

Chapter 2: The Development of Social Network Analysis

There are numerous very diverse strands in the development of present-day social network analysis. These strands have intersected and fused with one another at various times, only to diverge once more on to their separate paths. Nevertheless, a clear lineage for the mainstream of social network analysis can be constructed from this complex history. In this lineage there are three main lines: the sociometric analysts, who produced many technical advances by using the methods of graph theory; the Harvard researchers of the 1930s, who explored patterns of interpersonal relations and the formation of 'cliques'; and the Manchester anthropologists, who built on both of these strands to investigate the structure of 'community' relations in tribal and village societies (Figure 2.1).

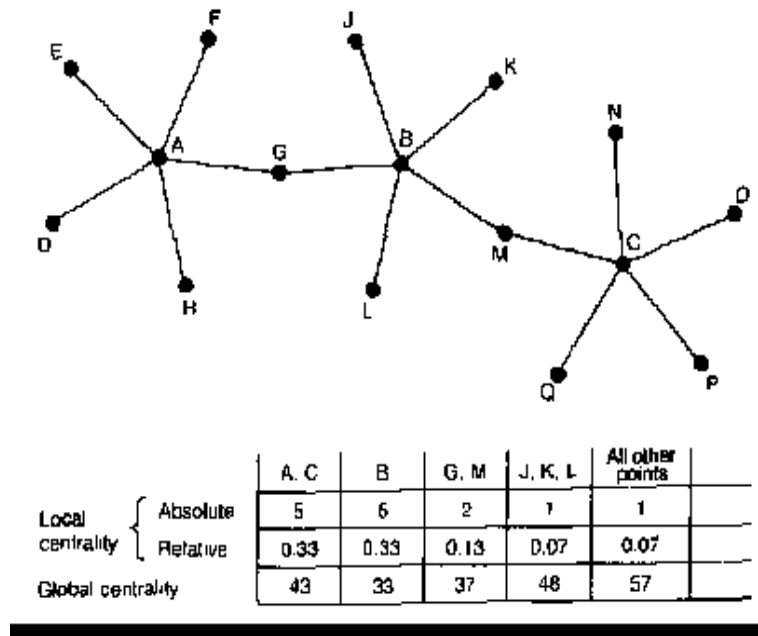


Figure 1.1 The lineage of social network analysis

A group of emigrants from Germany to the United States were working, during the 1930s, on topics in cognitive and social psychology. This work, influenced by Wolfgang Köhler's 'gestalt' theory, stimulated a considerable amount of research on the problems of sociometry and 'group dynamics'. Using laboratory methods or laboratory-like case studies, they looked at group structure and at the flow of information and ideas through groups. At the same time, anthropologists and sociologists at Harvard University were developing some of the ideas of the British social anthropologist Radcliffe-Brown in the direction of a concern with the interdependence of the structural elements in social systems. Their work produced a number of important factory and community studies, which emphasized the importance of informal, interpersonal relations in all social systems. In Britain, a parallel line of development from the work of Radcliffe-Brown emphasized the analysis of conflict and contradiction in social systems, and a whole school of social anthropologists, based principally at Manchester University, applied these ideas to the study of African tribal societies and, a little later, to rural and small town Britain. These writers built on the earlier traditions and made considerable advances in allying mathematics with substantive social theory. Not until well into the 1960s, however, did the final breakthrough to a well-developed methodology of social network analysis occur, and this event took place back at Harvard. Harrison White began to extend his investigations of the mathematical basis of social structure, forging together some of the key insights of his North American predecessors and creating a unique synthesis which was developed

and enlarged by the students that he trained. In the hands of these students, as they moved through their careers to departments across the world, the arguments of White and the work of the British researchers were united into a complex but increasingly coherent framework of social network analysis.

In this chapter, I shall give a brief outline of the three main lines of social network analysis and of the leading innovations of the Harrison White group at Harvard. This review will highlight a number of the continuing topics of debate in social network analysis, and I will give some indication of how these are rooted in the central substantive concerns of sociology.

Sociometric Analysis and Graph Theory

The 'gestalt' tradition in psychology, associated principally with the work of K6hler (see K6hler, 1925), involves a stress on the organized patterns through which thoughts and perceptions are structured. These organized patterns are regarded as 'wholes' or systems which have properties distinct from those of their 'parts' and which, furthermore, determine the nature of those parts. The individual objects which people perceive, for example, are seen in the particular way that they are because they are, literally, preconceived within the complex and organized conceptual schemes of the human mind. The objects of the world are not perceived independently of these mental schemes but are, in a fundamental sense, constituted by them. Social psychology in this research tradition has stressed the social determination of these conceptual schemes and has, therefore, emphasized the influence of group organization and its associated social climate on individual perceptions.

During the 1930s, many of the leading gestalt theorists fled from Nazi Germany and settled in the United States, where Kurt Lewin, Jacob Moreno (who had migrated to America in 1925) and Fritz Heider became prominent, though rather different, exponents of a gestalt-influenced social psychology. Lewin established a Research Centre at the Massachusetts Institute of Technology, later moving it to Michigan, and this Centre became the focus of research on social perception and group structure. Moreno, on the other hand, explored the possibilities in using psychotherapeutic methods to uncover the structure of friendship choices. Using such techniques as experimentation, controlled observation and questionnaire inquiries, he and his colleagues aimed to explore the ways in which people's group relations served as both limitations and opportunities for their actions and, therefore, for their personal psychological development. Although the word is particularly associated with Moreno, 'sociometric' is an apt description of the general style of research that arose from the gestalt tradition.

Moreno's work was firmly rooted in a therapeutic orientation towards interpersonal relations, reflecting his early medical training and psychiatric practice in Vienna. His aim, elaborated in a major book (Moreno, 1934) and in the founding of a journal (Sociometry, founded in 1937), was to investigate how psychological well-being is related to the structural features of what he termed 'social configurations'. These configurations are formed from the concrete patterns of interpersonal choice, attraction, repulsion, friendship and other relations in which people were involved, and they are the basis upon which large-scale 'social aggregates', such as the economy and the state, are sustained and reproduced over time. Moreno's concern for the relationship between small-scale interpersonal configurations and large-scale social aggregates is a very clear expression of some of the leading ideas of classical German sociology, most notably those developed in the works of Weber, Toennies and Simmel. Indeed, the latter's 'formal sociology' is a direct precursor of many sociometric concerns (Simmel, 1908; Aron, 1964).

Moreno's chief innovation was to devise the 'sociogram' as a way of representing the formal properties of social configurations. The latter could be represented in diagrams analogous to those of spatial geometry, with individuals represented by 'points' and their social relationships to one another by 'lines'. This idea is now so well established and taken for granted that its novelty in the 1930s is difficult to appreciate.

Before Moreno, people had spoken of 'webs' of connection, the 'social fabric' and, on occasion, of 'networks' of relations, but no one had attempted to systematize this metaphor into an analytical diagram.

For Moreno, social configurations had definite and discernible structures, and the mapping of these structures into a sociogram allowed a researcher to visualize the channels through which, for example, information could flow from one person to another and through which one individual could influence another. Moreno argued that the construction of sociograms allowed researchers to identify leaders and isolated individuals, to uncover asymmetry and reciprocity, and to map chains of connection. One of his principal sociometric concepts was that of the sociometric 'star', the recipient of numerous and frequent choices from others and who, therefore, held a position of great popularity and leadership. For Moreno, the concept of the 'star' pointed to an easily visualized picture of the relations among group members. In Figure 2.2, for example, person A is the recipient of friendship choices from all the other members of a group, yet A gives reciprocal friendship choices only to persons B and C. A is, therefore, the star of attraction within the group.

Lewin's early work on group behaviour was published in a book which outlined his view that group behaviour was to be seen as determined by the field of social forces in which the group was located (Lewin, 1936). A social group, he argued, exists in a 'field', a social 'space' which comprises the group together with its surrounding environment. But the environment of the group is not seen as something purely external to and independent of the group. The environment that really matters to group members is the perceived environment. The perceived environment is what writers in the symbolic interactionist tradition called the 'definition of the situation', and its social meaning is actively constructed by group members on the basis of their perceptions and experiences of the contexts in which they act. The group and its environment are, therefore, elements within a single field of relations. The structural properties of this social space, Lewin argued, can be analysed through the mathematical techniques of topology and set theory (Lewin, 1951). The aim of 'field theory' is to explore, in mathematical terms, the interdependence between group and environment in a system of relations, a view which brought Lewin close to subsequent developments in general systems theory. (See Buckley, 1967 for an application of this framework to sociology.)

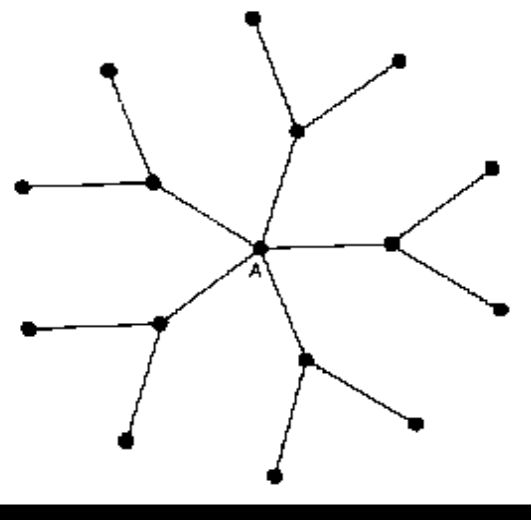


Figure 2.2 A sociogram: the sociometric star

In a topological approach, the social field is seen as comprising 'points' connected by 'paths'. The points represent individual persons, their goals, or their actions, and the paths represent the interactional or causal sequences which connect them. The field model, therefore, describes causal and interactional interdependencies in social configurations. The paths which run between points tie them together, and the pattern of paths divides a field into a number of discrete 'regions'. Each region is separated from the others by the absence of paths between them: paths run within but not between the regions. The opportunities which individuals have to move about in their social world are determined by the boundaries between the different regions of the field in which they are located. The constraints imposed by these boundaries are the 'forces' which determine group behaviour. The total social field, therefore, is a field of forces acting on group members and shaping their actions and experiences.

A further strand of cognitive psychology which made a major contribution to the development of theories of group dynamics was the work of Heider. His initial work was on the social psychology of attitudes and perception, and Heider was especially concerned with how a person's various attitudes towards others are brought into a state of 'balance'. The different attitudes which an individual holds are balanced in his or her mind when they do not produce a state of psychological tension. Psychological balance, therefore, depends on the holding of attitudes which are not contradictory with one another. Heider's particular concern was with interpersonal balance, the congruence (or lack of congruence) among attitudes to other people. He was concerned, for example, with how a person who is emotionally close to two other people might respond to any perceived conflict or hostility between them. In such a situation, there is an imbalance in the whole field of attitudes. Heider (1946) held that attitudes can be seen, at their simplest, as positive or negative. 'Balance' exists among a set of attitudes when they are similar to one another in their sign - all positive or all negative. If person A likes person B, and person B likes person C, a state of balance exists only if A also likes C. All the attitudes are 'positive'. It is important to note that, for Heider as for Lewin, this kind of analysis relates to the way in which the world is perceived from the standpoint of a focal individual: Heider was adopting an explicitly, phenomenological' stance. From this point of view, the important thing is not the actual relation between B and C, but A's perception (accurate or otherwise) of this relationship. 'Balance' refers to a psychological, phenomenological state, and not to any actually existing relations in a social group.

While field theory, as a theoretical framework for social analysis, proved a dead-end, Lewin's advocacy of mathematical models of group relations proved to be a fruitful foundation for later work. Of particular importance in building on the insights of Lewin was Cartwright, who, together with the mathematician Harary, pioneered the application of graph theory to group behaviour (Cartwright and Zander, 1953; Harary and Norman, 1953; see also Bavelas, 1950). Graph theory had first been formulated by K6nig in 1936, but, like many works published in Germany in the 1930s, it had little immediate impact on the wider intellectual world. Its significance for the mainstream of intellectual effort was appreciated only in 1950, when his book (Kbnig, 1936) was republished in the United States and its ideas were developed in the work of Harary and Norman (1953). These mathematical ideas made possible a crucial breakthrough in the theory of group dynamics. This breakthrough consisted of moving from the concept of *cognitive* balance in individual minds to that of *interpersonal* balance in groups. Newcomb (1953) was one of the first researchers to move in this direction, arguing that there was a tendency for two people who were close to one another to adopt similar attitudes towards third parties or events. Researchers could, therefore, build models of the systematic interdependence between the attitudes held by *different* individuals within a group. This claim was generalized within the theoretical framework outlined by Cartwright and Harary (1956). In the hands of these writers, the insights of Lewin, Moreno and Heider were brought together into a novel and more powerful synthesis (see also Harary, Norman and Cartwright, 1965, which was under preparation from the mid-1950s). The attempt to apply mathematics to the structure of group relations was not, of course, a new idea - as well as the work of Lewin there were other early contributions, using different mathematical models, at the end of the 1940s (for example, Bavelas, 1948 and Festinger, 1949). Building on Lewin's work, however, Cartwright, Zander and Harary evolved powerful models of group cohesion, social pressure, cooperation, power and leadership.

Cartwright and Harary (1956) had outlined the basic idea of representing groups as collections of points connected by lines - the basic insight of Moreno. The resulting sociogram or 'graph' represented the network of actual interpersonal relations among group members and could be analysed, they argued, by using the mathematical ideas of graph theory. Graph theory has nothing to do with the graphs of variables familiar from school mathematics. Instead, a graph is simply a set of lines connecting points, and graph theory consists of a body of mathematical axioms and formulae which describe the properties of the patterns formed by the lines. In the work of Cartwright and Harary, the points in a graph represented individuals and the lines showed their relations with one another. The lines in a graph can be given signs (+ or -) to indicate whether they refer to 'positive' or 'negative' relations, and they can be given arrow

heads to indicate the 'direction' of the relationships. The direction attached to a line is a way of distinguishing, for example, person A's orientation to person B from B's orientation to A: person A may direct a positive relation to B (he likes B), while person B may direct a negative relation to A (she hates A). This construction of 'signed' and 'directed' graphs allowed Cartwright and Harary to analyse group structure from the standpoint of each of its members simultaneously, and not simply from the standpoint of a particular focal individual. It was, therefore, a major move forward in a strictly *sociological* direction.

The fundamental points that Cartwright and Harary were making can most easily be understood by considering the case of 'undirected' graphs. In an undirected graph, the relation of A to B is assumed to be identical with the relation of B to A. This can occur, for example, because their attitudes are perfectly reciprocated or because they have a common involvement in the same activity. For this reason, the line between any two points can be studied without considering its direction. In an undirected graph, 'balance' describes simply the particular patterns of signs attached to the lines which make up the graph. In Figure 2.3, for example, three different graphs of relations among three actors are shown. In graph (i), A and B have a positive relationship to one another and the whole graph is balanced because of the existence of positive relations between A and C and between B and C. In graph (ii), however, a negative relation between A and C puts a strain on the positive relation between A and B, because of the positive relation which exists between B and C: the graph is unbalanced. Put simply, if my friend likes someone to whom I am antagonistic, there is likely to be a strain in the relation between us. I might be expected to respond to this by persuading my friend to give up their liking of the third party, by altering my own relation to that person, or by breaking the relationship with my friend. Each participant in an unbalanced network will be under a similar strain and so will be attempting to resolve the tensions that they experience.' Group relations are in a dynamic flux, with the final balanced outcome - if it is achieved - resulting from the actions and compromises of all the participants involved. Responses aimed at restoring balance to the group can be mapped in new graphs with different signs attached to the various lines. Graph (iii), for example, represents the situation where A successfully persuades B to dislike C and so restores balance.

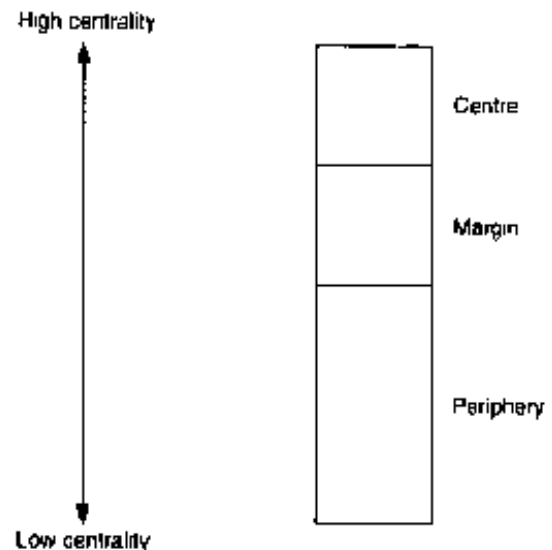


Figure 2.3 Balanced and unbalanced structures

Cartwright and Harary argued that complex social structures can be seen as built from simple structures. More particularly, they are composed of overlapping 'triads' such as those depicted in Figure 2.3. Simple triadic structures are the building blocks of larger social structures, and the properties of complex networks of social relations can, they argue, be derived from an analysis of these building blocks. In the simplest case, for example, a whole network is balanced when all of its constituent triads are balanced. While the idea of a balanced triad is, perhaps, fairly clear and comprehensible, the idea that a large and complex network is 'balanced' is less so. Indeed, the claim might seem to be neither an interesting nor a useful piece of information. This would, however, be an erroneous conclusion to draw. A very important finding, which has been derived from the work of Cartwright and Harary, is that any balanced graph, no matter how large or complex, can be divided into two sub-groups with rather interesting properties: the relations within each of these sub-groups will be positive, while those between the sub-groups will be negative. Thus, a balanced social network, defined, for example, by relations of solidarity, will consist of two cohesive sub-groupings between which there is conflict and antagonism.

In the simple case where all the relations in a network are positive, one of these sub-groups will be an empty or null set: all points will fall into a single group. ³ This will not be the case in more complex balanced structures, and a division into subgroups might highlight important structural features of the network. So, the identification of a network as balanced or unbalanced is merely a first step in the move towards its 'decomposition' into its constituent sub-groups. Much of the mathematical work concerned with the analysis of balance has centred on the attempt to discover such decomposition techniques. The successful decomposition of a balanced network would allow researchers to derive an understanding of network structure simply from information about the relations between individuals. This discovery has enormous implications for the understanding of group structure, and James Davis (1967, 1968) has been a leading figure in the attempt to discover the conditions under which it might be possible to move towards more realistic decomposition techniques which would allow researchers to identify the existence of more than two sub-groups within a network.'

The notion of balance has been especially influential in experimental studies of group cooperation and leadership and has resulted in one classic study of small group behaviour in a natural setting (Festinger et al., 1959). Many of the ideas which emerged from the sociometric tradition of small group research were, however, taken up by researchers with an interest in general systems theory and in the mathematical aspects of cybernetics and rational action. Indeed, the first applications of sociometric ideas to large-scale social systems were initiated by just such researchers. Initial studies explored the spread of disease from one person to another through chains of contacts, aiming at the derivation of predictive epidemiological models of contagion. A leading figure in this work was Rapoport, who elaborated on the formal implications of the studies (Rapoport, 1952, 1958) and helped to stimulate an interest in applying similar ideas to the transmission of ideas and innovations. Although such work has been undertaken before, along with investigations of the spread of rumour and gossip, the 1960s saw the first major works of this kind to use network concepts (Fararo and Sunshine, 1964; Coleman et al., 1966).

Interpersonal Configurations and Cliques

Theoretical work in the sociometric tradition, I have argued, has involved a considerable effort to uncover ways of decomposing networks into their constituent sub-groups. This search for what have variously been termed as 'cliques', 'clusters', or 'blocks' has also been a feature of the research tradition which developed at Harvard University during the 1930s and 1940s. In this line of work, the investigation of 'informal relations' in large-scale systems led to the empirical discovery that these systems did, in fact, contain cohesive sub-groupings. The task that the researchers then faced, and only partly solved, was to discover techniques which could disclose the sub-group structure of any social system for which relational data were available.

Radcliffe-Brown and, through him, Durkheim were the major influences on this tradition of research. Radcliffe-Brown's ideas had been especially influential among anthropologists in Australia, where he had taught for a number of years. His influence was particularly strong in the work of W. Lloyd Warner, who moved to Harvard in 1929 to join his fellow Australian, the psychologist Elton Mayo. The two men worked together in a series of closely related investigations of factory and community life in America, and they saw these investigations as applications of the structural concerns of Radcliffe-Brown.

Mayo had moved from Australia to Harvard in 1926 in order to take on a leading role in the newly developed research programme of its business school. His principal contact with sociological ideas was through the dominating influence of the biologist L. J. Henderson, who actively promoted the work of Pareto among his Harvard colleagues. Henderson held that this was the only appropriate basis for a truly scientific sociology and that it was, furthermore, the only viable political bulwark against revolutionary Marxism. Mayo's psychological concern for individual motivation was complemented by a growing

awareness of what Pareto termed the 'non-rational' components of action. Economic action, for Mayo, was not a purely rational form of action, but was structured also by non-rational sentiments such as those of group solidarity. Pareto was also the great exponent of 'elite' theory, and Mayo saw that a managerial elite which recognized this influence of group relations on economic motivation could most successfully control worker behaviour. Warner's contribution to the Harvard research programme, as befitted a trained field worker, showed a greater concern for detailed investigations of the actual patterns of group behaviour which could be found in particular social settings. To Mayo's theoretical and 'applied' concerns, Warner brought an empirical dimension. Despite these differences - or, perhaps, because of them - the work that the two began at Harvard was crucially important in the development of social network analysis. Their careers overlapped there for only six years, but their research proved massively influential. The major projects which they and their colleagues undertook were investigations of the Hawthorne electrical factory in Chicago and a study of the New England community of 'Yankee City'.

The Hawthorne studies have become classics of social investigation, and they need little discussion here (see the useful discussion in Rose, 1975). Briefly, a series of studies of worker efficiency had been undertaken during the 1920s by managers in the Hawthorne works of the Western Electric Company in Chicago. These managers were attempting to discover how alterations in the physical conditions of work (heating, lighting, rest periods and so on) affected productivity, and they discovered, to their considerable surprise, that productivity increased almost regardless of the particular changes that were made. In an attempt to understand these paradoxical results, the managers called on Mayo and his Harvard team for some guidance in restructuring the research programme. Mayo concluded that the crucial factor responsible for increased productivity had been the very fact of participation in the research project: the workers were pleased that their managers were taking an interest in them, and their sense of involvement and integration into the life of the factory motivated them to greater efforts.

With the advice of Warner, the Hawthorne investigators began an anthropological study, an observation of work group behaviour in a natural setting in the factory. The scene of their observations was the bank wiring room, and the team approached their research in the factory in the same way that a social anthropologist would carry out fieldwork in a village in an alien society. They recorded all that they could observe of group behaviour, aiming to construct a full anthropological account. The importance of the Hawthorne studies to the development of social network analysis lies in their use of sociograms to report on group structure. Just as the kinship structure of a village community might be illustrated using a genealogical diagram, the Hawthorne team constructed sociograms to illustrate the structure of informal relations within the work group.

The principal report on the Hawthorne studies (Roethlisberger and Dickson, 1939: 500 ff.)-5 includes various sociograms constructed by the research team. They saw these as reflecting the 'informal organization' of the bank wiring room, as opposed to the formal organization which was depicted in the managerial organization chart. Sociograms were constructed to show each of a number of aspects of group behaviour: involvement in games, controversy over the opening of windows, job trading, helping, and friendships and antagonisms. The Hawthorne study was, I believe, the first major investigation to use sociograms to describe the actual relations observed in real situations. In their diagrams, people are represented by circles and their relationships by arrows. The similarity of these diagrams to the sociograms subsequently developed by the group dynamics researchers are obvious, but the researchers give no indication of how they hit upon the idea of such diagrams. There is, for example, no discussion of the evolving work of Moreno. It will be seen from Figure 2.4, however, that the diagrams resemble not only the formal organization charts which were used by managers, but also the electrical wiring diagrams that would have been a very familiar feature of the plant. It must be assumed that the influence of Warner must have encouraged the researchers to adapt conventional anthropological kinship diagrams by drawing on these other influences of the organizational setting.

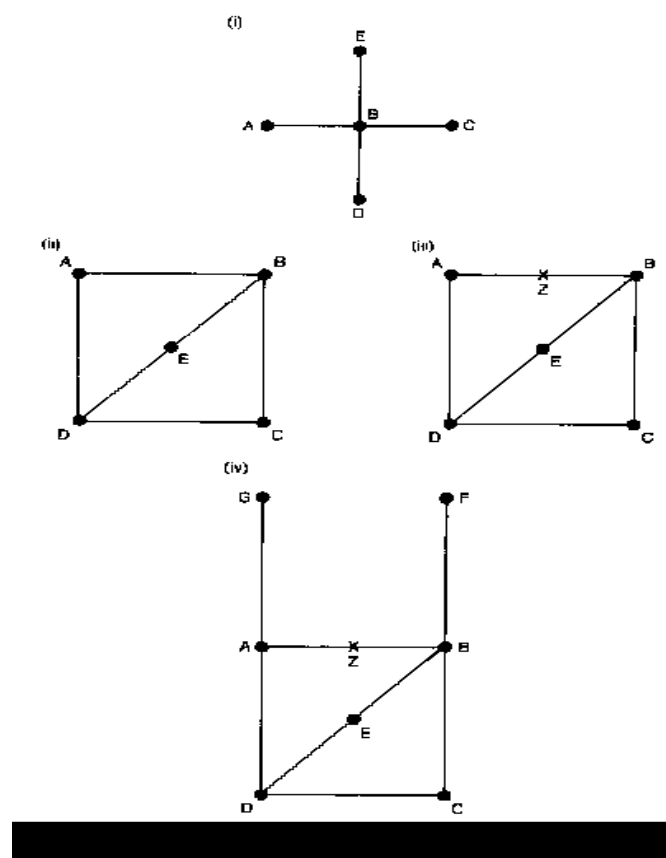


Figure 2.4 A Hawthorne sociogram

In drawing the sociograms of the bank wiring group, certain general conventions were followed, but these were artistic rather than sociological conventions. The precise location of each circle on the page was decided by the artist, the principal constraint being simply that any sub-groups identified by the observers should be drawn as close to one another as possible. Apart from this, purely artistic principles of clarity and simplicity governed the design: the number of lines which cross one another, for example, should be as small as possible, and the lines should not vary too much in length. The sub-groups identified by the researchers - they called them 'cliques' - were those which the workers themselves recognized as important elements of their situation. Much as any anthropologist might use 'native' categories and concepts as pointers to the structural features of group life, the workers' own terms were taken as indicators of the existence of 'cliques'. 'The group in front' and 'the group in back' were identified from observations of group behaviour and from group vocabulary as the two sub-groups within the bank wiring group. There was no attempt to use the sociograms themselves to identify sociometrically defined 'cliques' - the socially perceived sub-groups were simply mapped on to the sociograms. Having plotted group structure in this way, however, the researchers made little further use of them. They appear to have lacked any theoretical understanding of how social networks might shape the behaviour of individuals.

Warner, meanwhile, had begun a study of the small New England city of Newburyport, to which he gave the pseudonym 'Yankee City'. His fieldwork was carried out between 1930 and 1935, and the research was conceived as a full-blown anthropological study of a modern, urban community. As such, it combined observation with the use of interviews and historical documents. The end of the main phase of fieldwork, however, coincided with a growing antagonism between Warner and Mayo, and Warner left Harvard for Chicago University, where his mentor, Radcliffe-Brown, was already a visiting professor. Warner and Radcliffe-Brown had two years together at Chicago, a period when the analysis of the fieldwork material from Yankee City would have been at its most intense. Warner spent the rest of his

career at Chicago, and it was from there that he supervised and sponsored a number of related studies, most importantly that of 'Old City' in the American Deep South.

Warner's own early work had used the methods and ideas of Durkheim and Radcliffe-Brown in the traditional manner to study an Australian tribe, and it was through his contact with Mayo that he first formulated the idea of applying anthropological methods to the study of a modern urban community. Warner had originally intended to study the district of Chicago in which the Hawthorne works were located, but the work of the Chicago school of sociologists forced him to conclude that the district was 'disorganized' and so would not be amenable to anthropological investigation (Park et al., 1925). Warner felt that only in New England and in parts of the southern United States would he find the kind of established and integrated communities that he wished to study.

Warner's work shows a rich variety of theoretical influences. While the influence of Radcliffe-Brown was uppermost, he allied this with an organismic, systems model of society which, undoubtedly, shows the influence of Henderson's interpretation of Pareto. This led Warner to emphasize such factors as stability, cohesion and integration in the structuring of communities. But he also drew on Simmel's ideas of reciprocal relations and of the influence of numbers on group life. It was, I have suggested, Simmel (1908) who pioneered the analysis of dyads and triads as the building blocks of social life. Following the terminology of Simmel and other German sociologists, also adopted by Moreno, Warner talked of social 'configurations', holding that the social organization of a community consists of a web of relations through which people interact with one another.

The social configuration which comprises a modern community, argued Warner, consists of various sub-groups, such as the family, the church, classes and associations. Alongside these is also to be found the sub-group that he terms the 'clique': an informal association of people among whom there is a degree of group feeling and intimacy and in which certain group norms of behaviour have been established (Warner and Lunt, 1941:32). A clique is 'an intimate non-kin group, membership in which may vary in numbers from two to thirty or more people' (Warner and Lunt, 1941: 110).⁸ For Warner, therefore, the clique has the same social significance in community studies as the informal group had in the Hawthorne factory studies. The concept describes a particular configuration of informal interpersonal relations.

The Yankee City researchers claimed that a large number of these cliques could be identified in the city. The major cliques were the groups that many Yankee City respondents referred to by such terms as 'our crowd', 'our circle', and so on. Having discovered the existence of these cliques from the comments made by those they studied, Warner and his associates claimed that they were second in importance only to the family in placing people in society. People are integrated into communities through 'informal' and 'personal' relations of family and clique membership, not simply through the 'formal' relations of the economy and political system. Any person may be a member of several different cliques, and 'such overlapping in clique membership spreads out into a network of interrelations which integrate almost the entire population of a community in a single vast system of clique relations' (Warner and Lunt, 1941: 111). This is undoubtedly one of the earliest, if not the earliest use of network terminology to describe the structuring of whole societies into sub-groups.

The Yankee City reports used various diagrams to model such things as class structure and family organization, and it is hardly surprising that the researchers also constructed clique diagrams. To represent the social structure that they described, they drew cliques as a series of intersecting circles in a Venn diagram (Warner and Lunt, 1941: 113), but they do not advance to any formal, structural analyses of these diagrams. In the second volume of the Yankee City report, however, there was an attempt to undertake what would now be termed a 'positional analysis' (Warner and Lunt, 1942: 52, Figure X). They present a series of matrices which show the numbers of people occupying each of a number of structurally defined positions. Figure 2.5 shows the format of one of these diagrams. Having identified six classes and 31

types of clique in Yankee City, Warner and Lunt cross-classified class and clique membership in a data matrix. Each type of clique was defined by the predominant class composition of its overall membership, and the cells of the matrix show the numbers of people in each class who were members of each of the 31 types of clique.⁹ From among the large number of possible combinations - 6 times 31, or 186 they argue that only 73 'positions' actually occurred. All the remaining cells in the matrix were empty. By constructing similar matrices for class against each of a number of other social groupings (types of formal association, types of family etc.,) they were able to combine the matrices together, stacking them one on top of another, and they identified 89 structural positions in the overall 'combined networks'. The particular procedure that they employed was rather cumbersome, and it is unnecessary to go further into its outmoded operation, but the Yankee City work remains interesting for its attempt to pioneer such methods of formal structural analysis.

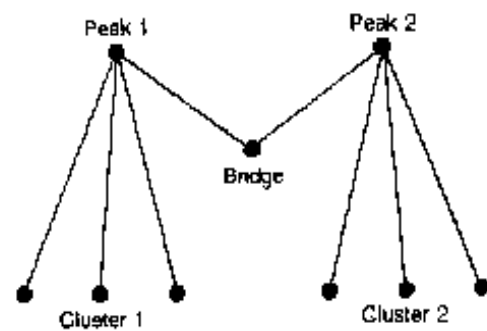


Figure 2.5 A matrix of cliques

Colleagues of Warner began an investigation of 'Old City', in the southern United States, during 1936, and in this research they further explored the idea of the 'clique' (Davis et al., 1941). In looking at 'coloured society' in Old City, they follow Warner's method of seeing cliques as intersecting circles, mapping the overlapping memberships of the most active cliques in a 'space' defined by class and age (Davis et al., 1941: 213, Figure 12). They referred to 'social space' and its 'two dimensions', but there is no explicit mention of any of the work of Lewin on topological field models. The major innovation of this study was its attempt to explore the internal structure of cliques. The researchers argued that a clique could be seen as comprising three 'layers': a 'core' of those who participate together most often and most intimately, a 'primary circle' of those who participate jointly with core members on some occasions but never as a group by themselves, and a 'secondary circle' of those who participate only infrequently and so are 'almost non-members'. On the basis of their investigation of 60 cliques, using similar techniques to those of the Yankee City researchers, they suggested a number of structural hypotheses about the connections between cliques. They argue, for example, that peripheral, lower class members of a clique might be able to contact higher class members of another clique only through the higher class core members of their own clique.

The ideas that emerged in the Hawthorne, Yankee City and Old City research developed in parallel with those of the sociometric tradition of small group research, but there is no evidence that the leading figures in the two traditions were even aware of one another's work during the 1930s and 1940s. In the work of George Homans, however, there occurred the first important intersection of these two strands of research. Homans, a faculty member in the Harvard sociology department, was dissatisfied with the 'grand theory' of Harvard colleagues such as Parsons, which he felt operated at a much too abstract level of analysis. Homans felt that social theory had to be built up from the foundations of a firm understanding of small-scale social interaction. To this end, he began, during the late 1940s, to try to synthesize the mass of smallgroup research that had been undertaken in the United States. He aimed at nothing less than a theoretical synthesis of this work, drawing on the experimental work of the social psychologists and the observational work of sociologists and anthropologists. His theoretical synthesis centred around the idea that human activities bring people into interaction with one another, that these interactions vary in their 'frequency', 'duration', and 'direction', and that interaction is the basis on which 'sentiments' develop among people. Homans saw Moreno's sociometry as providing a methodological framework for applying this theory to particular social situations. To illustrate his ideas, he re-examined a number of earlier studies.

One section of the Old City report has achieved considerable fame - among network analysts at least - because of its re-analysis by Homans. In this section, Davis and his colleagues used matrix methods to look at the involvement of 18 women in 14 social events (Davis et al., 1941: Chapter 7)." Homans took these data, presented them in matrix form, and set out one of the first published statements of the method of 'matrix re-arrangement' in social network analysis (see also Festinger, 1949). The Old City matrix shows 18 rows (women) and 14 columns (events), with an 'x' entry placed in a cell to represent the participation of a particular woman at a specific event. The raw matrix, argued Homans, was not necessarily arranged in any significant order - the columns, for example, were simply arranged in the date order of the events. For this reason, the crosses appear to be distributed at random across the matrix. A re-arrangement of the rows and columns of the matrix, bringing together the events in which particular women predominate, would, he believed uncover important structural features of the clique. He described his method as follows:

we put in the center the columns representing events ... at which a large number of women were present, and we put toward the edges the columns representing the events ... at which only a few women were present. As far as the lines [rows] are concerned, we put together toward the top or bottom the lines representing those women that participated most often together in social events. A great deal of reshuffling may have to be done before any pattern appears. (Homans, 1951: 83)

Homans argued that this 'reshuffling' must go on until the distribution of the crosses in the cells shows a clear pattern, and he produced a re-arranged matrix in which there were clear signs of a division into two 'cliques' among the women: there were two distinct clumps of crosses in the re-arranged matrix. Homans's method is analogous to what has subsequently come to be called 'block modelling', but he made no use of any formal mathematical methods. In fact, his re-arrangement seems to be simply a trial-and-error process which continued until he was able to spot an apparently significant pattern.

Figure 2.6 shows a simplified version of the re-analysis undertaken by Homans. The matrices show artificial data for the participation of eight people in eight events. In matrix (i), the 'X' entries are scattered evenly across the whole matrix, but a re-arrangement of the rows and columns into the order shown in matrix (ii) brings out a structural opposition between two distinct sub-groups: Ann, Chris, Ed and Gill participate together in events 1, 3, 5 and 7, while Beth, Don, Flo and Hal participate jointly in events 2, 4, 6 and 8. There are two separate sets of people and two specific categories of events. It can be appreciated that re-arrangement by trial-and-error would not be such an easy task, even for such a small matrix, when the data are not so tightly structured as in this artificial example. The real data on 18 women and 14 events would have taken a considerable amount of time to analyse. There is, furthermore, no certainty that the final results produced by Homans would be the same as those produced by any other researcher, as there are no criteria by which a 'correct' result can be identified. It is for these reasons that later attempts at this kind of

(i) Original matrix		Events							
		1	2	3	4	5	6	7	8
People	Ann	X		X		X		X	
	Beth		X		X		X		X
	Chris	X		X		X		X	
	Don		X		X		X		X
	Ed	X		X		X		X	
	Flo		X		X		X		X
	Gill	X		X		X		X	
	Hal		X		X		X		X
(ii) Re-arranged matrix		Events							
		1	3	5	7	2	4	6	8
People	Ann	X	X	X	X				
	Chris	X	X	X	X				
	Ed	X	X	X	X				
	Gill	X	X	X	X				
	Beth					X	X	X	X
	Don					X	X	X	X
	Flo					X	X	X	X
	Hal					X	X	X	X

Figure 2. 6 Matrix re-arrangement

analysis have involved a search for programmable algorithms, so that computers can reliably undertake the task of re-arrangement.

To illustrate his position further, Homans re-analysed the Hawthorne data on the bank wiring room. Using the sociograms constructed by the observers, he looked at the cliques which Roethlisberger and Dickson had identified (Homans, 1951: 66-70). But Homans retained these original clique identifications, and did not attempt a sociometric investigation of clique structure along the lines of his analysis of the Old City data. He does imply, however, albeit without elaboration, that the matrix re-arrangement method had been used by the original Hawthorne researchers (Homans, 1951: 84). 13

The theoretical framework that Homans constructed to explain group behaviour was an elaboration of the model of the early smallgroup researchers, in which the group is understood as a system within an environment. He divides the structure of any group into an 'internal system', which expresses the sentiments that arise through the interactions of its members, and an 'external system' through which group activities are related to the problem of environmental adaptation. 14 The environment itself consists of the physical, technical and social contexts of group behaviour. Homans's main concern was with the internal system, which he saw as a more scientific concept than that of the 'informal organization' which it designates. His interest, therefore, was in the scientific elaboration of the insights of research on informal organization by translating these insights into propositions about the structure of 'internal systems'.

To this end, he set up a number of hypotheses about the internal system, starting from the assumption that people who interact frequently with one another will tend to like one another and that, as the frequency of their interaction increases, so the degree of their liking for one another will increase. If there are frequent interactions in the external system, because of such environmental constraints as the demands imposed by supervisors and managers, then the members of the work group will tend to develop sentiments of liking and will engage in further interactions with one another, unrelated to the needs of the external system. It is in this way, he argues, that the internal system gets elaborated into complex social configurations divisible into cliques. 15

Despite the power of Homans's theoretical synthesis of sociometric and anthropological research, there were few major advances that were directly inspired by his work. Homans himself became increasingly concerned to explore the explanation of social behaviour using behaviourist and rational choice models, and he became identified with the framework of 'exchange theory' (Homans, 1961). Robert Bales, a colleague of Homans, carried out some interesting small-group research (Bales, 1950), but he did not use a sociometric approach to his work and became increasingly linked with Parsonian structural functionalism (Parsons et al., 1953). The work of many who had contributed to the development of the idea of balance returned to exclusively psychologicistic concerns, and the influential text of Festinger (1957) became an important charter statement in directing these researchers back into the social psychology of perception. The area of group dynamics all but stagnated, with most advances being in the purely mathematical problems of balance, cliques and clusters. While these mathematical explorations were to prove important and fertile sources for the advances later made by Harrison White, they had little impact on the shape of social research during the 1950s and 1960s.

Networks: Total and Partial

It was in the work of a small group of active fieldworkers associated with the Department of Social Anthropology at Manchester University - most notably John Barnes, Clyde Mitchell and Elizabeth Bott 16 _ that the framework of social network analysis took a novel turn. Those whom I have loosely described as the 'Manchester' anthropologists were even more strongly influenced by RadcliffeBrown than were their Harvard counterparts, and they sought to develop his ideas in a novel direction. Instead of emphasizing integration and cohesion, they emphasized conflict and change. A central figure at

Manchester was Max Gluckman, who combined an interest in complex African societies with a concern to develop a structural approach which recognized the important part played by conflict and power in both the maintenance and the transformation of social structures. For Gluckman, conflict and power were integral elements of any social structure, and his analyses stressed the everpresent activities of negotiation, bargaining and coercion in the production of social integration. Gluckman actively encouraged his colleagues and students who were undertaking investigations of small-scale interpersonal communities to pursue these themes.

The dominance of the Parsonian approach to sociology and of cultural approaches in anthropology during the 1950s was an important factor in directing the work of the Manchester school as a distinctly critical tradition. Where classical sociologists had emphasized that actions were to be understood in terms of their location in a structure of social relations, Parsons (1951) held that actions must be explained as expressions of internalized value orientations. The work of the Manchester anthropologists, with its emphasis on seeing structures as 'networks' of relations, combined the formal techniques of network analysis with substantive sociological concepts. This proved an impressive and powerful mixture, which brought it close to the emerging framework of 'conflict theory' in sociology, but their emphasis on interpersonal relations meant that it did not appear as a full-blown alternative to Parsonian theory. For this reason, social network analysis could not help but be seen as a specialized area of study rather than a critical alternative to conventional sociology.

The Manchester researchers, then, paid less attention to the formally institutionalized norms and institutions of a society and rather more to the actual configuration of relations which arose from the exercise of conflict and power. The theoretical ideas inherited from the past, geared to the understanding of simple, kinship-based societies, were unable to handle these phenomena, and it was in recognition of this inadequacy that they began to try to systematize such metaphorical notions as the 'web' and 'network' of social relations to which such writers as Radcliffe-Brown had pointed.

Initially, these researchers began to employ the idea of a social network simply in its metaphorical sense, but Barnes, in the early 1950s, took a lead in applying this idea in a more rigorous and analytical way. His approach had a considerable influence on the work of Bott, and the two began to explore more closely the work that had been undertaken in the sociometric tradition. Their various papers (Barnes, 1954; Bott, 1955, 1956) received a broad welcome among social anthropologists, the concept of the social network seeming to meet a need for appropriate concepts to use in understanding complex societies. Siegfried Nadel espoused this approach in a set of lectures and an associated book (Nadel, 1957) which became a programmatic charter statement from a leading figure in the discipline. But it was Clyde Mitchell who undertook the tasks outlined by Nadel and laid the basis for a systematic framework of social network analysis. Mitchell turned to the mathematics of graph theory which had emerged from the early sociometric concerns, and he reformulated these ideas as the basis of a distinctly sociological framework. Summarizing the ideas that had begun to crystallize during the 1950s in his own work and that of his colleagues (Mitchell, 1969), he set out a body of sociological concepts which, he believed, could adequately grasp the structural properties of social organization. Intriguingly, Mitchell's translation of graph theory and sociometry into a sociological framework led him to a concentration on exactly those features of 'informal' and interpersonal organization that had been highlighted by Mayo, Warner and Homans.

Barnes began his academic career at the Rhodes-Livingstone Institute in Central Africa, a major research centre for many of the Manchester anthropologists. After joining the Manchester department in 1949 he decided to undertake some fieldwork in the rather unusual setting of a fishing village in south-west Norway. Although it was a small village community, Bremnes was not an isolated locale structured exclusively through the kinship relations of its members. It was an integral part of a complex and socially differentiated national society, but it had its own economic, political and other institutions, which were

only imperfectly coordinated into an integrated system. Barnes was strongly drawn to the part played by kinship, friendship and neighbouring in the production of community integration. These primordial relations were not directly tied to territorial locales or to formal economic or political structures. Instead, they formed a distinct and relatively integrated sphere of informal, interpersonal relations. Barnes claimed that 'the whole of social life' could be seen as 'a set of points some of which are joined by lines' to form a 'total network' of relations. The informal sphere of interpersonal relations was to be seen as one part, a 'partial network', of this total network (Barnes, 1954: 43).

Bott, a Canadian psychologist, had studied anthropology under Lloyd Warner at Chicago, and it may be assumed that, like Barnes, she had some familiarity with the Yankee City studies. She joined the Tavistock Institute in 1950 and soon began some fieldwork on the lives of a number of British families. Bott was principally concerned with their kinship relations, and she employed the concept of a 'network' as an analytical device for investigating the varying forms taken by these kinship relations. This work was published in two influential articles and a book (Bott, 1955, 1956, 1957), and it was the basis of the PhD that Bott received from the London School of Economics in 1956.

The evolving theoretical framework of her study was undoubtedly influenced by her colleagues at the Tavistock Institute which had, in 1947, joined with the Research Center for Group Dynamics at Ann Arbor to publish the journal *Human Relations*. As a psychologist with an interest in psychotherapy, she was aware of the work that had been undertaken by Moreno. Indeed, both she and Barnes cited Moreno in their own papers. The more immediate influence on Bott's work, however, was Lewin's field theory, and even Barnes wrote of the existence of distinct 'fields' of activity in Bremnes society. *Human Relations* published articles by Lewin, Festinger, Newcomb, Cartwright and other American leaders of small-group research, and it was there that both Bott and Barnes published their work on social networks.

Barnes had presented his initial ideas in seminars at Manchester and Oxford during 1953. It was in 1954 that Bott learned of Barnes's work and adopted the term 'network' as the basis of her own theoretical interpretations. By the time that Barnes's article was published, he was working under Raymond Firth at the London School of Economics, where Bott was already registered for her PhD - she presented drafts of her own paper that year at the LSE and at Manchester. These biographical details are not given for purely antiquarian reasons, nor are they given simply as illustrations of the importance of academic networks. My concern is to show how a small number of key individuals were responsible, in a very short space of time, for constructing the basis of a major theoretical innovation in British social anthropology. Once Barnes and Bott had made their breakthrough, the way was open for further developments which would consolidate their advances with further lessons from the American researchers. A key voice in legitimating this direction of theoretical advance was Siegfried Nadel. An Austrian psychologist, influenced by K6hler and Lewin, Nadel had transferred to anthropological studies in the early 1930s. In 1955 he presented a series of lectures on social structure at the LSE. Barnes and Bott had been important influences on the development of his work, and they were mentioned as both commentators and friends in the Preface to the published version of these lectures (Nadel, 1957). Nadel's starting point was a definition of 'structure' as the articulation or arrangement of elements to form a whole. By separating the forms of relations from their contents, he argues, the general features of structures can be described and they can be investigated through a comparative method. To pursue the aim of the construction of formal models, he advocated a mathematical approach to structure.

Social structure, according to Nadel, is 'an overall system, network or pattern' of relations (1957: 12), which the analyst abstracts from the concretely observable actions of individuals. By 'network' he means 'the interlocking of relationships whereby the interactions implicit in one determine those occurring in others, (Nadel, 1957: 16). A particular claim of Nadel was the idea that 'role' should be seen as the central concept in sociological theory. Social structures are structures of roles, and roles, together with their role sets, are defined through networks of interdependent activities. Nadel argued that algebraic and matrix

methods should be applied to role analysis, but apart from one or two brief illustrations, he gave little indication of how this was to be done. His early death, in 1956, prevented him from contributing further to the advances that he had signposted.

Mitchell and others associated with Manchester and the RhodesLivingstone Institute attempted to systematize this view during the 1950s and 1960s. Indeed, Mitchell can be seen as the true inheritor of Nadel's aspirations. Mitchell's codification of social network analysis in 1969 generalized Barnes's conception of the sphere of interpersonal relations into that of the 'personal order'.¹⁷ The personal order is the pattern of 'personal links individuals have with a set of people and the links these people have in turn among themselves' (Mitchell, 1969: 10). These patterns of interaction are, for Mitchell, the sphere of network analysis. Such interpersonal networks, he added, are built from two different ideal types of action, which combine in varying ways to form concrete interaction networks. There is, first of all, 'communication', which involves the transfer of information between individuals, the establishment of social norms and the creation of a degree of consensus. On the other hand, there is the 'instrumental' or purposive type of action, which involves the transfer of material goods and services between people (1969: 36-9).¹⁸ Any particular action will combine elements of both of these ideal types, and so particular social networks will embody both a flow of information and a transfer of resources and services.

Mitchell goes on to conceptualize the 'total network' of a society as 'the general ever-ramifying, ever-reticulating set of linkages that stretches within and beyond the confines of any community or Organisation' (Mitchell, 1969: 12). In actual research, he argues, it is always necessary to select particular aspects of the total network for attention, and these aspects he conceptualizes as 'partial networks'. There are two bases on which such abstraction can proceed, though Mitchell concentrates his own attention almost exclusively on one of these. First, there is abstraction which is 'anchored' around a particular individual so as to generate 'ego-centred' networks of social relations of all kinds. Second is abstraction of the overall 'global' features of networks in relation to a particular aspect of social activity: political ties, kinship obligations, friendship or work relations etc. For Mitchell and for most of the Manchester researchers, it was individually anchored partial networks that were to be the focus of attention. In this kind of research, individuals are identified and their direct and indirect links to others are traced. Such research generates a collection of ego-centred networks, one for each of the individuals studied. A similar approach was taken in Bott's earlier investigation of the ego-centred networks of husbands and wives, where she measured the 'connectedness' of these networks and the degree of overlap between marital partners' networks.

Mitchell recognizes the importance of the second mode of abstraction identified above - that which defines partial networks by the 'content' or meaning of the relations involved - but he sees this also as needing to be anchored around particular individuals. The 'partial networks' studied by sociologists and social anthropologists are always ego-centred networks focused around particular types of social relationship. Most such networks, Mitchell argues, are 'multistranded' or 'multiplex': they involve the combination of a number of meaningfully distinct relations. Thus, Barnes's original notion of the network, and that taken up by Bott, was a partial network in which kinship, friendship and neighbourliness were combined into a single, multi-stranded relationship which it was inappropriate to break down into its constituent elements.

Interpersonal networks, Mitchell claimed, can be analysed through a number of concepts which describe the quality of the relations involved. These are the 'reciprocity', the 'intensity' and the 'durability' of the relations (Mitchell, 1969: 24-9), concepts which echo Homans's distinctions between direction, frequency and intensity. Some, but not all, relationships involve a transaction or exchange, and so can be considered as 'directed' from one person to another. An important measure of such relations, therefore, is the degree to which the transaction or orientation is reciprocated. One person may, for example, choose another as a

friend, but this choice may not be returned: the chooser may be ignored or spurned. Multistranded relationships can involve a complex balance of compensating reciprocated and unreciprocated relations, in which, for example, financial aid flows in one direction and political support in the other. 19 'Durability' is a measure of how enduring are the underlying relations and obligations which are activated in particular transactions (Mitchell refers to Katz, 1966). Those which are constantly being activated in interaction are highly durable, while those which persist only for one or two activities are highly transient. While kinship obligations, for example, are very durable - they last for the whole of one's life - those that arise for a particularly limited purpose are more likely to be transient. 'Intensity' refers to the strength of the obligations involved in a relation. This reflects either the strength of the commitment to these obligations or the multiplexity of the relationship: multi-stranded relationships tend to be more intense because they are more diffuse in character. 20

Mitchell adds a further set of concepts, derived from a translation of graph theory into sociological language, which can be used to describe the texture of social networks. 'Density', for example, he sees as the completeness of the network: the extent to which all possible relations are actually present. This is what Barnes and Bott tried to describe with their notions of the 'mesh' and 'connectedness' of networks. 'Reachability' refers to how easy it is for all people to contact one another through a limited number of steps: how easy is it, for example, for gossip, ideas or resources to be diffused through the network. To these concepts, Barnes (1969) has added 'cliques' and 'clusters' as terms for identifying social groupings within networks, but these were not taken up in the empirical studies collected together by Mitchell (1969).

Institutionalized roles and statuses are the framework within which interpersonal networks are constructed, but they exist only in and through the reproduction of interpersonal networks. But Mitchell and the Manchester tradition equivocated about whether the institutional structure of roles is itself a part of network analysis or is separate from it. While some of the Manchester school saw the institutional role structure as a network of relations which exists alongside the interpersonal network, Mitchell often distinguished networks of interpersonal relations from structures of institutional relations. Mitchell's discussion, therefore, tended towards a 'residual' definition of the social network: network analysis concerns only the interpersonal sphere that is left behind after formal economic, political and other roles are extracted (Whitten and Wolfe, 1973). This proved to be highly significant for the subsequent development of social network analysis in Britain. To the extent that he sees social network analysis as a special method for the analysis of interpersonal relations, Mitchell departs from Nadel's aspiration for a general framework of structural sociology rooted in formal network analysis. This equivocation proved fateful for the development of social network analysis in Britain, which largely failed to attract adherents from outside the area of community studies.

The Harvard Breakthrough

The arguments of Mitchell, Barnes and Bott were extremely influential in Britain (see Frankenberg, 1966), but their very success meant that social network analysis came to be identified with the specific ideas of the Manchester anthropologists. That is to say, network analysis was seen to be concerned specifically with informal, interpersonal relations of a 'communal' type, and the method was seen as specifically concerned with the investigation of egocentric networks. As a result, the crucial breakthrough to the study of the global properties of social networks in all fields of social life was not made in Britain.

It was, in fact, at Harvard that this breakthrough occurred. A decade after Homans's initial explorations, a trickle of papers began to appear from Harrison White and his associates which pushed the analysis much further. Soon, the work of students and colleagues of the authors of these publications produced a torrent of papers which firmly established social network analysis as a method of structural analysis.

The key elements in this breakthrough were two parallel mathematical innovations (see the discussion in Berkowitz, 1982). The first of these was the development of algebraic models of groups using set theory to model kinship and other relations in the spirit of Lévi-Strauss. This led to a re-consideration of the early work in graph theory and in other branches of mathematics and to the attempt to use algebraic methods to conceptualize the concept of 'role' in social structure (White, 1963; Boyd, 1969; Lorrain and White, 1971). White's continued explorations of 'block Modelling' (see Chapter 7 below) can be seen as carrying forward the very emphasis on role structure to which Nadel had pointed. The second innovation was the development of multidimensional scaling, a 'scaling' technique for translating relationships into social 'distances' and for mapping them in a social space. Very much in the tradition of Lewin's work on field theory, these developments proved extremely powerful methods of analysis. (For applications in sociology see Laumann, 1966 and Levine, 1972.)

The confluence of these two strands led to the important and influential work of the new Harvard group centred around White (see Mullins, 1973). White had moved to Harvard from Chicago, and his work retained important links with that of Davis and others, who had elaborated on the basic sociometric views throughout the 1960s. The Harvard group developed as mathematically orientated structural analysts, concerned with the modelling of social structures of all kinds. There was no single theoretical focus to their work, the unifying idea being simply that of using algebraic ideas to model deep and surface structure relations. It was network analysis as a method that united them. The public reception of Granovetter's article (1973) popularized this viewpoint in American sociology and helped to stimulate many other studies. Although it was not a highly technical piece of mathematics - or, perhaps, because of this Granovetter's work was of central importance as a charter statement for popularizing and legitimating the position (see also Granovetter, 1982). Although many researchers continued to work in such areas as the analysis of 'community' structure, others were interested in such phenomena as corporate interlocks and so helped to move network analysis away from its 'residual' focus on purely interpersonal relations. In doing so, they stimulated numerous substantive applications of the techniques. Much of the effort of the Harvard group - no longer based solely at Harvard - was centred on the International Network for Social Network Analysis (INSNA) at Toronto, which acted as a focus for the development of social network analysis under the leadership of Wellman and Berkowitz, both former students of White .21

Two classic studies by Granovetter and by Lee grew out of the earliest discussions of the Harvard school. While they were not explicitly algebraic in their approach, they became important exemplars for others. This was not least because they offered substantive and analytical continuity with earlier sociometric work.

Granovetter's work on *Getting A Job* (1974) started out from a critical consideration of attempts by labour economists to explain how people find work. In particular, he wanted to explore the ways in which people acquire information about job opportunities through the informal social contacts that they have. His interest was in the kinds of links involved in the transmission of information, whether these were 'strong' or 'weak', and how they were maintained over time. To this end, he selected a sample of male professional, technical and managerial workers in a suburb of Boston who had changed their jobs during the previous five years. Granovetter found that informal, personal contacts were the primary channels through which individuals found out about job opportunities: 56 per cent of his respondents relied on this means, and this was particularly true for information about the higher-paying jobs. These results were not especially striking, being broadly in line with earlier research, and Granovetter set himself the task of identifying those who provided information and the circumstances under which they passed it.

Granovetter showed that the 'rational' choice of methods for acquiring job information was of little importance. Individuals did not really compare the rewards and costs attached to different sources of information, and there was little active 'search' for jobs. Instead, information was acquired accidentally whenever contacts volunteered the information. The most important people in providing information were

work or work-related contacts. They were rarely family or friends, and they tended to be people who were in different occupations from the respondent. The probability that a person would make a job change was dependent on the proportion of work contacts who were in different occupations from him or herself.

To explain these findings, Granovetter drew on an information diffusion model. Those people with job information were assumed to pass this on to a certain proportion of their immediate contacts, who passed it on, in turn, to a certain proportion of their contacts, and so on. Assuming that the information attenuates over time as it passes through subsequent links in the chain, it is possible to track its passage through a social network and to discover the number of people who will acquire the information and their various locations in the network. The acquisition of information, therefore, depends upon, first, the motivation of those with information to pass it on, and, second, the 'strategic' location of a person's contacts in the overall flow of information (Granovetter, 1974: 52).

It was at this point in his argument that Granovetter introduced his now-famous argument on 'the strength of weak ties'. The importance of strong ties is well understood. Those to whom a person is closest (family and close friends, workmates etc.) have many overlapping contacts with one another. They all tend to know and to interact with one another in numerous situations and so there is a tendency for them to possess the same knowledge about job opportunities. Information which reaches any one of them is more than likely to reach them all. Conversely, they are less likely to be the sources of new information from more distant parts of the network. The information received is likely to be 'stale' information already received from someone else. It is through the relatively weak ties of less frequent contacts and of people in different work situations that new and different information is likely to become available. What this means is that 'acquaintances are more likely to pass job information than close friends' (Granovetter, 1974: 54). In almost all cases studied by Granovetter, information came directly from an employer or one of the employer's direct contacts - there was, typically, a maximum of one intermediary. Links through more than two intermediaries were very rare. It was the short, weak chains of connection that were of greatest significance in the receipt of useful job information.

A comparable, and slightly earlier study was Lee's work on *The Search for an Abortionist* (1969). In a situation where abortion was illegal, Lee wanted to discover how women acquired information about the opportunities for such terminations. Doctors who undertake illegal terminations cannot advertise and must often operate from hotel rooms rather than from clinics. Those who seek an abortion must, therefore, try to obtain information from those of their friends and acquaintances who may have had some experience with abortion in the past, as these people are likely to have that information or to be able to put them in contact with others who can help.

To study this process, Lee contacted abortionists and women who had had recent experience of an abortion. In constructing her sample she was, interestingly, having to use information search techniques which were similar to those used by the women themselves. Like Granovetter, she used a mixture of interviews and questionnaires to gather her data. Having explored various aspects of their life and social background and their attitudes towards conception and abortion, Lee turned to an examination of their search for an abortionist. The search involved the making of informed guesses about who might be able to help, either by providing the name of an abortionist or mentioning a further contact who might help. Lee found that women approached an average of 5.8 people before successfully contacting an abortionist the actual numbers of contacts ranging from 1 to 31. A number of the contacts, of course, were 'dead ends', and the 'successful chains' varied in length from one to seven steps, the average length being 2.8. Over three-quarters of the successful chains involved two or fewer intermediaries (Lee, 1969: Chapter 5). Contacts tended not to be relatives or those in authority (employers, teachers etc.), and the most important channels were female friends of the same age.

Both Granovetter and Lee explored network processes through the use of simple frequency tabulations, making only qualitative comments on the structure of the network relations that they discovered. Indeed, Lee argued that it is extremely difficult to trace the structure of overlapping personal networks in large-scale systems. Their studies were, however, important as outgrowths of and contributors to the systematic and analytical development of social network analysis. Their studies showed the power of even the most basic of social network methods, and they suggested an immense power for the more rigorous techniques being developed by their Harvard colleagues.

The power of social network analysis has become apparent in its use as an orientating idea and specific body of methods. But the application of formal mathematical ideas to the study of social networks has encouraged some writers to suggest that social network analysis offers the basis for a new theory of social structure. Barnes and Harary (1983), for example, have argued that it is possible to advance from the use of formal concepts to the use of formal theory. They argue that the promise of social network analysis can be realized only if researchers move beyond the use of formal concepts for purely descriptive purposes (see also Granovetter, 1979). Mathematics consists of theorems which specify the determinate logical links between formal concepts. Barnes and Harary argue that if the formal concepts prove to be useful ways of organizing relational data, then the theorems too should be applicable to those data. The application of theorems drawn from formal mathematics, then, 'reveals real world implications of the model that might otherwise have not been noticed or utilized by the designer of the model' (Barnes and Harary, 1983: 239).

Some have gone further, and have suggested that developments in social network analysis already point the way to novel frameworks of sociological theory, or to the re-assertion of earlier theories. Particularly influential, for example, have been advocates of an exchange theoretical perspective on social networks (Emerson, 1962, 1964; Cook, 1977, 1982), which is associated with wider 'transactionalist' approaches (Bailey, 1969; Boissevain, 1974) and rational choice theories (Lin, 1982). (See also the discussion in Banck, 1973 and van Poucke, 1979.) Whether social network analysis will, in the long run, point to the predominance of a particular theoretical framework is not a matter that will detain me in this book. It is undoubtedly the case that social network analysis embodies a particular theoretical orientation towards the structure of the social world and that it is, therefore, linked with structural theories of action. But it seems unlikely that any one substantive theory should be regarded as embodying the essence of social network analysis. The point of view that I shall elaborate in this book is that social network analysis is a particular set of methods and not a specific body of theory.