# THE NETWORK RESEARCHERS' NETWORK

## A Social Network Analysis of the IMP Group 1984-2006

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## Abstract

The Industrial Marketing and Purchasing (IMP) Group is a network of academic researchers working in the area of business-to-business marketing. The group meets every year to discuss and exchange ideas, with a conference having been held every year since 1984 (there was no meeting in 1987). In this paper, based upon the papers presented at the 22 conferences held to date, we undertake a Social Network Analysis in order to examine the degree of co-publishing that has taken place between this group of researchers. We identify the different components in this database, and examine the large main components in some detail. The egonets of three of the original 'founding fathers' are examined in detail, and we draw comparisons as to how their publishing strategies vary. Finally, the paper draws some more general conclusions as to the insights that SNA can bring to those working within business-to-business marketing.



## Keywords

Social Network Analysis, Business Network, IMP Group



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Networks seem to be everywhere. The importance of networks has been linked to the fabric of society itself (Kilduff and Tsai, 2003; Knox et al., 2006). Some authors claim that interactions with other individuals or organisations and the resulting embeddedness in structures of interlinked and web-like relationships are a dominant characteristic of modern life (Castells, 2000; Bauman, 2005). The same can be assumed of research communities: scholars are themselves held in a social network which they impact on and by which they are impacted upon. Such academics are not autonomous and self-guiding actors, but work within a social world (Bourdieu, 2004).

The challenge is therefore to understand academic knowledge-creation as a network, by uncovering the structures of the networks around academic activities (Bourdieu, 1990). These structures of social networks can be understood as 'fields of power' which influence knowledge and cultural production (Bourdieu, 1993). Therefore, following a 'social constructivist' view of scientific knowledge creation (Pinch and Bijker, 1984), we posit that analysing issues of 'content', 'output', or 'performance' of an academic network must start by focusing on its structure (Newman et al., 2003; Piselli, 2007). As Kilduff and Tsai have observed: "*the network of relationships within which we are embedded may have important consequences for the success or failure of our projects*" (2003:1-2). To understand the knowledge creation environment of one specific group of researchers, i.e. those of the Industrial Marketing &

Purchasing (IMP) Group, we will analyse the developing network characteristics of their conference paper co-authorships. Co-authorship is used over other possible relationship traits (e.g. citation, employed research theory or method; Cote et al., 1991; Robinson and Adier, 1981) because it implies a social bond (Eaton et al., 1999; Liu et al., 2005; Acedo et al., 2006; van der Merwe et al., 2007). Using the IMP Group as the focus of a network analysis is poignant in itself, as the academics who are loosely associated with this group can be characterised by their shared belief that issues of 'interactions', 'relationships', and 'networks' best characterise business-to-business exchanges (Ford and Hakansson, 2006). We use other networks of other groups of researchers as a reference point to discuss the specificity of the IMP Group network. We therefore add to and extend the work done in this field by Morlacchi, Wilkinson and Young (2005). However, our analysis is also meant to exemplify the method of Social Network Analysis (SNA) as an important tool for the analysis of organisational interactions and relationships.

Using co-authorship patterns as the unit of analysis for characterising network structures points to its (mainly) intentional character. As Vidgen, Henneberg and Naudé (2007) have pointed out: "*While the* **option** *to co-publish* […] *(instead of not publishing or publishing solipsistically) may be a function of serendipity, planning, co-incidence, etc., the* **decision** *to do so is that of human agency*." (p. 5, emphasis in original). In analysing the patterns of co-authorship, we will cover the whole time period of the formal existence of the IMP Group, from the beginning in 1984 through to 2006. We therefore use a longitudinal view of discreet datapoints (i.e. annual conferences) which represents the totality of all papers presented at the annual IMP Conference (and we thereby delineate artificially network boundaries). Papers presented at the Asia IMP conferences in 2002 and 2005 are excluded from our dataset. In order to understand the community of network researchers better, we ask what insights a social network analysis provides about the morphology and development of the network in terms of power, sub-groups, cliques, or structural holes, in order to understand how knowledge in the area of business networks has come about.

We try to understand more specifically the following research objectives:

- *How coherent is the IMP group community? Are there dominant components within the group? Does it show 'small world' characteristics?*
- *Is there a 'centre' around which, or from which, knowledge (and hence we might hypothesise, research strategy), is pushed out, or does the structure reflect a more random process?*
- *What are the 'collaboration strategies' of core individuals in the IMP group? Are these based on 'weak' or 'strong' ties?*
- *How can SNA be used by the IMP group?*

In the following section, we initially introduce and clarify the concept of social networks as well as the research method used, specifically how we deploy it for our analysis. We describe the growth of the IMP Group since its first meeting in 1984, examining the total number of papers and the percentage that are co-authored. From this set, the main component it extracted and examined. A number of individual-level centrality measures are given for the 50 most active co-authors in the database, and we then identify the main component based on strong ties. Finally, we compare the egonets of three of the 'founding fathers' of the IMP Group, drawing conclusions as to how their publishing strategy has varied. The paper ends with a discussion of the insights that SNA has given us, and briefly looks at the role that this type of techniques holds for researchers in the are of b2b marketing more generally.

## Social Networks and Social Network Analysis

Academic work is characterised by knowledge exchanges and interactions, i.e. it is a social process. The consumption of knowledge is necessarily a joint endeavour involving both creator and consumer. However, so too the creation of knowledge is often a joint process, involving multiple scholars. In fact, any perusal of refereed journal articles shows the majority of work to be co-authored (Newman, 2001). While this tendency to multi-authored papers is strongest in the natural sciences, it has also become the norm in social sciences and the humanities. The way in which the various authors interact in working to submit such conjoined work is therefore of some importance for the process of knowledge production itself (Bourdieu, 2004). The kind of structures and ties which develop consequently shape specific disciplines of academic work (Cross *et al*., 2001; Morlacchi *et al*., 2005). While anthropological enquiries are often used to get to grips with this question (Latour and Woolgar, 1986), we employ Social Network Analysis (SNA) to understand the governing principles of interactions in the IMP Group. Social networks and their structuralist analysis have been used in sociology and anthropology (Degenne and Forse, 1994; Wasserman and Faust, 1994; Berry *et al*., 2004; Moody, 2004) but have recently also been adopted in adjacent disciplines to analyse citation and co-publication patterns (Newman et al., 2003; Watts, 2004; Liu et al., 2005), e.g. in the broad area of management studies (Eaton et al., 1999; Morlacchi et al., 2005; Oh et al., 2005; Acedo et al., 2006; Carter et al., 2007, Vidgen et al, 2007).

The use of SNA allows us to analyse co-authorship networks in a systemic and formalised way "*by mapping and analysing relationships among people, teams, departments or even entire organisations*" (Cross *et al.,* 2001:103) with an interdependent web of actors and their actions

(Wasserman and Faust, 1994). We are initially interested in the shape, size, and characteristics of the network 'as it is', i.e. examining its overall morphology, before looking at individual level analyses (ego-nets).

## Research Method and Design

SNA comprises a broad range of cross disciplinary tools. This is linked to its historical development as emanating from a diverse range of academic disciplines, most notably from *Gestalt* theory, group dynamics, graph theory and anthropology (Scott, 2000; Berry *et al*., 2004; Knox et al., 2006; Piselli, 2007). In general, SNA can be defined as a structured way of analysing relationships within groups (Cross *et al*., 2002) by providing "*a rich and systemic means of assessing information networks by mapping and analysing relationships among people, teams, departments, or even entire organisations*" (Cross *et al*., 2001:103). SNA uses two main constructs: 'nodes' and 'linkages' in any network, with nodes representing data points (in our analysis these are authors), and the linkages characterising connectivity between the nodes (in our case, the linkage is evidence of two or more nodes being connected through having published work jointly in one of the IMP conferences).

Based on these two constructs, social networks can be analysed in many different ways, using ever more complex metrices. On the simplest level, the number of linkages between nodes represents the cohesiveness of the network as well as the notion of tie strength: if A has co-authored work with B, and also with C, then within a SNA there must be linkages between A and B and also between A and C. However, if A has written four papers with B but only one with C, then clearly the strength ('value') of the tie between A and B is stronger than that with C (see analysis below). Network density can provide an initial understanding of network characteristics or performance: Reagans and Zuckerman (2001) found in a study of corporate R&D teams that network productivity is related the average strength of the relationship among team members. However, they also found that the heterogeneity within a network, in this case relationships within any team which go beyond normal organisational boundaries, has positive performance impact. For SNA analyses of jointly published work Newman (2001) surveyed a range of academic subjects and demonstrates that many research networks form 'small worlds' of closely knit clusters of collaborating authors (Watts, 1999). Cross *et al* (2001) look at the productivity of such clusters with the result that some are much more productive and/or influential than others. Longitudinal studies of the evolution of social co-publication networks found that while many networks were growing over time, the average distance between any two players in fact decreases, in line with 'small world' characteristics (Barabási et al., 2002; Moody, 2004; Morlacchi et al., 2005).

## The IMP Conference data

The data source for our SNA was the proceedings of the annual IMP conferences from 1984 through 2006 (22 years). These were transformed into an IMP input database containing relevant information about nodes and linkages. Our unit of analysis is the co-authored conference paper, i.e. any IMP conference paper with two or more authors. The relationships (linkages) in the IMP data are *non-directional* and *valued*. A directional network would be appropriate when mapping friendship, for example, where person A identifies person B as a friend but person B does not reciprocally identify person A. However, co-authorship does not say anything about the direction of a relationship. Dichotomous relationships simply represent the presence or absence of a relationship, but do not assess the strength of the tie. The IMP data is valued as we use the frequency of co-authorship occurrences, with the implication that the higher the value then the stronger the tie between those actors (Granovetter, 1985). We therefore are able to use SNA methods which support valued ties (some SNA routines only work on non-valued data).

The UCINET and Pajek programmes are used for the SNA, together with the NetDraw programme for network visualization (see the websites www.analytictech.com, and vlado.fmf.uni-lj.si/pub/networks/pajek/). We used visual inspection of the data to identify and correct a number of miscodings in the original data entry (these were mostly misspellings of author name or inconsistency of author name representation such as the treatment of middle initials). As these numbers are only based on IMP conference co-authorship, it maybe that authors who do not appear in our dataset have published together in other journals. However, as the IMP conference is the most important forum for conference papers on business networks, we are confident that we cover the main structural relationships of the network researchers' network.

## Analysis and Findings

The development of the IMP community from 1984 through to 2006 is shown in Table 1. The *size* of the network is given by the number of actors, in this case the overall number of papers as well as the percentage of co-authored ones. The IMP input database which included the base data set for the social network analysis contains 2172 conference papers. Of these, 827 are by single authors, resulting in a population of 1345 co-authored research papers (61.9 per cent overall, varying between 27.5 to 76.2 per cent by year).

| Year | Conference | No. of conference papers | No. of co-authored papers | Percentage |
|---|---|---|---|---|
| *1984* | 1st IMP | 20 | 11 | 55.0% |
| *1985* | 2nd IMP | 40 | 11 | 27.5% |
| *1986* | 3rd IMP | 38 | 18 | 47.4% |
| *1988* | 4th IMP | 30 | 9 | 30.0% |
| *1989* | 5th IMP | 40 | 19 | 47.5% |
| *1990* | 6th IMP | 55 | 29 | 52.7% |
| *1991* | 7th IMP | 62 | 34 | 54.8% |
| *1992* | 8th IMP | 68 | 39 | 57.4% |
| *1993* | 9th IMP | 90 | 45 | 50.0% |
| *1994* | 10th IMP | 102 | 58 | 56.9% |
| *1995* | 11th IMP | 71 | 42 | 59.2% |
| *1996* | 12th IMP | 84 | 58 | 69.0% |
| *1997* | 13th IMP | 115 | 58 | 50.4% |
| *1998* | 14th IMP | 108 | 67 | 62.0% |
| *1999* | 15th IMP | 215 | 143 | 66.5% |
| *2000* | 16th IMP | 113 | 76 | 67.3% |
| *2001* | 17th IMP | 143 | 89 | 62.2% |
| *2002* | 18th IMP | 139 | 84 | 60.4% |
| *2003* | 19th IMP | 172 | 119 | 69.2% |
| *2004* | 20th IMP | 124 | 77 | 62.1% |
| *2005* | 21st IMP | 133 | 99 | 74.4% |
| *2006* | 22nd IMP | 210 | 160 | 76.2% |

*Table 1: Overview IMP Conference Papers 1984-2006*

While overall size (in terms of papers) has fluctuated somewhat, co-authorship has tended to increase over time (with 1985 and 1988 being outliers). In order to assess the relationship between number of papers presented at a conference and the probability that a paper is co-authored, we ran a linear regression model. Figure 1 shows that the more papers are submitted, the higher the percentage of co-authored papers, in line with findings co-authorship networks of management and organizational behaviour researchers (Acedo et al., 2006). In the case of the IMP group, this may be due to the fact that there are only a limited number of scholars working within the ‘core paradigm’ of interaction, relationships, and networks. Therefore, in order to increase their productivity, they tend to rely on synergies through collaborative research and publications. Other proposed reasons, i.e. the increase in quantitative studies, may be less important for the IMP group as it is dominated by qualitative studies (Ford and Hakansson, 2006).

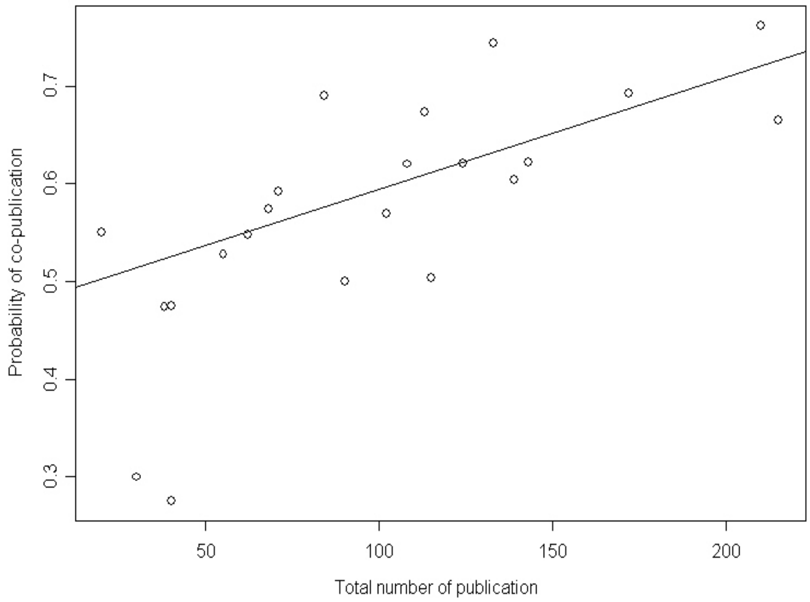


*Figure 1: Relationship between percentage of co-authored papers in conference (Prob) and overall number of papers in conference (PaperNo);* [Prob = 0.4799 + 0.0011*PaperNo., $R^2$ = 0.526]

We found that the average number of co-publications per author was 1.92 over the 22 year period, with a standard deviation of 3.12. The maximum number of co-authored papers by any one member was 32 by WILK[1]. The average number of authors with whom another author has collaborated in producing co-published papers is = 2.17. The maximum of people who any one actor had co-authored with was 28 in the case of JOHN1 - this being the definition of 'neighbourhood size' below. However, the IMP Group network is not fully connected. A number of subsets exist for which there are no paths between authors in one subset and authors in another

[1] Authors are identified in a list in the appendix.

subset (i.e. there exist different clusters or components). Wassermann and Faust (1994) refer to components of a network as a maximal connected subgraph, i.e. a path exists between all authors in the subgraph (all nodes are reachable) and there is no path between a node in the component and any node outside the component. The main component is the component with the largest number of actors. According to Table 2, by 2006 there were 1653 authors in the network who had publications, of which 1402 had co-published, with 723 in the main component. Note that this is a cumulative result. The fact that nearly half of all actors are in the main component is in line with results from other 'established' co-authorship networks (Newman, 2001; Liu et al., 2005).

| *Year* | **Conference** | **No. of actors in network** | **No. of actors in main component** | **Percentage** | **Density of main component** | **Diameter of main component** |
|---|---|---|---|---|---|---|
| *1984* | 1st IMP | 30 | 4 | 13.3% | 0.6667 | 2 |
| *1985* | 2nd IMP | 70 | 7 | 10.0% | 0.3810 | 3 |
| *1986* | 3rd IMP | 109 | 9 | 8.3% | 0.2778 | 3 |
| *1988* | 4th IMP | 141 | 10 | 7.1% | 0.2444 | 4 |
| *1989* | 5th IMP | 173 | 19 | 11.0% | 0.1170 | 6 |
| *1990* | 6th IMP | 223 | 25 | 10.0% | 0.0900 | 8 |
| *1991* | 7th IMP | 272 | 38 | 11.2% | 0.0612 | 9 |
| *1992* | 8th IMP | 353 | 42 | 11.9% | 0.0557 | 9 |
| *1993* | 9th IMP | 397 | 62 | 15.6% | 0.0386 | 11 |
| *1994* | 10th IMP | 481 | 67 | 13.9% | 0.0366 | 12 |
| *1995* | 11th IMP | 523 | 87 | 16.6% | 0.0297 | 15 |
| *1996* | 12th IMP | 590 | 117 | 19.8% | 0.0227 | 16 |
| *1997* | 13th IMP | 681 | 133 | 19.5% | 0.0197 | 15 |
| *1998* | 14th IMP | 756 | 153 | 20.2% | 0.0179 | 12 |
| *1999* | 15th IMP | 951 | 243 | 25.6% | 0.0118 | 15 |
| *2000* | 16th IMP | 1018 | 274 | 26.9% | 0.0108 | 14 |
| *2001* | 17th IMP | 1119 | 313 | 28.0% | 0.0096 | 13 |
| *2002* | 18th IMP | 1185 | 339 | 28.6% | 0.0093 | 13 |
| *2003* | 19th IMP | 1310 | 451 | 34.4% | 0.0070 | 12 |
| *2004* | 20th IMP | 1390 | 558 | 40.1% | 0.0057 | 20 |
| *2005* | 21st IMP | 1488 | 627 | 42.1% | 0.0052 | 19 |
| *2006* | 22nd IMP | 1653 | 723 | 43.7% | 0.0046 | 25 |

*Table 2: Basic characteristics of IMP Conferences*

The growth of the main component is also shown, as well as the proportion of the main component to the entire network. In 2006, nearly 44 per cent of all actors were part of the biggest component, an increase from around 10 per cent in the first 8 years of the conference. *Density* of the network refers to the number of connections between nodes. If there are no connections between any of the nodes in a network then density is zero. On the opposite extreme, if each node is connected to every other node, the density is one. Density quickly drops with time as relationships are added over the years, down to less than 1 per cent by 2006. The asymptotic convergence towards 0.0 indicates a sparsely connected network. The *diameter* of the network is the length of the largest geodesic distance between any pairs of nodes in a graph, with the geodesic distance being the shortest path between any two nodes (Wasserman and Faust, 1994). Hence, the diameter is the 'longest shortest' path between two nodes in a network. This is an informative measure because it provides an approximation of the time and effort it would take for information (e.g. the use of new concepts or research methods) to pass through the network. 'Small-worlds' (with a small diameter) are clearly more efficient in communication (Watts, 1999). The diameter of the main component by 2006 has reached 25. Similar to other research networks, this indicates that the IMP network is anything but small (Liu et al., 2005; Vidgen et al., 2007).

The following analysis will refer to the cumulative network as shown for 2006. Table 3 presents all components which have more than 7 actors. All other components, except for the main one, do indeed display small-world properties (diameters of 5 or lower). However, this can be a spurious phenomenon: if only one of the members of these smaller components co-authors a paper with an actor from the main component, the smaller component will be sub-merged into a ‘large world’ (and it is for this reason that networks will usually contain a single large component) (Newman, 2001; Watts, 2003; Vidgen et al., 2007).

| *Component* | **No. of actors** | **Density** | **Diameter** |
|---|---|---|---|
| *1* | 723 | 0.0046 | 25 |
| *2* | 13 | 0.2308 | 4 |
| *3* | 10 | 0.3111 | 2 |
| *4* | 10 | 0.2444 | 5 |
| *5* | 9 | 0.3056 | 4 |
| *6* | 8 | 0.4643 | 2 |
| *7* | 8 | 0.4286 | 2 |
| *8* | 8 | 0.2857 | 5 |
| *9* | 8 | 0.2857 | 4 |
| *10* | 8 | 0.2857 | 4 |

*Table 3: Main Co-Authorship Component Characteristics (based on cumulative data)*

## Centrality measures

An ego analysis provides further insights into individual actors within the network. Table 4 shows a range of node-relevant measures of *centrality* for the top 50 members of the main component (i.e. the 723 actors identified in Table 3).

*Degree centrality* is a measure of the number of direct ties that an actor has (Freeman, 1979), therefore, the higher the number, the more active that author is. This takes account of the value of the ties between co-authors, in this case the number of times that an actor has co-authored with another actor. High level of degree centrality can suggest gregariousness or popularity, or can be an indication of the probability of receiving information. *Neighbourhood size* refers to the number of other actors with whom someone had links. *Betweenness centrality* is the extent to which an actor benefits from being on the shortest path (the geodesic distance) between other actors (Freeman, 1979).This is the number of times that an actor needs another given actor to reach any other actor by the shortest path. High levels of betweenness mean that actors control the flow of information as gatekeepers or intermediaries. Freeman et al. (1980) note that high betweenness score indicate individuals who are perceived as leaders in a network. *Closeness centrality* can be interpreted as a measure of 'farness' which is based on the sum of geodesic distances of an actor to all other actors in the network. The reciprocal of the sum is closeness centrality. The results are further normalized as a percentage of the minimum possible closeness for each actor (Borgatti et al. 2002), which equals $1/(n-1)$ (where $n$ is the number of actors). Actors with higher closeness scores are likely to receive information more quickly and reliably than other actors due to the fact that less intermediaries are involved. The measure of *Reach centrality* calculates the percentage of nodes in the network that the focal node can reach in a given number of steps. In our case, we look at two or three steps (e.g. WILK can reach nearly half of the main component in three steps). The *eigenvector centrality* is a recursive version of degree centrality. It characterises an actor as central to the extent that connectedness exists with other central actors (Bonacich, 1972; Scott, 2000). An actor with a high eigenvector centrality score in a co-publication network is connected to many other actors who are well connected and thus are most likely to be receiving new ideas. Finally, *flow betweenness* is an extension of the betweenness concept (Freeman et al., 1991). It considers all the relationships between actors (not just the geodesic one). Flow betweenness also takes into account the value of relations, i.e. it separates weak and strong ties. It is therefore an interesting measure for the IMP Group data, in the sense that an otherwise central actor (HAKA) scores relatively low on this measure. Formally defined, flow betweenness is a measure of the extent to which the flow between other pairs of actors in the network would be reduced if a particular actor were removed (Freeman et al., 1991). It measures the 'contribution' of an actor to the flow within a network (Zemljič and Hlebec, 2005).

| | Degree centrality | | Neighbour-hood size | | Betweennes centrality | | Closeness centrality | | Reach centrality | | | | Eigenvector centrality | | Flow betweenness | | Structural hole | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | two-step | | three-step | | | | | | | |
| *1* | WILK | 49 | JOHN1 | 28 | WILK | 28.82 | WILK | 26.18 | WILK | 0.211 | WILK | 0.475 | HAKA | 51.96 | JOHN1 | 7.12 | JOHN1 | 26.93 |
| *2* | NAUD | 44 | HAKA | 24 | HAKA | 24.65 | HAKA | 25.65 | HAKA | 0.184 | HAKA | 0.468 | WILK | 39.30 | ROKK | 5.96 | WILK | 22.42 |
| *3* | GEMU | 43 | WILK | 24 | RITT | 18.54 | HAVI | 24.90 | RITT | 0.179 | HAVI | 0.429 | DUBO | 32.74 | WILK | 5.93 | HAKA | 21.92 |
| *4* | PEDE | 42 | GEMU | 20 | MOLL | 13.35 | RITT | 24.73 | HAVI | 0.159 | RITT | 0.428 | PEDE | 30.87 | MOLL | 5.45 | NAUD | 18.40 |
| *5* | TURN | 40 | MOLL | 20 | HAVI | 12.60 | GEMU | 23.92 | TURN | 0.133 | NAUD | 0.388 | HAVI | 28.93 | WATH | 4.74 | MOLL | 18.30 |
| *6* | MOLL | 40 | NAUD | 20 | TURN | 12.46 | FORD | 23.47 | NAUD | 0.127 | GEMU | 0.363 | GEMU | 28.48 | SHAR | 4.53 | GEMU | 17.90 |
| *7* | HAKA | 37 | SALL | 19 | NAUD | 10.84 | NAUD | 23.42 | MOLL | 0.120 | TURN | 0.353 | GADD | 24.57 | JOHA2 | 4.26 | SALL | 17.21 |
| *8* | HOLM2 | 35 | DUBO | 19 | JOHA1 | 10.26 | JOHN1 | 22.94 | DUBO | 0.114 | JOHN1 | 0.339 | RITT | 24.12 | BION | 4.16 | DUBO | 17.00 |
| *9* | SALL | 35 | RITT | 18 | JAHR | 9.62 | JOHA1 | 22.91 | JOHA1 | 0.109 | FORD | 0.338 | HOLM2 | 22.21 | WILS | 4.10 | RITT | 16.22 |
| *10* | YOUN | 35 | ANDE1 | 17 | SALL | 8.87 | TURN | 22.86 | SALL | 0.107 | EAST | 0.327 | JOHN1 | 18.81 | TURN | 3.92 | EAST | 15.25 |
| *11* | DUBO | 34 | EAST | 16 | JOHN1 | 8.65 | HARR1 | 22.85 | HARR1 | 0.104 | HIBB1 | 0.324 | HARR1 | 17.95 | ULVN | 3.88 | ARAU | 15.25 |
| *12* | RITT | 33 | ARAU | 16 | FLYG | 8.52 | HIBB1 | 22.73 | GEMU | 0.102 | JOHA1 | 0.321 | FORD | 17.01 | NAUD | 3.71 | ANDE1 | 14.29 |
| *13* | GADD | 33 | TURN | 15 | ARAU | 7.90 | EAST | 22.70 | YOUN | 0.102 | MOLL | 0.319 | HIBB1 | 16.89 | TORN | 3.55 | TURN | 14.07 |
| *14* | EAST | 31 | ALAJ | 15 | ROKK | 7.66 | DUBO | 22.66 | HIBB1 | 0.101 | LEEK | 0.317 | YOUN | 16.74 | WELC | 3.51 | YOUN | 13.27 |
| *15* | ANDE1 | 30 | PEDE | 15 | FORD | 6.83 | MOUZ | 22.65 | JOHN1 | 0.101 | MOUZ | 0.307 | ARAU | 16.69 | HALL | 3.36 | ALAJ | 13.13 |
| *16* | FORD | 30 | YOUN | 15 | TAHT1 | 6.51 | TUNI | 22.57 | ARAU | 0.101 | MATT | 0.302 | TUNI | 16.47 | FLET | 3.29 | FORD | 13.00 |
| *17* | COVA | 29 | HAVI | 15 | EAST | 6.29 | GADD | 22.56 | LEEK | 0.096 | HARR1 | 0.299 | WALU | 16.39 | EAST | 3.25 | HAVI | 12.87 |
| *18* | JOHN1 | 29 | FORD | 14 | WATH | 6.18 | ARAU | 22.48 | FORD | 0.093 | GADD | 0.292 | JOHA1 | 16.33 | JOHA1 | 3.22 | WILS | 12.85 |
| *19* | ARAU | 29 | GADD | 14 | DUBO | 6.18 | MOLL | 22.34 | GADD | 0.091 | AXEL | 0.292 | EAST | 15.97 | SOLB | 3.12 | JOHA2 | 11.92 |
| *20* | HAVI | 28 | TAHT1 | 13 | WILS | 6.12 | SNEH | 22.32 | EAST | 0.091 | DUBO | 0.291 | TORV | 14.97 | ARAU | 3.06 | GADD | 11.71 |
| *21* | ALAJ | 25 | JOHA2 | 13 | ALAJ | 5.97 | MATT | 22.07 | MATT | 0.090 | ARAU | 0.287 | HULT | 13.48 | FANG | 2.93 | PEDE | 11.67 |
| *22* | TAHT1 | 23 | WILS | 13 | ANDE1 | 5.84 | FREY | 21.88 | PEDE | 0.090 | SNEH | 0.287 | JAHR | 13.36 | ANDE1 | 2.82 | TAHT1 | 11.31 |
| *23* | MATT2 | 23 | COVA | 13 | BION | 5.66 | ZOLK | 21.85 | MOUZ | 0.087 | TUNI | 0.281 | ANDE1 | 13.29 | GEMU | 2.81 | COVA | 11.31 |
| *24* | BARR | 23 | KOCK | 12 | JOHA2 | 5.64 | PEDE | 21.82 | TAHT1 | 0.078 | SALL | 0.280 | MATT | 12.87 | OWUS | 2.73 | KOCK | 10.67 |
| *25* | LEEK | 20 | HARL | 12 | HALL | 5.55 | LEEK | 21.75 | ANDE1 | 0.078 | PEDE | 0.267 | SNEH | 12.55 | DURR | 2.73 | KJEL2 | 9.73 |
| *26* | MAND | 20 | HOLM2 | 12 | ULVN | 5.41 | WALU | 21.70 | ALAJ | 0.076 | ZOLK | 0.265 | NAUD | 11.73 | SALL | 2.65 | TORN | 9.60 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *27* | HARL | 20 | KJEL2 | 11 | DAMG | 5.27 | HALI1 | 21.68 | ZOLK | 0.075 | FREY | 0.263 | AXEL | 11.39 | HAKA | 2.65 | BREN | 9.55 |
| *28* | CALD | 19 | BREN | 11 | TORN | 5.19 | YOUN | 21.68 | SNEH | 0.075 | HALI1 | 0.262 | PREN | 11.00 | SPEN | 2.62 | FREY | 9.40 |
| *29* | RAJA | 19 | CALD | 11 | FREY | 4.95 | ANDE3 | 21.60 | SALM | 0.072 | YOUN | 0.245 | SALM | 10.82 | MCLO | 2.59 | HERT | 9.40 |
| *30* | MOUZ | 19 | HERT | 10 | MOUZ | 4.95 | AXEL | 21.60 | HALI1 | 0.072 | VAAL | 0.245 | RAES | 10.75 | WELC3 | 2.44 | HALL | 9.00 |
| *31* | KOCK | 18 | FREY | 10 | WELC | 4.89 | SALM | 21.57 | PARD | 0.071 | WALU | 0.244 | ROOS | 10.75 | FREY | 2.43 | MATT | 8.80 |
| *32* | JOHN3 | 18 | ANDE2 | 10 | HARR1 | 4.82 | JAHR | 21.57 | ANDE2 | 0.069 | SALM | 0.242 | BYGB | 10.67 | YOUN | 2.39 | PURC | 8.80 |
| *33* | SALM | 17 | MATT | 10 | SHAR | 4.64 | ANDE1 | 21.54 | AXEL | 0.069 | BREN | 0.242 | BOER | 10.60 | KOCK | 2.38 | JOHA1 | 8.80 |
| *34* | MATT | 17 | ANDE3 | 10 | GEMU | 4.61 | VAAL | 21.48 | TORN | 0.069 | ANDE3 | 0.240 | KALL | 10.60 | MAND | 2.37 | HOLM2 | 8.67 |
| *35* | BREN | 17 | WELC3 | 10 | FLET | 4.47 | BREN | 21.26 | TUNI | 0.066 | TAHT1 | 0.235 | ZOLK | 10.49 | KRIZ | 2.35 | WELC3 | 8.40 |
| *36* | LILL | 17 | PURC | 10 | COVA | 4.39 | TAHT1 | 21.24 | JAHR | 0.066 | ANDE1 | 0.231 | BARA | 10.47 | ANDR | 2.27 | HART | 8.40 |
| *37* | KJEL2 | 17 | JOHA1 | 10 | SOLB | 4.35 | CHER | 21.20 | WALU | 0.066 | JAHR | 0.230 | HAUG1 | 10.43 | FORD | 2.25 | SPEN | 8.33 |
| *38* | FREY | 16 | TORN | 10 | HALI1 | 4.34 | PARD | 21.14 | FREY | 0.065 | CHER | 0.230 | FOLG | 10.43 | ALAJ | 2.16 | ANDE2 | 8.20 |
| *39* | WILS | 16 | HART | 10 | FANG | 4.08 | WEDI | 21.12 | WYNS | 0.065 | PARD | 0.226 | CANT1 | 10.43 | RITT | 2.13 | HARL | 8.17 |
| *40* | JOHA2 | 16 | HALL | 10 | SPEN | 3.85 | FLET | 21.02 | ANDE3 | 0.064 | WELC | 0.226 | ANDE2 | 10.32 | REUN | 2.12 | ERIK2 | 8.11 |
| *41* | ANDE2 | 16 | ZOLK | 9 | DURR | 3.81 | HART | 20.99 | DAMG | 0.064 | WEDI | 0.223 | TURN | 10.28 | TAHT1 | 2.10 | ANDE3 | 8.00 |
| *42* | HART | 15 | LILL | 9 | OWUS | 3.81 | BARR | 20.98 | SPEN | 0.061 | FLET | 0.220 | GRES | 10.18 | ZERB | 2.02 | BARR | 7.89 |
| *43* | WELC3 | 15 | SPEN | 9 | MATT | 3.70 | WELC | 20.97 | VALK | 0.061 | WELC3 | 0.220 | SUND | 10.06 | ERIK2 | 1.99 | MAND | 7.89 |
| *44* | SEPP | 15 | BYGB | 9 | BREN | 3.63 | HENN | 20.97 | BREN | 0.060 | WELC2 | 0.220 | JONS | 10.06 | PURC | 1.98 | DAMG | 7.89 |
| *45* | HERT | 15 | HARR1 | 9 | WEDI | 3.62 | WELC3 | 20.95 | HOLM2 | 0.058 | BARR | 0.217 | FORB | 9.89 | PARD | 1.87 | PARD | 7.67 |
| *46* | FLET | 15 | PARD | 9 | ANDE3 | 3.59 | WALT | 20.94 | WEDI | 0.058 | SHAR2 | 0.216 | WALT | 9.43 | CAMP | 1.84 | ZOLK | 7.22 |
| *47* | JOHA1 | 15 | SEPP | 9 | ZOLK | 3.43 | HELF | 20.93 | WILS | 0.055 | GLAS | 0.216 | FREY | 9.38 | HEDA | 1.82 | SHAR | 7.00 |
| *48* | WALT | 15 | ERIK2 | 9 | PARD | 3.33 | HEYD | 20.93 | WELC3 | 0.054 | MORL | 0.216 | WELC3 | 9.36 | SCHU | 1.79 | CALD | 7.00 |
| *49* | HALL | 15 | MAND | 9 | KOCK | 3.29 | MULL | 20.92 | BYGB | 0.054 | WILE | 0.216 | BANG | 9.35 | CAST1 | 1.77 | HARR1 | 7.00 |
| *50* | HALI1 | 15 | BARR | 9 | MAND | 3.29 | RYSS | 20.92 | BANG | 0.053 | WYNS | 0.215 | HART | 9.32 | HART | 1.76 | SEPP | 6.78 |
| **Average of the main component** | | 4.9 | | 3.3 | | 0.74 | | 16.50 | | 0.023 | | 0.079 | | 2.42 | | 0.37 | | 2.39 |

*Table 4: Centrality Measures and Rank Order by Author*

Using these centrality measures for our IMP Group data, Table 4 provides an overview of the key players. WILK and HAKA dominate most of the centrality measures. However, JOHN1 with a high neighbourhood size leads the flow betweenness indicator. It is also noteworthy that one important IMP author, FORD, has relatively low centrality scores ($16^{th}$ for degree, $15^{th}$ for betweenness, $37^{th}$ for flow betweenness). Other actors such as ROKK and MOLL occupy cut-points in the network (represented by high flow betweenness), who, if removed, would lead to fragmentation of the main component into sub-components. Flow betweenness is arguably a particularly useful measure of centrality (it represents 'who counts') as it takes account of tie strength. We show visually the main component in Figure 2, where the node (actor) size has been differentiated by the size of the bubbles using neighbourhood size scores from Table 4.

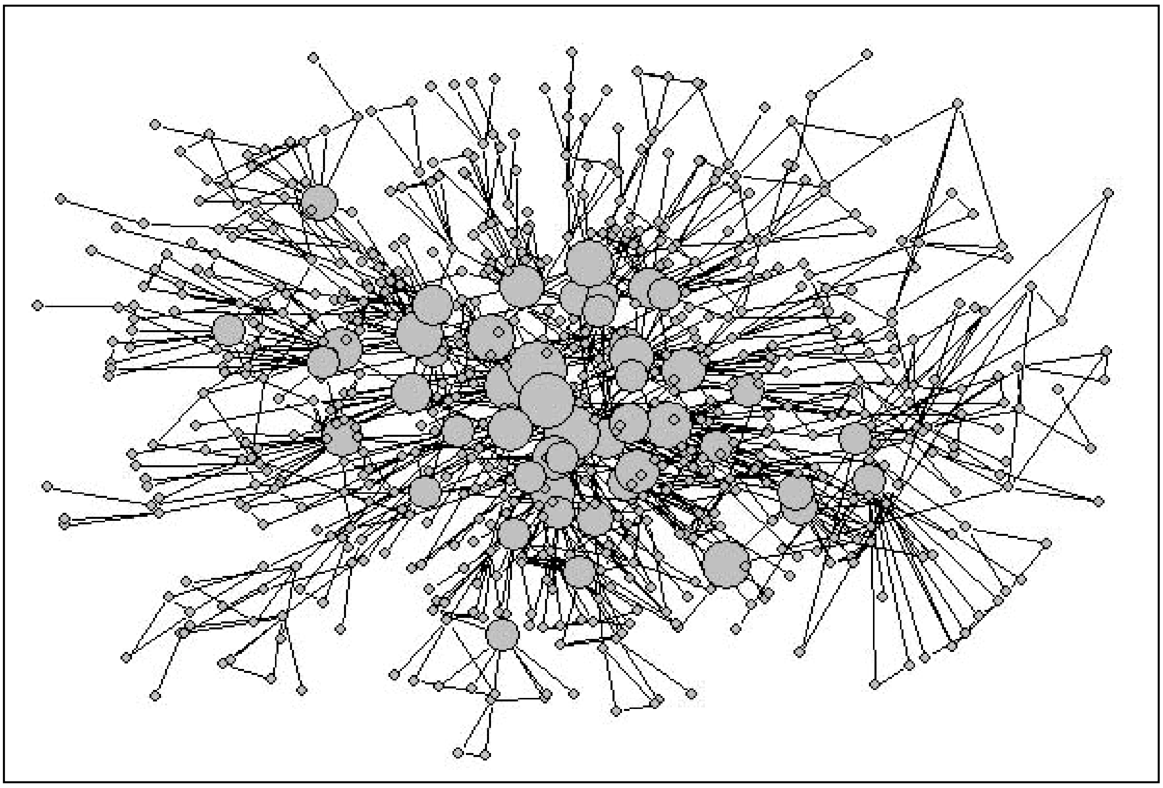

*Figure 2: Main component IMP Group co-authorships (using neighbourhood size to differentiate nodes; based on Pajek)*

Visual inspection of the main component shows a relatively robust network structure (e.g. compared to the co-publication network of ICT researchers presented in Vidgen et al., 2007), based on a lower diameter value (25 for IMP compared to 31 for ICT).

## Weak and strong ties

According to Granovetter (1973), weak ties are indispensable for an actors' integration into a community. This is due to the fact the personal experience of actors is bound up with the larger social structure in which they are embedded. Weak ties are essential for the flow of information which integrates otherwise disconnected social clusters (Burt, 1992). While strong ties support the high-speed circulation of information and local cohesion, they also lead to an overall fragmentation of the social network (Granovetter, 1973). Although there is no definitive view of what constitutes a strong link in the social network or interaction literature (Jack, 2005), one can introduce cut-off points defining when any two actors have strong ties, e.g. co-authorship occurring three or more times. Such a parsimonious proposition creates radically different networks. When this is done, the main component comprises a mere 27 actors (Figure 3), in which FORD, TURN, NAUD, and WILK occupy central positions. However, ARAU (via MOUZ and EAST) resides in a crucial linking position which makes this large component in the first place. Of the centrally important actors, only HAKA (who is in the second largest strong-tie component with 11 actors) and JOHN1 (who is not in one of the larger strong-tie components) are missing from this main component. Imposing an even more severe constraint on tie strength (having a minimum of either 4 or 5 co-publications) the main component shrinks to just 8 or 7 actors respectively. The local cohesion of such groups is indeed strong and indicative of sustained collaboration over a period of time, indicating what Burt (1982) called 'invisible colleges' as centres of knowledge creation. However, according to Granovetter (1973), it is the weak ties (which are beyond the control of particular individuals) from which the community is forged.

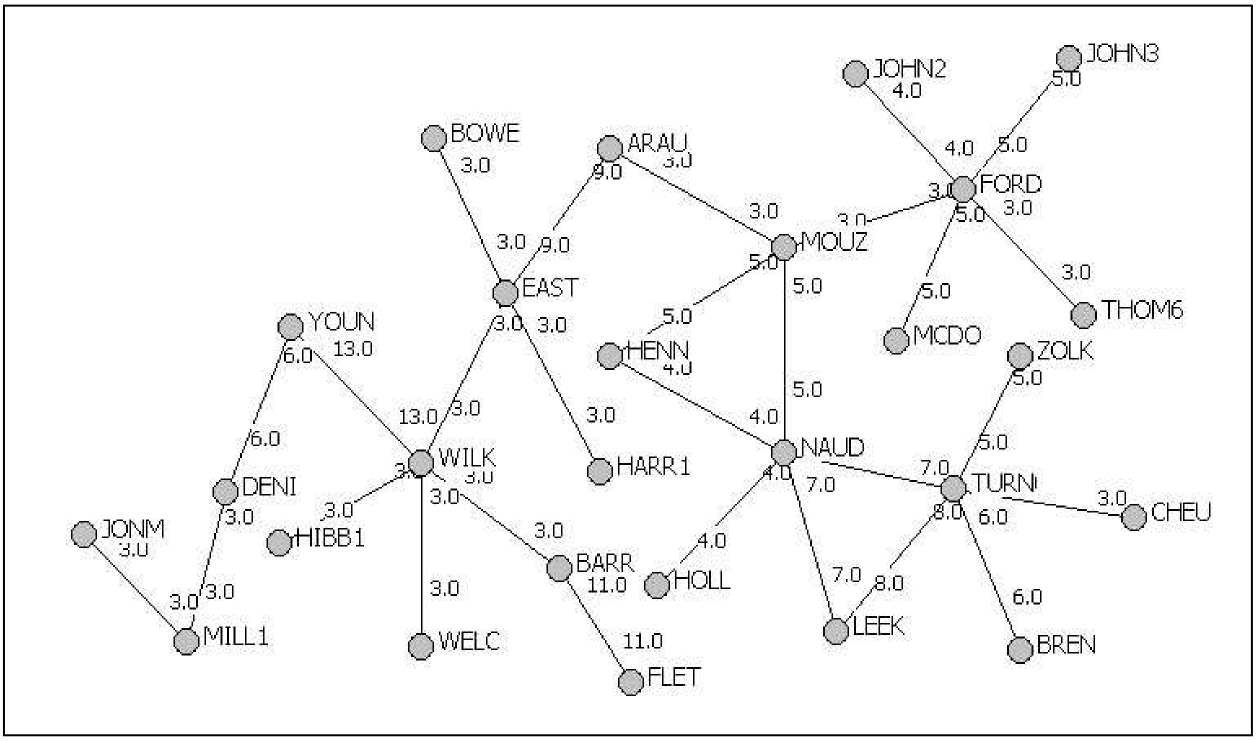


*Figure 3: Main component based on strong ties (three or more IMP conference co-authorships)*

## Egonet strategies

Looking at co-authorship patterns over time allows for the emergence of structure in the individual's publication preferences. While these may only be ascribable in very limited ways to an intentional strategy, these structures nevertheless provide some insight into the network environment in which individuals operate. We use three important scholars from the IMP community, all of whom are 'founding fathers' of the group and have continued over the last 25 years to stimulate research in the area: two whom our analysis has consistently shown to dominate most centrality measures (HAKA and JOHN1), while the third (FORD), as has been noted before, is only found to exhibit lower centrality scores.

HAKA's and JOHN1's egonets (see Figures 4 and 5) are characterised not just by many direct publishing partners (24 and 28 respectively), compared to FORD's egonet (see Figure 6), but they also show that many of their co-authors themselves published with each other (without HAKA's or JOHN1's collaboration). This is especially pronounced in HAKA's egonet (25 co-author interconnections, compared to 15 for JOHN1). However, the FORD egonet shows higher tie values, i.e. multiple co-publications with the same person. He has published three or more times with 36 per cent of his co-authors, while the same ratio is nil for JOHN1 and 13 per cent for HAKA. Therefore, FORD's co-authorship network is based on stable and strong ties, contrasting with the weak tie-based pattern exhibited by JOHN1.

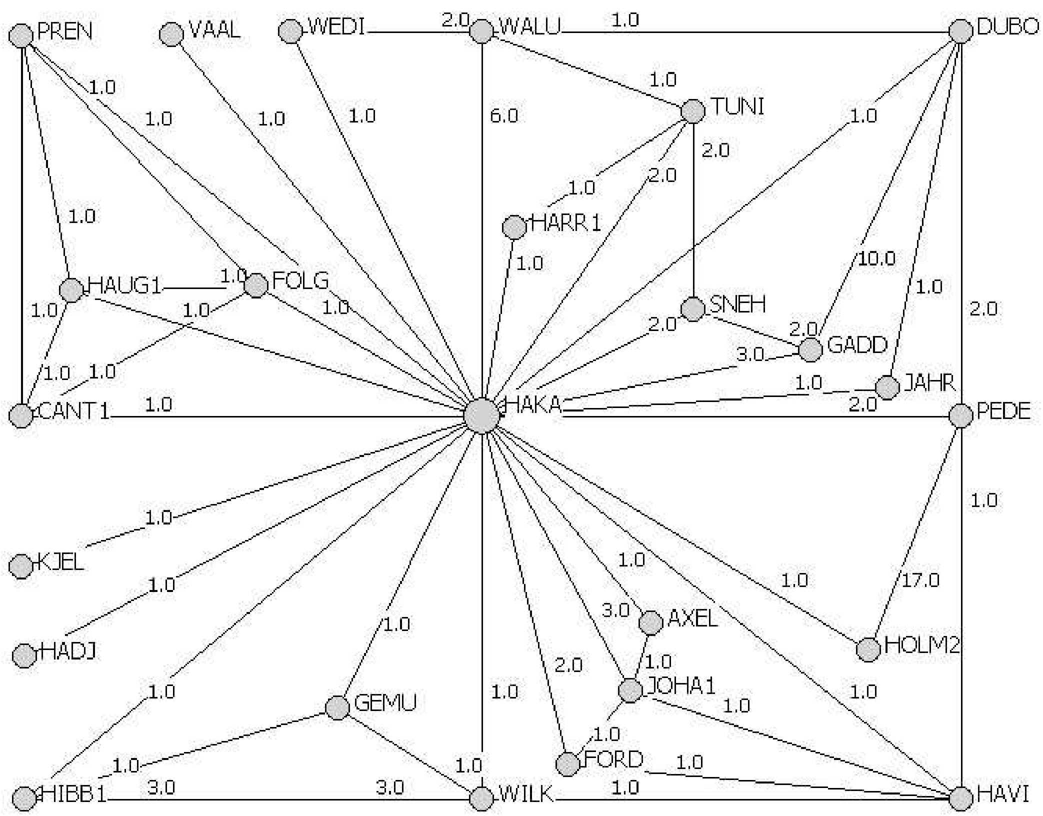


*Figure 4: Egonet HAKA*

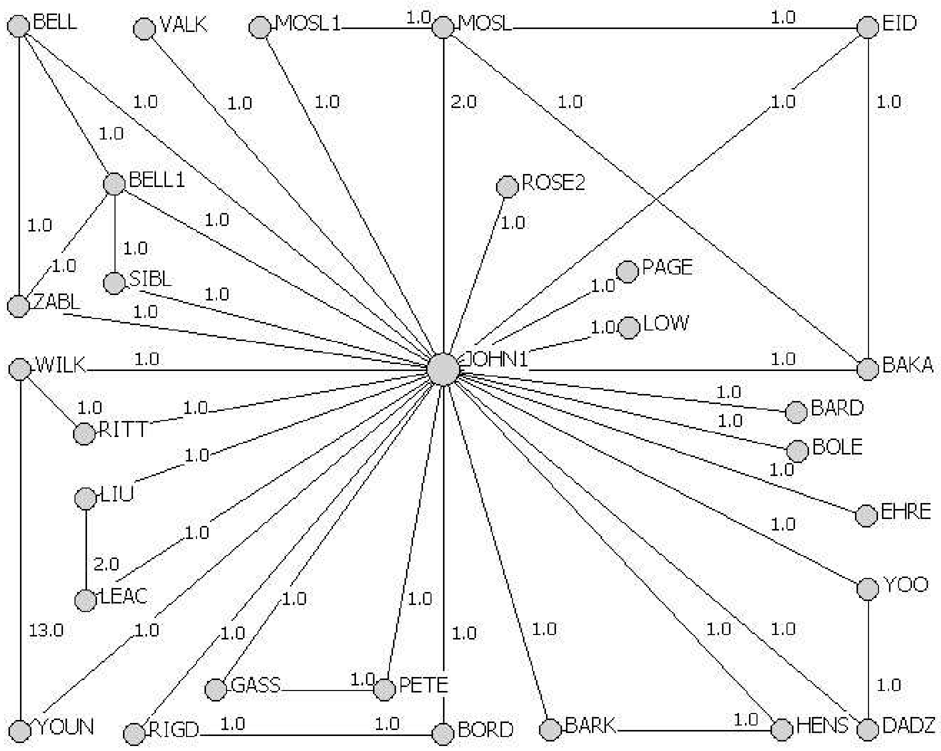


*Figure 5: Egonet JOHN1*

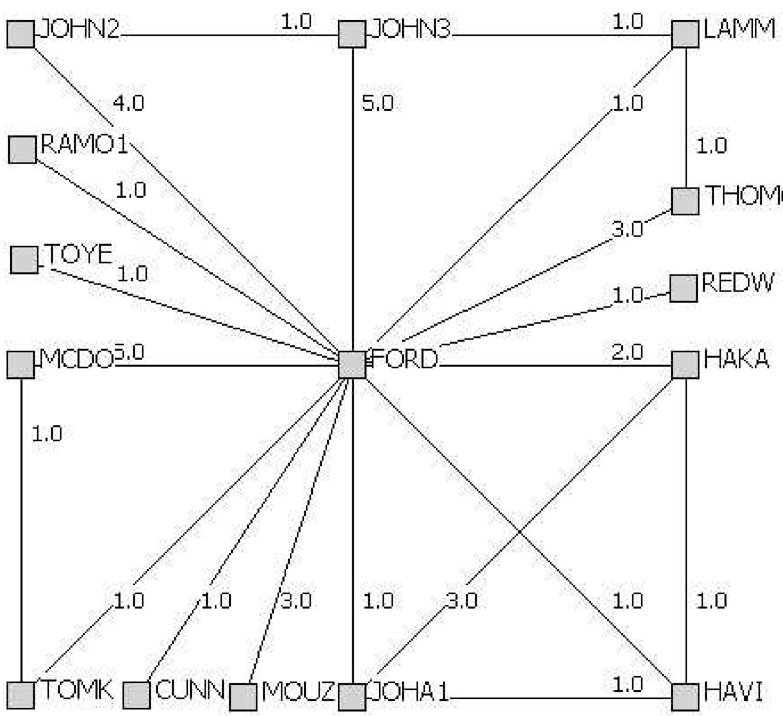


*Figure 6: Egonet FORD*

## Conclusion and Implications

Our results point to a number of interesting issues concerning the structure of the IMP Group's research activities. The number of papers shows an increase over time, as do the number of co-authored papers. However, the IMP Group has grown far more slowly than the ICT Network reported by Vidgen et al. (2007). The ICT network started in 1993 (vs. 1984), and has 2009 actors vs. the IMP Group's 1653. In addition, they had 588 in the main component, against the 723 reported above, indicating less cohesion: The IMP Group has 43.7% of actors in the core, the ICT Group only 29.3%. This would indicate a higher 'core' within the IMP Group, where there are less small clusters 'doing their own thing.' This would indicate to us that the IMP exhibits more of a 'large world' tendency, where they actors are more likely to be connected through co-publishing, and hence more likely to be 'singing from the same hymn sheet.' This is supported by the fact that the ICT network had a diameter of 31 in their network, whereas this network has a diameter of 25, indicating that the actors in the main component are more closely aligned.

This perspective is backed up by examining the different individual centrality figures, as shown in Table 4 above. When compared to the IST, we see a marked difference. For example, their highest betweenness score was for Galliers (56), whereas the IMP Group's highest is for WILK at 29. This would indicate to us that the IMP Group is a 'closer' network, needing fewer connections to navigate our way through the network to other nodes. In addition, the IMP Group's flow betweenness scores are much lower, indicating that the actors 'talk to each other' more effectively.

We have also examined the co-publishing strategies of three of the ‘founding fathers’ (HAKA, JOHN1, and FORD) and show how they exhibit strong evidence of different research strategies – in the case of HAKA and JOHN1, both seem to have adopted a strategy of publishing a relatively low number of papers with a wide variety of co-authors: 36 papers with 24 different authors in the case of HAKA, and 29 papers with 28 different co-authors for JOHN1. In addition, many of these co-authors have then published between themselves. FORD, on the other hand, has co-authored with fewer people (14), but seems to have worked more consistently with them (30 papers), hence exhibiting stronger ties with fewer people.

At a broader level, the question to be addressed is how analysis based upon social networks, as evidenced by the application above, could potentially add value to researchers in the area of business-to-business marketing. Given that the type of analyses undertaken above can provide insights into how sets of relationships are managed, we need to identify ways in which analysing interactions between multiple actors within either a dyadic relationship, or a broader network, could be undertaken. We believe that there are two potential ways of doing this. The simpler would be to use self-reporting type data, where respondents are asked to report on who it is that they interact with, the nature and strength of such ties, etc. The computationally more complex approach would be to collect macro-level data on telephone and/or email data, analysing the complete set of interactions either within a company or in a focal relationship.

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# Appendix

List of abbreviations and names

| | Code | Surname | First Name | | Code | Surname | First name |
|---|---|---|---|---|---|---|---|
| 1 | ALAJ | Alajoutsijarvi | Kimmo | 41 | FOLG | Folgesvold | Atle |
| 2 | ANDE1 | Anderson | Helen | 42 | FORB | Forbord | Magnar |
| 3 | ANDE2 | Andersson | Per | 43 | FORD | Ford | David |
| 4 | ANDE3 | Andersen | Poul | 44 | FREY | Freytag | Per |
| 5 | ANDR | Andresen | Edith | 45 | GADD | Gadde | Lars-Erik |
| 6 | ARAU | Araujo | Luis | 46 | GASS | Gassenheimer | Jule |
| 7 | AXEL | Axelsson | Bjorn | 47 | GEMU | Gemunden | Hans-Georg |
| 8 | BAKA | Bakary | Ahmedal | 48 | GLAS | Glaser | Stan |
| 9 | BANG | Bangens | Lennart | 49 | GRES | Gressetvold | Espen |
| 10 | BARA | Baraldi | Enrico | 50 | HADJ | Hadjikhani | Amjad |
| 11 | BARD | Bardzil | James R. | 51 | HAKA | Hakansson | Hakan |
| 12 | BARR | Barrett | Nigel | 52 | HALI1 | Halinen | Aino |
| 13 | BELL | Bellenger | Danny N. | 53 | HALL | Hallen | Lars |
| 14 | BELL1 | Bello | Dan C. | 54 | HARL | Harland | Christine |
| 15 | BION | Biong | Harald | 55 | HARR1 | Harrison | Debbie |
| 16 | BOER | Boer | Luitzen | 56 | HART | Hartmann | Evi |
| 17 | BOLE | Boles | James | 57 | HAUG1 | Haugnes | Svanhild |
| 18 | BOWE | Bowey | James | 58 | HAVI | Havila | Virpi |
| 19 | BREN | Brennan | Ross | 59 | HEDA | Hedaa | Laurids |
| 20 | BYGB | Bygballe | Lena | 60 | HELF | Helfert | Gabi |
| 21 | CALD | Caldwell | Nigel | 61 | HENN | Henneberg | Stephan |
| 22 | CAMP | Campbell | Alexandra | 62 | HENS | Hensen | Steve |
| 23 | CANT1 | Cantillon | Sophie | 63 | HERT | Hertz | Susanne |
| 24 | CAST1 | Castaldo | Sandro | 64 | HEYD | Heydebreck | P. |
| 25 | CHER | Chery | Marie-Celine | 65 | HIBB1 | Hibbert | Brynn |
| 26 | CHEU | Cheung | Metis | 66 | HOLL | Holland | Christopher |
| 27 | COVA | Cova | Bernard | 67 | HOLM2 | Holmen | Elsebeth |
| 28 | CUNN | Cunningham | Malcolm | 68 | HULT | Hulthen | Kajsa |
| 29 | DADZ | Dadzie | Kofi Q | 69 | JAHR | Jahre | Marianne |
| 30 | DAMG | Damgaard | Torben | 70 | JOHA1 | Johanson | Jan |
| 31 | DENI | Denize | Sara | 71 | JOHA2 | Johanson | Martin |
| 32 | DUBO | Dubois | Anna | 72 | JOHN1 | Johnston | Wesley |
| 33 | DURR | Durrieu | Francois | 73 | JOHN2 | Johnsen | Rhona |
| 34 | EAST | Easton | Geoff | 74 | JOHN3 | Johnsen | Thomas |
| 35 | EHRE | Ehret | Michael | 75 | JONM | Jonmundsson | Brian |
| 36 | EID | Eid | Mohamed | 76 | JONS | Jonsson | Patrik |
| 37 | ERIK2 | Eriksson | Kent | 77 | KALL | Kallevag | Magne |
| 38 | FANG | Fang | Tony | 78 | KJEL | Kjellberg | Mia |
| 39 | FLET | Fletcher | Richard | 79 | KJEL2 | Kjellberg | Hans |
| 40 | FLYG | Flygansvar | Bente M. | 80 | KOCK | Kock | Soren |

List of abbreviations and names cont'd

| | Code | Surname | First name | | Code | Surname | First name |
|---|---|---|---|---|---|---|---|
| 81 | KRIZ | Kriz | Anton | 119 | SALL | Salle | Robert |
| 82 | LAMM | Lamming | Richard | 120 | SALM | Salmi | Asta |
| 83 | LEAC | Leach | Mark | 121 | SCHU | Schurr | Paul H. |
| 84 | LEEK | Leek | Sheena | 122 | SEPP | Seppanen | Veikko |
| 85 | LILL | Lilliecreutz | Johan | 123 | SHAR | Sharma | Deo |
| 86 | LIU | Liu | Annie H. | 124 | SHAR2 | Sharma | Neeru |
| 87 | LOW | Low | Brian | 125 | SIBL | Sibley | R.Edward |
| 88 | MAND | Mandjak | Tibor | 126 | SNEH | Snehota | Ivan |
| 89 | MATT | Mattsson | Lars-Gunnar | 127 | SOLB | Solberg | Carl |
| 90 | MATT2 | Matthyssens | Paul | 128 | SPEN | Spencer | Robert |
| 91 | MCDO | McDowell | Raymond | 129 | SUND | Sundquist | Viktoria |
| 92 | MCLO | McLoughlin | Damien | 130 | TAHT1 | Tahtinen | Jaana |
| 93 | MILL1 | Miller | Kenneth | 131 | THOM6 | Thomas | Richard |
| 94 | MOLL | Moller | Kristian | 132 | TOMK | Tomkins | C.R. |
| 95 | MORL | Morlacchi | Pierangela | 133 | TORN | Tornroos | Jan-Ake |
| 96 | MOSL | Mosli | Tamer | 134 | TORV | Torvatn | Tim |
| 97 | MOSL1 | Mosly | Ahmed Raafat | 135 | TOYE | Toye | Sharon |
| 98 | MOUZ | Mouzas | Stefanos | 136 | TUNI | Tunisin | Annalisa |
| 99 | MULL | Mullerm | Thilo | 137 | TURN | Turnbull | Peter |
| 100 | NAUD | Naude | Peter | 138 | ULVN | Ulvnes | Arne |
| 101 | OWUS | Owus | Richard A. | 139 | VAAL | Vaaland | Terje |
| 102 | PAGE | Page Jr. | Thomas J. | 140 | VALK | Valk | Wendy van der |
| 103 | PARD | Pardo | Catherine | 141 | WALT | Walter | Achim |
| 104 | PEDE | Pedersen | Ann-Charlott | 142 | WALU | Waluszewski | Alexandra |
| 105 | PETE | Peters | Linda | 143 | WATH | Wathne | Kenneth |
| 106 | PREN | Prenkert | Frans | 144 | WEDI | Wedin | Torkel |
| 107 | PURC | Purchase | Sharon | 145 | WELC | Welch | Catherine |
| 108 | RAES | Raesfeld | Ariane von | 146 | WELC2 | Welch | Denice |
| 109 | RAJA | Rajala | Arto | 147 | WELC3 | Welch | Lawrence |
| 110 | RAMO1 | Ramos | Carla | 148 | WILE | Wiley | James |
| 111 | REDW | Redwood | Michael | 149 | WILK | Wilkinson | Ian F. |
| 112 | REUN | Reunis | Marc | 150 | WILS | Wilson | David |
| 113 | RIGD | Rigdon | Edward | 151 | WYNS | Wynstra | Finn |
| 114 | RITT | Ritter | Thomas | 152 | YOO | Yoo | Boonghee |
| 115 | ROKK | Rokkan | Aksel | 153 | YOUN | Young | Louise |
| 116 | ROOS | Roos | Kaspar | 154 | ZABL | Zablah | Alex R. |
| 117 | ROSE2 | Rose | L. | 155 | ZERB | Zerbini | Fabrizio |
| 118 | RYSS | Ryssel | Ricky | 156 | ZOLK | Zolkiewski | Judy |