in Figure 1.
The greater the degree of perceived trust, the greater the degree of perceived success.

Relative to the total number of relationships in the network: the greater the number of hubs, the greater the aggregate measure for success.

The greater the density of a network, the greater is the perceived success of that network.

Dyadic property measures for mutual relationships differ between individuals.

Trust is the key element allowing individuals to live and work together without conflict (Cohen and Prusak 2001).

Success in a relationship dyad may be viewed as the perceived impact that the interrelationship has on performance.

Hubs are nodes that are centrally connected to the greatest number of people in the network and denote interactivity between people (Mintzberg 1999). The greater the level of interactivity, the more potential there is for relationships to develop over time and the greater the probability of achieving success.

Density is the extent to which the people in the network know/interrelate with each other. Methods for calculating network density rely on knowledge regarding the reciprocal nature of relationships (Ibarra et al. 1998).

Differences in perception of own/mutual relationships.

Figure 1. Research findings
Comparative analysis across network topologies further supported the concept of differences in perception. Figure 2 shows this as the construct resulting from the links reported by A and B with each other, together with their respective links with C, where the thicker the line, the greater the perceived level of success. Perceived trust is denoted by the colour (grey scale shade) of the line, where red (black) depicts no trust at all and green (grey) very much trust. The location of the arrowhead denotes the origin and direction of reported link. The arrowhead on the line that links A and C, for example, denotes A’s perception of the levels of success and trust in the relationship with C.

Thus:
- A reports no trust at all for/success in the relationship with C, while B trusts C very much and perceives a very successful relationship in terms of outcomes
- While A trusts B very much and perceives the relationship as very successful in terms of outcomes, B reports no trust at all for A and perceives no success at all from the relationship in terms of outcomes.

Figure 2. Differences in perception

Perceived levels of trust and success in own and mutual relationships were observed to differ within and between individuals, within and between project teams, and within and between organisations. While adhering strictly to the agreed policy on personal network confidentiality, the comparative analysis of network topologies unveiled a wealth of information for later discussion that, in turn, further informed tool development.

Refinement to the data collection process progressed through a series of iterations such that initial activities began to occur within a full day workshop: trust-building and information gathering in the morning – review and discussion of the resultant data in the afternoon. Over an extended lunch period, the researcher would construct a 3D rough draft visual
representation of the network topology that presented a ‘snapshot’ of team interaction for immediate discussion. A validated computer-based version was produced at a later date, utilising a range of software packages for subsequent printing of A1-size full-colour maps.

As the portfolio of large-scale snapshots increased so too did the opportunities for immediate comparison of networks. Such in-situ data handling and display required innovatory methods for data collection that would enable comparative analysis of category contacts and the differing perceptions of mutual relationships, while ensuring data confidentiality.

Workshop participants needed to feel confident about revealing highly-subjective personal perceptions, frequently in the company of some of the contacts to whom the information referred, safe in the knowledge that personal network data would remain between the researcher and the network owner and would not become part of the public domain. Without the trust, respect and loyalty of the very network the researcher was trying to delineate, it may have been difficult to gauge these attributes. The introduction of face to face workshops for initial activities proved to be very important in establishing high levels of trust between researcher and research subjects – the swift trust of temporary groups (Meyerson, Weick et al. 1996). This was evidenced by an increasing willingness of subjects to participate as the research progressed, and to provide the highly personal subjective perceptions central to the research activities.

**Discussion**

The ‘summary review’, to which all Company A personnel who had been involved in the research were invited, comprised 3 stages:

- Presentation of the findings
- Organisational perspective
- Discussion
Presentation of the findings from an academic perspective enabled the research team to show delegates how valuable were their contributions perceived, together with providing opportunities for further discussion that would inform future research. Figure 3 summarises the further feedback provided by the organisational ‘champion’ - a key member of the company’s senior management team - in the context of the organisational benefits accrued from/actions taken as a result of the tool’s practical application within Company A

**Figure 3. Benefits to the organisation**

The posing of the following questions terminated the presentation of the organisational perspective:

- How do we integrate networking into the everyday business?
- How do we regularly assess network performance?
- How do we spread the lessons learned?

Table 2 below provides a summary of the responses generated by the discussion that followed.
### Table 2. Discussion Responses

<table>
<thead>
<tr>
<th>Response</th>
<th>How to achieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team network appraisal process</td>
<td>• regular health checks</td>
</tr>
<tr>
<td></td>
<td>• planned schedule generated from start</td>
</tr>
<tr>
<td>Individual appraisals</td>
<td>• should address/encourage:</td>
</tr>
<tr>
<td></td>
<td>• network skills &amp; abilities</td>
</tr>
<tr>
<td></td>
<td>• team roles &amp; functions</td>
</tr>
<tr>
<td>Create space</td>
<td>• to build networks</td>
</tr>
<tr>
<td></td>
<td>• to appraise networks</td>
</tr>
<tr>
<td>Assist development of the team</td>
<td>• HR role</td>
</tr>
<tr>
<td></td>
<td>• adequate access to technical specialists</td>
</tr>
<tr>
<td></td>
<td>• inventory of people [team roles]</td>
</tr>
<tr>
<td></td>
<td>• disseminate lessons learned</td>
</tr>
</tbody>
</table>

**Conclusions and Further Research**

Case study project teams adopted different approaches, had different purposes for use of the tool and differed in its deployment. The findings suggest that the tool should be sufficiently generic such that it would address the requirements of any organisation. Figure 4 shows the infrastructure and the implications for implementation of the developed tool.
<table>
<thead>
<tr>
<th>Planning</th>
<th>Compliance with pre-requisites for use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoping</td>
<td>Information gathering</td>
</tr>
<tr>
<td>On-boarding</td>
<td>Introduction/negotiation, issues, schedules</td>
</tr>
<tr>
<td>Data Collection</td>
<td>FTF interviews/workshops, data collection, in-situ preliminary analysis</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>Quantitative – individual/aggregate measures</td>
</tr>
<tr>
<td></td>
<td>Qualitative – interviews, group work</td>
</tr>
<tr>
<td>Share findings</td>
<td>Feedback, discussion, contribution, way forward</td>
</tr>
<tr>
<td>Shape Networks</td>
<td>Organisational supported - action, guidance, evaluation</td>
</tr>
</tbody>
</table>

**Figure 4. Infrastructure of the management tool**

The actions taken by the organisation as a result of applying the managerial tool suggest that Company A exploited, or harnessed the power of, the informal organisation to improve product development performance, which provides support for the tool as a mechanism for management to:

- Visualise and manipulate the informal organisation
- Increase added value to the customer by improving intra- and inter-organisational relationships
Further Research

The network-building strategies of effective individuals will be investigated to identify the core skills required for effective relationship management. Further to the actions taken as a result of organisational participation, the potential to shape networks is being investigated in terms of aggregate measures (developing social capital, engendering trust), and individual measures (encouraging effective relationship management, changing the formal organisation, changing the individual).

Further investigation is being undertaken into the possibility of funding for the development of a bespoke software package to accelerate the mapping process and to meet the technical requirements of the developed tool.

It was also observed that case study project teams adopted different approaches, had different purposes for use, and differed in practical application of the tool. Additional work is also being undertaken to determine the myriad use of the developed tool and to further define its potential as a managerial tool for exploiting the power of relationship networks to improve performance in organisational areas external to that of project/product development.

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References


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