

INFORMATION FLOW IN AN
R&D LABORATORY

Thomas J. Allen and Stephen I. Cohen

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INTRODUCTION

Several recent studies (Shilling and Bernard, 1964; Allen, 1964; 1966b; 1966c) of industrial and government scientists and engineers have shown an inverse relation between extra-organizational communication, contrasting with a direct relation between intra-organizational communication, and performance. A related study of academic scientists (Hagstrom, 1965) in which the organization (an academic department) appears to occupy a subsidiary position to a more inclusive social system ("invisible college" or academic discipline), and where the communication process measured was external to the first entity but internal to the second shows a strong positive relation between the extent of communication and performance. Moreover, in the instances in which external communication bears an unfruitful relation to performance, there is evidence that it is not this communication, per se, which degrades performance but other factors, such as lack of necessary knowledge on the part of the engineer or scientist seeking information. The internal channels are better able to compensate for this deficiency, than are external ones.

Applying the rationale of a shared coding scheme produces a rather simple and straightforward explanation. In industrial and governmental situations, the laboratory organization dominates the scene. These organizations demand a degree of loyalty and affiliation far outweighing that required by academic departments. In addition, the members of industrial and governmental organizations acquire through common experience, and organizational imposition, shared coding schemes or common ways of ordering the world, that can be quite different from the schemes held by other members of their particular discipline. This is

not true of the academic scientists. They generally feel more aligned with scientists who share their peculiar research interests than with a particular university or department, and would therefore tend to share a common system of coding with such individuals outside of their department. In other words, the "invisible college" now becomes the mediator of the coding scheme.

The mismatch problem is compounded when, as is often the case, incompatibilities between the two coding schemes go unrecognized, or when identical coding systems which do not in fact exist are assumed.

There are, of course, possible measures that can be applied to reduce the organizational boundary impedance. One that may well take place under uncontrolled circumstances is a two-step process, analogous to that found in public opinion research, in which certain key individuals act as bridges linking the organization members to the outside world. Information then enters the organization most efficiently when it is channeled through these individuals, who are capable to operating within and transmitting between two coding schemes.

The possibility that such individuals exist, who in effect straddle the coding systems and are able to both function efficiently in the two, and perform a transformation between them, holds promise for their potential utilization in information transfer. [The present study addresses this problem directly by examining the flow of information both into and within the confines of a small research organization. But before turning directly to the problem at hand, let us briefly review a large body of research devoted to the examination of the flow of information in a somewhat different context.

Public Opinion Research

Twenty years ago, Lazarsfeld, Berelson and Gaudet (1948), to explain a phenomenon which they had observed in a study of popular decision-making during the course of the 1940 election campaign, first proposed what has become known as the two-step information flow hypothesis. It appeared that ideas flow from radio and print to opinion leaders and from them to the remainder of the population. Katz and Lazarsfeld (1955) in a subsequent study built a major hypothesis around this "two-step" process and were able to marshal considerable support for it. Instead of a simple direct connection between mass media and the general public they discovered the process to be more complex and to involve a number of intervening variables. Furthermore, the intervening variables (e.g., relative exposure; channel preference; the effect of message content; attitudes and psychological predispositions of the audience) all involve the individual's social attachments to other people, and the character of the opinions and activities which he shares with them. Thus, the response of an individual to a communicated message could not be accounted for without reference to his social environment and to the character of his interpersonal relations. This two-step flow was found to be mediated by "opinion leaders" who in every stratum of society perform a relay function: controlling the flow, for example, of political information from mass media to electorate, and thus influencing the vote. It was found that the opinion leaders were considerably more exposed than the rest of the population to the formal media of communication. As a result, Lazarsfeld and his colleagues (1948) argued that "ideas flow from radio and print to opinion leaders and from these to the less active sections of the population."

Specifically, it was found that "leaders in a given sphere (fashions, public affairs, etc.) were more likely to be exposed to the media appropriate to that sphere" (Katz, 1960). In addition to mass media exposure, influentials tend to have a greater number of interpersonal contacts outside of their own groups. Thus in a study of drug adoption by physicians, Menzel and Katz (1956) discovered that the more influential doctors were characterized not only by greater attention to medical journals but also by more frequent attendance at out-of-town meetings and the diversity of places with which they maintained contact. Similarly in studies of the adoption of such innovations as hybrid seed corn, Rogers (1962) concluded that opinion leaders, in this instance, can be characterized in terms of the relative frequency of their trips out of town, and in a general predisposition toward "cosmopolitanism."

Relation to the Flow of Technology

The most obvious connection between the flow of scientific and technological information and the studies cited above would appear to be through the studies of the adoption of agricultural and other innovations. The qualitative nature of the information being exchanged is certainly more akin to the type of information with which we are concerned, than is, for example, the information contained in communications which influence a person's vote or his choice of food or fashions. The results of such studies have been well summarized in the volume by Rogers (1962). There is certainly a clear analogy between transfer of information in the form of innovations from technology into societal utilization, and our present concern, the transfer of information from science to technology or from one organization to another within science or technology. Nevertheless, there is much that can be learned from the mass communications

studies that will be of value in better understanding the process of technological information flow. The research to be reported in the paper has, therefore, drawn heavily upon the work of both the mass communication theorists and of social scientists concerned with the transfer of innovation.

Katz and Lazarsfeld (1955) and Rogers (1962) stress the importance of the individual's face-to-face relations in transferring information of these two diverse types. Katz and Lazarsfeld, for example, confess that their studies have led them to "rediscover" the primary group. There is quite clearly a parallel in the research and development laboratory. Strong evidence has been found that engineers are not very closely connected to the formal communication media, and that they rely much more heavily upon oral channels. There is also some evidence from Allen's studies, that other members of the engineer's immediate work group or colleagues and friends in other parts of the organization are often instrumental in delivering information to him, or making him aware of the existence of a particular source. Repeatedly, when the researchers attempted to determine the source of a particular idea, it turned out that no single source was responsible, but rather that several sources contributed to the discovery or formulation. In one case, an engineer's colleague hears a paper delivered at an SAE conference, associates the device described with a problem which the engineer has and tells him about it. The engineer, himself, follows up the lead, searches the literature, contacts the man who delivered the paper, and gets in touch with a vendor who can supply some of the hardware. Another case is quite similar. A vendor visits a particular engineer, and tells him about a new piece of equipment which his company has developed. The engineer knows of a colleague to whose problem this equipment might be relevant. He

suggests that vendor contact his friend; the vendor does, and the application is found appropriate.

These instances are stated exactly as they were related to the interviewer, and they are not isolated occurrences. Very frequently a mediator either directly relates information which he has obtained from another source, or indirectly assists in the transaction. The evidence from the parallel studies is sufficient to at least indicate the possibility of a two-step flow in technological communication.

The Hypotheses

Two major hypotheses have been generated based upon the findings of earlier studies in mass communication, and upon other research on information flow.

1. Technological gatekeepers. There can exist in an R&D laboratory certain key individuals who are capable of effectively bridging the organizational boundary impedance and who provide the most effective entry point for ideas into the lab. These gatekeepers will be characterized in three ways:
 - a. They will be the people to whom others in the lab most frequently turn for technical advice and consultation.
 - b. They, themselves, will be more exposed (than others in the lab), to such formal media as the scientific and technological literature.
 - c. In addition to exposure to formal media, the gatekeepers will maintain a greater degree of informal contact with members of the scientific/technological community outside of their own laboratory.
2. The influence of the primary group. The role of the primary group in mediating information flow will be manifested in two ways:
 - a. Communication patterns will tend to follow the structure of both the formal work group structures and the informal social relationships in the laboratory.

- b. Technological attitudes, attitudes toward such things as feasibility of particular approaches which are not yet physically testable, will be strongly influenced by the attitudes held by other members of the primary groups to which the engineer belongs.¹

RESEARCH METHODS

As an initial step in testing the hypotheses, a sociometric study of interpersonal relations and information flow was conducted in a small R&D laboratory. This laboratory is actively engaged in work on new materials and devices, in the fields of direct energy conversion and solid state electronics, for both military and industrial applications.

The data were collected from the 28 of the 34 professional members of the laboratory by means of written questionnaires followed up by brief personal interviews.

Sociometric Relations. Table I shows a listing of some of the different sociometric responses that were obtained. The questions were aimed at determining the manner in which information flow in the lab relates to other sociometric choices. For instance, are the persons that a respondent sees socially also the same persons with whom he has technical discussions. Two distinct classes of sociometric relations were considered. The first of these deals with the

¹This hypothesis is, of course, directly attributable to the thinking of Kurt Lewin and his followers, who proposed that when an opinion or attitude cannot be tested directly against "physical reality" that the individual will resort to a test against "social reality." In other words, he will look to his peers for confirmation or disconfirmation and react accordingly. This is now a concept which is treated in some detail in most Social Psychology textbooks, see for example, Newcomb, Turner and Converse (1965), p. 234. The present hypothesis merely extends this line of reasoning into an area where attitudes are usually, but not always accessible to physical testing.

various social relations within the lab, and the second provides an indication of the routing of technical information through the organization. To the sociometric queries were added a third class of question, dealing with individual information gathering behavior, and including questions on technical reading habits, and degree of technical discussion and contact with members of organizations other than their own (Table II). The respondents were also asked to indicate their attitude on each of three rather uncertain technological questions confronting the laboratory.² The amount of agreement within various groups (work group, social cliques, etc.) could then be examined. Two persons were said to agree on attitude if their scores on each question were within plus or minus one category on a seven point attitude scale.

Table I

Sociometric Relations Studied

| | |
|----------------------|--|
| socialization | name the 3 or 4 persons from the lab with whom you meet most frequently on social occasions. |
| work group | name the people whom you consider to be members of your present work group. |
| technical discussion | name the 3 or 4 people with whom you most frequently discuss technical matters. |
| special information | (obtained during the interviews subsequent to the questionnaire) -- the source, if any, from which the respondent reported having received special information that influenced him during the course of his last completed research project. |
| research idea | to whom in the lab would you first express an idea for a new research project. |

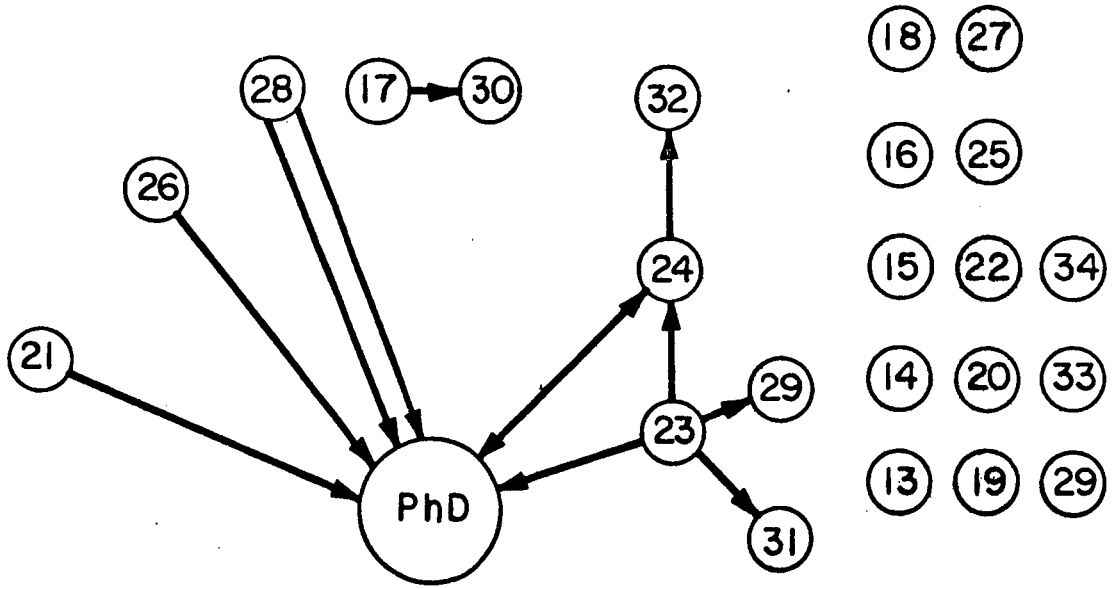
²These were obtained from the research director of the lab.

Table II
Factors Related to Information Gathering Behavior

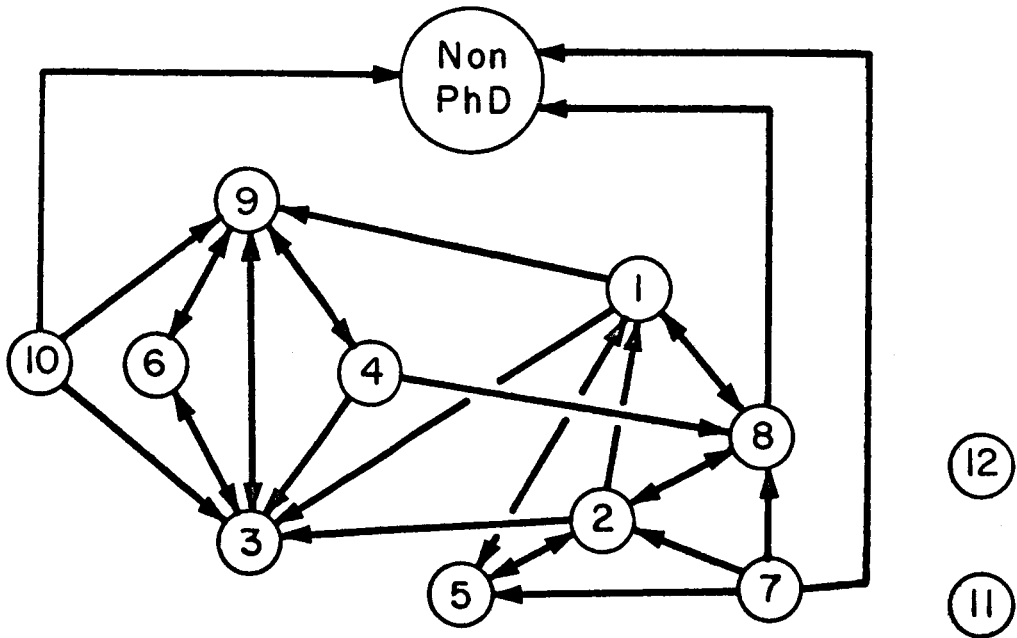
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1. the number of technical periodicals read regularly by each subject.
 2. the extent to which each subject reports using the following information sources:
 - a. personal friends outside the organization
 - b. technical specialists within the lab
-

The Sociograms. A preliminary examination of the sociometric relations revealed a marked distinction between those members of the lab holding and not holding Ph.D. degrees. This distinction so permeates the data, that in much of the ensuing analysis, it will be treated as a variable for which some control is required. The socialization matrices are especially pointed in illustrating the dichotomy (Figure 1). Except for subjects 11 and 12, who were social isolates, the Ph.D.'s group together quite strongly. Non-Ph.D.'s, on the other hand, show relatively few social contacts among themselves. The large circle labelled "non-Ph.D." in Figure 1(b) represents the Ph.D. to non-Ph.D. choices, and shows practically no social intercourse. The circle labelled "Ph.D." in Figure 1(a) gives an indication of which non-Ph.D.'s choose into the Ph.D. group. Only five non-Ph.D.'s do so, and in only one case, subject 24, is the choice reciprocated. Reciprocal choices are indicated in the diagram by double-headed arrows.

In order to compare sociograms for two or more types of choice (e.g., technical discussion and socialization), the sociometric choices for each question were laid out in the format of an $N \times N$ matrix where N equals the number of persons in the laboratory (34). An entry "1" at a_{ij} indicates that there is a



(a) Non - PhD's



(b) PhD's

Figure 1 Socialization - Choices

direct connection from person i to person j . An entry "0" indicates that no connection exists. The rows are subscripted i and the columns are subscripted j . In examining the matrices it can be seen that the number of times the j^{th} person was chosen is indicated by number of 1's in the j^{th} column.

In order to determine the relationships between any two matrices for the sociometric choices, a count is made of the number of times $a_{ij} = b_{ij} = 1$, $a_{ij} = b_{ij} = 0$, $a_{ij} = 1$ and $b_{ij} = 0$, and $a_{ij} = 0$ and $b_{ij} = 1$. These numbers are inserted in a 2 x 2 table and tested for significance with the chi-square statistic. Some hypothetical results from this procedure are illustrated in Table III. The number 27 is the number of times that the two matrices agree on

Table III
Sample Contingency Table Resulting from the
Sociometric Analysis

| | | Technical discussion | | |
|---------------|-----|----------------------|-----|----------------------------|
| | | Yes | No | |
| socialization | Yes | 27 | 17 | $X^2 = 125$ $p = 0.001$ |
| | No | 71 | 837 | |

on choice of person. Seventeen persons who were chosen for socialization were not chosen for technical discussion. Seventy-one persons were selected for technical discussion and not selected for socialization. Eight hundred and thirty-seven is the number of times that the two matrices have a corresponding absence of choice. In other words, there were 837 possible choices which do not appear in either matrix. The value of chi squared for these data is

equal to 125 which is statistically significant at less than the 0.001 level. In other words, out of the 34 socialization choices made by the entire laboratory, 27 choices involved the same people with whom the choosers also have technical discussion. Thirty-four is the sum of the numbers in the Yes row.

RESULTS

Relations Among Sociometric Choices. Considering the way in which the social structure of the lab affects the exchange of information, Table IV presents

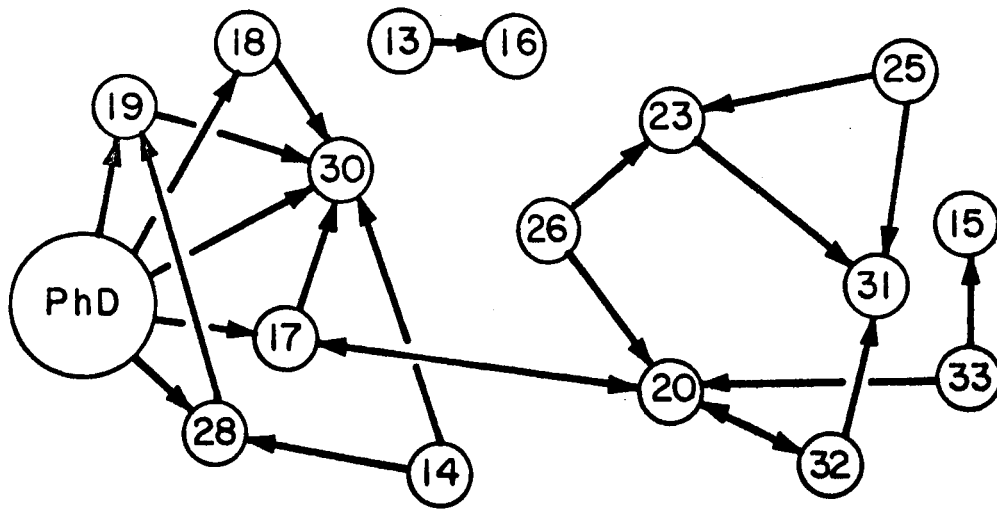
Table IV
Comparison of Socialization and Communication-Oriented Sociometric Choices

| | chosen socially | not chosen socially | X ² | level of statistical significance |
|---|-----------------|---------------------|----------------|-----------------------------------|
| percentage of technical discussion choices | 28% | 2% | 125 | 0.001 |
| percentage of choices as a person to whom respondent turned for special technical information on his last completed project | 35 | 4 | 62 | 0.001 |
| percentage of choices as a person to whom the respondent would take a new research idea | 86 | 4 | 42 | 0.001 |

results for the comparison of three communication-oriented sociometric choices with the socialization choice. There is strong agreement between the selection of individuals for socialization and technical communication. This is due in part, but certainly not entirely, to the rather tight clique found among the

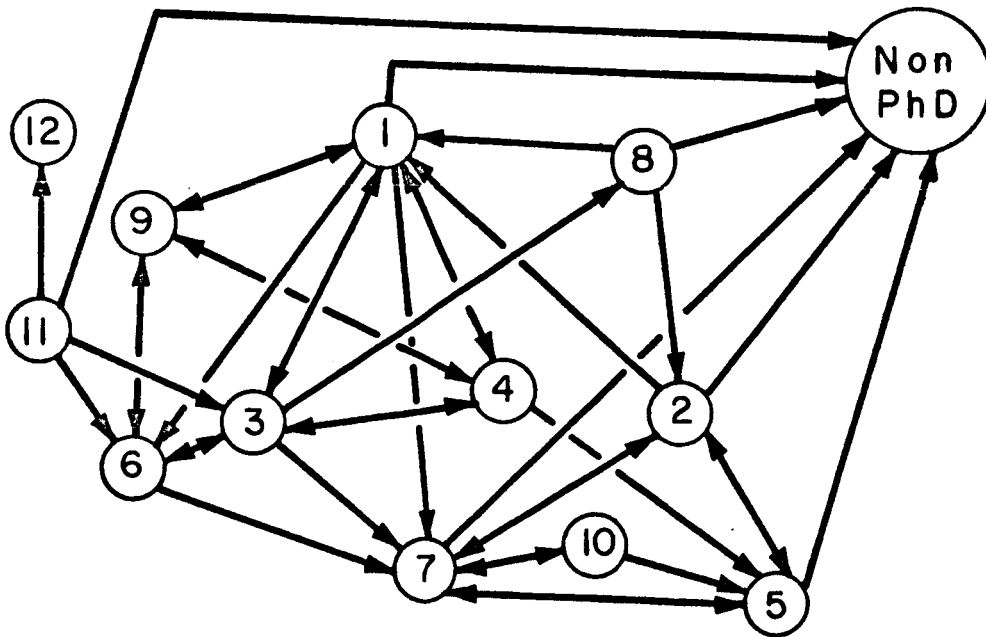
Ph.D.'s in the lab. The technical discussion matrix shows three rather well defined cliques (Figure 2). In addition to the Ph.D.'s there are two cliques among the non-Ph.D.'s. The relation between technical discussion and socialization is statistically significant among the non-Ph.D.'s in these two cliques as well as among the Ph.D.'s alone, although the latter relation is somewhat stronger. Social contact, then correlates very highly with the three mechanisms considered in Table IV, for the transfer of technical information. Furthermore, the relations hold equally well in this lab for both Ph.D.'s and non-Ph.D.'s. While it is impossible from data such as these to determine the direction of the causal link (i.e., does socialization bring about transfer of technical information, or do people socialize more with those with whom they like to discuss technical matters), we are led to conclude that the informal structure of the lab occupies a very important position in the transfer of information.

A question concerning the impact of the formal organizational structure upon communication now remains. Since the organization of the lab studied is quite flexible and revolves around a number of long and short-term projects, all under one or two research directors, our consideration of formal structure will be restricted to the ad hoc project groups. The respondents were asked to name "the people whom you consider to be members of your present work group." Table V shows that much, but not all of the socialization occurs within the work groups. A similar situation exists for technical communication (Table VI). Most of the technical discussion choices are directed to work group members. Replies to the critical incident question concerning information which influenced the course of the respondent's last completed project, however, show an interesting difference. This information (in the eleven instances in which



- 34
- 29
- 27
- 24
- 22
- 21

(a) Non - PhD's



(b) PhD's

Figure 2 Technical Discussion-Choices

Table V
Comparison of Work Group and Socialization Choice

| | chosen socially | not chosen socially | X^2 | level of statistical significance |
|---|-----------------|---------------------|-------|-----------------------------------|
| percentage who are members of the individual's work group | 42% | 7% | 26 | 0.001 |

Table VI
Comparison of Communication Choices with Work Group Structure

| | members of work group | non-members | X^2 | level of statistical significance |
|--|-----------------------|-------------|-------|-----------------------------------|
| percentage of technical discussion choices | 54% | 6.5% | 165 | 0.001 |
| percentages of choices to whom the respondent turned for special technical information on his last completed project | 0 | 5.3 | 4.9 | 0.05 |
| percentage of choices as a person to whom the respondent would take a new research idea | 2.9 | 7.1 | 2.3 | 0.20 |

another person within the lab was the source) came exclusively from people outside of the recipient's immediate work group. There is also a tendency to take new research ideas to someone outside the work group, but this difference is not statistically significant.

Both the formal and informal structures are important in mediating information transfer in somewhat different ways. They employ slightly different mechanisms (discussion vs. query or statement) and possibly handle different types of information. Unfortunately, our data are insufficiently detailed to determine the precise nature of the information which is transferred; this will be the subject of future investigation.

Controlling for the effects of the formal organization, by comparing only those social and technical discussion links which are external to each individual's work group (Table VII) produces an even stronger relationship than was found when work group members were included.

As would be expected, the formation of work groups operates to channel the direction of technical discussion within the lab. However, this flow is also

Table VII

Comparison of Socialization and Technical Discussion Choices External to the Work Group

| | chosen socially | not chosen socially | χ^2 | level of statistical significance |
|--|-----------------|---------------------|----------|-----------------------------------|
| percentage of technical discussion choices | 40% | 20% | 96 | 0.001 |

directed by informal patterns of socialization.

Information Habits and Sociometric Communication Choices. More relevant for our purposes is the relation between actual selection of an individual as a potential source of information and that individual's own personal information gathering

behavior. We asked each respondent to name individuals with whom he regularly had technical discussions, and those from whom he received special information which influenced the course of his last completed research project. The individuals who were rated high and low on these sociometric measures were then compared on the extent to which they themselves used three information channels, viz., friends outside the lab, technical staff within the lab, and the literature.

Turning first to those members of the lab who are highly chosen for technical discussion³ (Table VIII), we find that the sociometric stars have more exposure to both the literature and to oral sources outside of the laboratory than does the average employee of the lab. Contact by these stars is most frequent with the literature that is sponsored by scientific or professional engineering societies.

When requested to indicate the source of any information which influenced the course of their most recently completed research projects, twelve people cited other individuals (seven) within their own laboratory as the source of such information. In Table IX these seven people are compared in terms of their own information gathering behavior in the same manner as were the technical discussion stars. We again see the pattern of greater contact with experts outside of the organization and more exposure to the literature.

Individuals who are highly chosen as sources or potential sources of technical information are considerably different from their colleagues. They have

³Those who receive six or more technical discussion choices (eight people). Splitting the sample at the median number of choices (1.5) produces no significant difference between upper and lower halves. The data, however, show a distinct discontinuity between four and six choices so the sample was divided at this point and the sub-samples compared.

Table VIII

Comparison of Communication Behavior and
Technical Discussion Choices

| Communication Characteristics | Number of Times Chosen on Technical Discussion Matrix | | |
|---|---|---------------|-----------------------------------|
| | six or more | four or fewer | level of statistical significance |
| percentage who are above median in using personal friends outside the laboratory as an information source | 63% | 25% | 0.06 |
| percentage who are above median in using technical specialists within the laboratory as an information source | 50 | 40 | 0.47 |
| percentage who are above median in total number of technical periodicals read | 88 | 40 | 0.01 |
| percentage who are above median in number of professional and scientific periodicals read | 75 | 35 | 0.001 |

*Based on Mann-Whitney U-Test performed between the two groups.

greater contact with technical people outside of the organization and are more exposed to the technical literature. Moreover, they all rely to very much the same extent upon internal consultation.

There appear then to be two distinct classes of individuals within this laboratory. The majority have few information contacts beyond the bound of the organization. A small minority in contrast have rather extensive outside contacts and furthermore serve as sources of information for their colleagues. There is then evidence of a two-step flow of information in the laboratory studied. Six or seven individuals act as technological gatekeepers for the

Table IX

Comparison of Communication Behavior and Identification as
The Source of Special Technical Information
During One of the Lab's Projects

| Communication Characteristics | seven individuals cited | others | level of statistical significance |
|--|-------------------------------|--------|---|
| percentage who are above median in using personal friends out- side the laboratory as an infor- mation source | 67% | 30% | 0.10 |
| percentage who are above median in using technical specialists within the laboratory as an in- formation source | 57 | 40 | 0.17 |
| percentage who are above median in total number of technical periodicals read | 100 | 45 | 0.05 |
| percentage who are above median in number of professional and scientific periodicals read | 86 | 35 | 0.03 |

*Based on a Mann-Whitney U-Test performed between the two groups.

rest of the lab. As further support, it was found that two of these six or seven people were responsible for introducing all four of the "most important technical ideas" that had been introduced into the organization during the preceding year.

The gatekeepers themselves show some variation in the type of information sources they use. Some rely more upon the literature than upon oral sources, while some operate in reverse. A comparison of relative exposure to technically-oriented friends outside of the organization and to the scientific and professional literature shows a slight positive correlation (Kendall Tau = 0.27), but the relation does not approach statistical significance ($p = 0.21$).

Quite fortunately, it would appear for the lab the gatekeepers do not all tend the same gate.

Attitudes and Sociometric Choice. Table X reveals a rather interesting situation. A comparison of attitude agreement toward three technological areas with both socialization and technical discussion choices, shows technical discussion only to be related to attitudinal agreement. No relation is found between

Table X
Comparison of Sociometric Choices and
Technical Attitude Agreement

| | <u>technical attitude</u> | | χ^2 | level of statistical significance |
|---|---------------------------|----------|----------|---|
| | agree | disagree | | |
| percentage of socialization choices | 7.1% | 3.8% | 0.64 | 0.35 |
| percentage of technical dis- cussion choices | 16 | 8 | 9.12 | 0.01 |
| percentage who are members of work group | 16 | 7.3 | 5.74 | 0.02 |

socialization and attitude. We are therefore led to conclude that social interaction must take place on a technical base before it bears any relation to the attitudes held by the participants. Although one cannot determine directionality from data such as these, and it is therefore not certain whether technical discussion leads to attitudinal agreement or whether discussion choices are based upon prior knowledge of agreement, the mere existence of this relation should serve to warn us of possible dysfunctional consequences. For example, there is rather strong evidence (Allen, 1966a) that engineers,

once they have become committed to a particular technical approach tend to discount very strongly information which would disconfirm their attitude. If they, in addition, restrict their technical discussion to colleagues who share their attitudes, the probability of recognizing and accepting valid contradictory information is correspondingly lowered.

In other words, the bias that has already developed in the individual is reinforced by colleagues to whom he goes for technical discussion, since these discussants tend to be biased in the same direction.

The adverse consequences of such a phenomenon are too obvious to require further comment. Suffice it to say that engineers and scientists should be forewarned to consciously seek out contradictory opinions and attitudes concerning their work and to recognize the value of cultivating contrary-minded colleagues. Research and development managers can of course take this situation into account in forming their work groups. Judging from the second row of Table X, this was not done in the lab studied. In that instance, work groups for the most part comprised individuals who agreed rather uniformly in their attitudes toward the three technical areas. Merely introducing a single individual with conflicting attitudes should produce sufficient jitter to keep the group aware of other points of view. The possibility that the causal direction is such that interaction leads to agreement merely implies that management should periodically rotate their devil's advocates to prevent their capture by the prevailing group attitude.

But more important than this is the possible role of the primary group in attitude formation. Assuming for the moment that the causal arrow extends from

group to attitude,⁴ we have once again, to paraphrase Katz and Lazarsfeld (1955), "rediscovered the primary group." Katz and Lazarsfeld report doing just that in mass communication theory, meaning that the influence of the groups to which an individual belonged was for long ignored. The main concern was the direct impact of mass media upon individuals, and only when this was not evident did researchers turn to a consideration of group factors. The authors go on to recount a number of similar instances in social psychology beginning with the Hawthorne studies, where counter to expectations group dynamics were found to befuddle the researchers and to effectively nullify the intended effects of management's individual incentive schemes. The World War II studies of army life (Stouffer, et. al., 1949) again follow the same pattern, where, for example, combat motivation was found to be associated with attachment to an informal group. Soldiers assumed the attitude of their reference group toward combat involvement. Again, in sociological studies of the urban community, Warner and his associates (Warner and Lunt, 1941) found the "clique" to be of extreme importance in determining individual's positions in the social hierarchy of the community. Perhaps we should now add scientific and technological information flow to Katz and Lazarsfeld's list.

These studies began by relating in several ways the individual user, his choice of information channel and its effect upon his work. The evidence now requires examination of the individual's primary group relationships in any interpretation of user behavior. Clearly there are many engineers and even scientists who make little use of the formal literature. But this piece of evidence

⁴ And the studies of mass communication phenomena, as well as the overwhelming body of evidence from social psychological studies of group conformity (e.g., Asch, 1956) clearly make this a reasonable assumption.

viewed alone can be severely misleading. Only upon investigating the relationships of these individuals to their groups, both formal and informal, and the possible use of the formal literature by other members of these groups can we place literature (or any other channel's) value in its proper context.

CONCLUSIONS

The results of the current research provide substantial support for the two hypotheses concerned with the gatekeeper and the role of primary groups. There definitely appear to exist in the lab studied, technological gatekeepers, people to whom others turn for technical discussion and consultation, and who, in turn, report having a greater amount of contact with the professional and scientific literature or with technically trained friends outside the lab. In addition, we find two people who were responsible for introducing into the lab what were almost unanimously agreed upon by the respondents as the four most important ideas during the previous year. Both of these people are well above the average in their use of the literature and of interpersonal contacts outside of the organization as sources of technical information.

The complete and distinct relay personality does not, however, appear. Rather, there are varieties of people who are capable of performing the relay function. Some operate better translating from the literature; others from oral sources. Opinion leaders in the present context are not of a monolithic sort. They vary considerably in the nature of the sources from which they derive information and quite possibly in the functions for which their transmitted information is used. We are unable to test this latter possibility with the present data, but it remains an empirical question, and the subject for further research.

The situation described in the preceding paragraph is not unlike that discovered in mass communications research. In that context, opinion leaders were found to be differentiated by topic; those who were influential in public affairs were not necessarily influential in determining fashion patterns, and so on. Moreover, the nature of the area of influence was found to be related to media exposure.

When medium content was taken into account, it was found (at a more detailed level of analysis) that movie leaders read movie magazines more, public affairs leaders read more news magazines, fashion leaders more fashion magazines, and so on, suggesting that we should look in more detail at the content of the messages processed by the various gatekeepers in R&D laboratories. We are implying that the selection of channels (e.g., literature vs. external oral sources) by scientific and technological gatekeepers may be based upon the qualitative nature of the information in which the gatekeeper specializes, and that channels vary in their ability to provide different types of information. As an example, the literature has been shown to provide information which is important for keeping abreast of the state of a technological field, while oral sources are probably better in providing more specific detailed information about particular techniques. Gatekeepers who specialize in knowledge of the state-of-the-art would then tend to expose themselves more to the literature, while those specializing in particular research techniques would interact more with external oral sources.

We have already seen that a finer differentiation of channel information content can make some difference in our present data interpretation. When the Ph.D.'s are compared on the basis of number of periodicals read regularly

(Tables VIII and IX), the difference between those who were highly chosen for technical discussion and those who were not, is somewhat less than when they are compared on the basis of a particular subset of periodicals (scientific and professional journals).

The next stage in our research must then be concerned with a finer distinction among channels and information content, and must attempt to determine the characteristics which distinguish different types of gatekeepers. The latter goal has an important implication for management, since its attainment would allow the identification of these individuals who are the key nodes in the transfer of various kinds of information within the laboratory.

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