THE RESEARCH SUPERVISOR'S ROLE, NEEDS, AND PROBLEMS IN THE COMMUNICATION OF TECHNICAL INFORMATION*

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THE PROFESSIONAL ROLE OF THE RESEARCH SUPERVISOR

The research supervisor occupies a unique and key position in the structure of a research organization. He is at the crossroads between the research practitioner and the organization's management. As such he plays a management role analogous to that of the foreman in the production plant. However, instead of supervising plant operators in essentially repetitive routines, he is responsible for the productive utilization of non-routine intellectual and physical efforts of one or more scientists and engineers, who with their subprofessional aides and service specialists form the modern industrial research unit. The functional similarities of the research supervisor and the foreman in the organization's administrative machinery are striking. Each is a bridge between management, with its programs, policies, and objectives, and the personnel whose labors with processes, equipment, and scientific theory produce the raw product by which the organization exists. Each thus is required to speak two tongues and see two views, and to translate successfully from one to the other.

The research supervisor is the major source of instruction, guidance, and assistance for the men under his direction. He must be successful in this function despite the fact that the men he supervises usually possess in the aggregate considerably more detailed knowledge than he. He is also the primary evaluator and information channel through which the fruits of their efforts pass into other hands in the organization.

In the eyes of his superiors, the research supervisor has been entrusted with the vital responsibility of translating broadly defined research program plans into specific project tasks that can be mastered by his group. He is expected to have the resourcefulness to meet minor problems with simple and effective remedies, and the insight to call for more help, a changed objective, or abandonment of the project when major troubles arise. His superiors expect him to analyze experimental results from the viewpoint of their value as program accomplishments. They look to him as the person to call upon when some special need arises in a parallel unit of the organization for information that has been collected by his unit.

The term "research supervisor" evokes quite a clear-cut picture to most research personnel, and it is probable that the description just given of his functions and relationships will be considered valid by a good nine-tenths of the research supervisors.

HIS COMMUNICATION FUNCTIONS

The communication requirements thrust upon the research supervisor are staggering in their variety and complexity. In their intellectual demand they range from a simple dispatching function, that merely requires him to pass information on unchanged to the proper superiors or subordinates, to important decision-making and analysis whereby a broadly phrased request is converted into a set of project instructions, or experimental data are analyzed for future program recommendations.

The communications media available to the research supervisor similarly are widely varied. Mechanically they range from face-to-face conversations to the telephone, tape and wire recorders, the typewriter, and a host of reproduction devices. Organizationally, he can use highly personalized modes, such as face-to-face conversation, letters, or memoranda; or he can employ group and mass communication techniques such as conferences, formal reports, and forms. In practice, most research supervisors use all these devices and perform all these functions at certain times.

A SURVEY OF PRESENT PRACTICES

The study reported here only aimed to observe the present communication practices of the research supervisor class. To the extent

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it adequately describes the "baseline" of the techniques used by the experienced research supervisor, it may be useful as a vantage point from which to judge or design innovations aimed at improving the research supervisor's functional effectiveness. And since the present practice among successful research supervisors is probably the most reliable prescription for effective communication that can be offered in our present state of knowledge about this subject, the patterns revealed may prove a useful check-list for research managements with new communication requirements or present communication shortcomings.

The primary data used in this study were obtained from a questionnaire survey of 56 industrial research supervisors. The quantitative precision and representative character of the results are qualified by the limited sample population and the non-random selection method, the existence of non-respondents that inevitably are encountered with mail questionnaire techniques, and the variation in interpretation of the questions by differently oriented respondents. Despite these limitations, however, it is believed that portions of this exploratory study have yielded trends or contrasts pronounced enough to constitute reliable evidence of the contemporary supervisor's communications methodology.

Survey Techniques and Response.--The transmittal letter and questionnaire used in collecting data for this study may be obtained from the author. About 70% of the questionnaires were distributed by sending groups of about half a dozen questionnaires to one person in an organization who was asked to pass them on to appropriate staff members. A total of approximately 113 questionnaires were distributed, of which 56 were filled out and returned. Most respondents cooperated in answering all of the sections of the questionnaire. The questionnaire was intended to yield data revealing particularly these several facts about the communications pattern of the research supervisor:

1. The relative importance of his communications links with other levels, persons, and units of the organization.
2. The physical mechanism of his communications.
3. The functional character of his communications with superiors, subordinates, and other supervisors and units parallel to him in the organization.
4. The effect of his organizational environment on his communications.
5. His attitudes concerning the technical communication environment of his organization.

Since many of the persons contacted were personal acquaintances of the author, the replies were examined to see whether these acquaintances had a different response pattern from that of non-acquaintances. No such bias was discerned. It also should be mentioned that the author thought a sufficient number of replies would be obtained from small research organizations (containing less than 100 professional staff members reporting to the top research director) to permit comparative examination of communication patterns in small versus large research units. However, it was found that while a number of smaller companies (fewer than 1000 total employees) were represented among the replies, the research organizations of all but one or two of them were substantial in size, and the small-research-unit sample did not appear large enough to justify a comparison. With this sole exception the raw data of the questionnaire met expectations.

Survey Sample Represented Large Research Organizations.--The environment of the research supervisors studied in this survey may be described essentially as follows:

1. Respondents were about equally distributed among large organizations (above 1000 total employees) and small organizations.
2. But almost all respondents were in large research units. About half of them were in echelons where there were ten or more other research supervisors at their level in the organization.
3. Three-fourths of the respondents supervised fewer than ten professional-level staff members.
4. Respondents were about equally distributed among environments where the persons with whom they had important communication links were (a) within walking distance; (b) within local phone distance; (c) in more than one city.
5. Respondents reported multiple work functions, averaging 2.5 per respondent. "Applied research" and "scientific research" were most prominently represented, followed by the categories "engineering process development," "chemical process development," and "product development," with "market development" last.

The 56 respondents were employed in a total of 20 organizations, mostly chemical and petroleum companies. Although these organizations are not thought to represent any cross-section of industrial research organizations, the respondents as a group probably are representative of the typical research supervisor in a relatively large, well-organized, and successful research organization.

Two environmental factors were examined in most of the detailed analyses made on the research supervisor's communications. They cover the factor of geographic compactness or diffuseness in his communications requirements, and the factor of high-echelon or low-echelon status for supervisors in organizations with a relatively long supervisory ladder. The specific

definitions of these categories are:

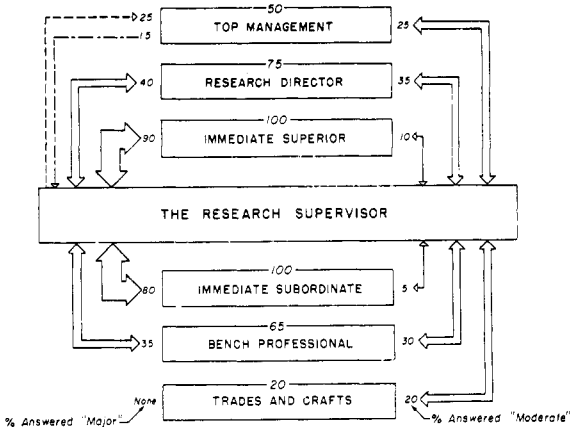
Geographically diffuse communications environments are defined as those environments where the research supervisor has important communications linkages with persons beyond walking distance or local telephone call.

Low-echelon supervisors are defined as supervisors who have one subordinate supervisor or no subordinate supervisor between them and the professional-level "bench" scientist or engineer.

Long supervisory ladders are defined as organizations where at least six echelons of supervision exist from the bench worker to the organization's top research director, inclusive.

Important Communications Linkages in the Organization.--In the research supervisor's line hierarchy, the importance of his technical communications linkage is affected strongly by his distance up or down the ladder from the person with whom he communicates. Figure 1 illustrates this effect. Perhaps the very noticeable attenuation with distance results from the relative formality of the line supervision ladder, with its spoken or unspoken rules about who has the obligation and prerogative of communicating with the research director or top management.

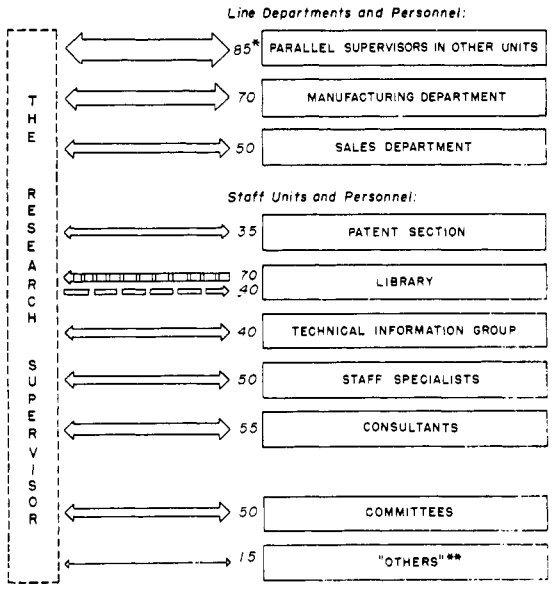
Fig. 1.—Important Technical Communication Links in the Research Supervisor's Line Hierarchy.



Numbers in blocks are total percentages of respondents indicating "Major" or "Moderate" importance for the communications link designated.

On the other hand, distance through the organizational structure has no apparent effect on the strength of the research supervisor's direct communications with persons and groups outside his own line supervision hierarchy. Figure 2 shows that strong links exist both with line and staff units and personnel. Probably few over-all formal procedures for these "sidewise" communications are spelled out in most organizations, but rather develop individually as the functional need for the communication linkage becomes evident to the parties concerned.

Fig. 2.—Important Technical Communication Links Between the Research Supervisor and Other Parts of the Organization.



*Total percentage of respondents indicating that these linkages were of "Major" or "Moderate" importance in their technical communication in the organization.

**Supplied as a block to be checked on questionnaire, with respondent to write in description of unit.

Only 14% of the respondents listed communication linkages with any other units besides those designated on the questionnaire and the linkages shown here probably constitute all the significant technical communication channels the typical research supervisor uses.

In most instances, the research supervisor considers the information he receives from all these communication links to be equal in importance in the company communications to the information that he transmits. The exceptions are his communication with top management and his communication with specialized staff and service units. In their exchanges with top management, 52% of the respondents rated their technical information flow to that echelon as of major or moderate importance, while only 39% rated the flow from top management in this category.

The most striking bias in the flow of information was reported with the library. There, only 39% of the respondents considered the information they sent to the library of major or moderate importance, but 70% considered that information sent them by the library constituted an information link of this importance. Interestingly enough, very little bias was reported by the respondents in their information transfer relations with the technical information group. This suggests that the member of the Technical Information Group is more likely to be like a working scientist than a librarian in his receipt, use, and transmittal of information, and that this distinction is recognized by the research supervisor.

Effect of Supervisory Level.--In several respects high-echelon supervisors reported communication linkages that varied enough from those of low-echelon supervisors to be worth noting. Some of these are reviewed:

1. Relative importance of the high-echelon supervisor's communications with top management and the research director is higher than those of the low-echelon supervisor. This should be expected as a natural consequence of the shorter communication linkage upward through the line hierarchy for the high-echelon supervisor.
2. Low-echelon supervisors reported relatively more important linkage with bench-level professionals and with trades and labor than did high-echelon supervisors. This further supports the belief that communications linkage length strongly affects the importance of the direct technical information transfer, and is the obverse of the effect reported above for high-echelon supervisors.
3. High-echelon supervisors show more important communications linkages than do low-echelon supervisors with: Parallel Supervisors in other units, Committees, Patent Section, Sales, Manufacturing.

   In no instance did low-echelon supervisors report more important communication with persons or units outside the line supervision chain than did the high-echelon class. It thus appears that high-echelon supervisors have in general a more complex and probably a heavier communication burden than the low-echelon supervisor. This conclusion is in keeping with the general conclusions of studies reported by Hertz and Rubenstein, who noted an increase in communication burden from assistants to professionals to supervisors.[1]

Effect of Geographic Concentration.--Similarly, some special bias seemed to distinguish certain communication patterns of supervisors in geographically diffuse organizations as compared with organizations having all their units operating in one city. Among these were:

1. Geographically diverse organizations showed stronger communications between the supervisor and the research director and top management than existed in geographically compact organizations. This may suggest that organizations with geographically diffuse units tend to offset the resulting communication handicap by establishing additional "direct-line" links between the research supervisor and higher research management.
2. Substantially more supervisors in geographically compact organizations report strong communication with "bench level" professionals than do supervisors from diffuse organizations. No ready explanation for this bias is advanced.
3. Geographically diffuse organizations show stronger communications than compact organizations with: Staff Specialists, Library, Manufacturing. For the library and staff specialists, this bias may mean that more people in geographically diffuse organizations are using an available staff service for help, whereas people in a compact organization may communicate the desired information directly with the active sources or users of the information. The stronger link with manufacturing may mean that more research supervisors in diffuse organizations are located in field facilities consisting of a major manufacturing unit with a somewhat specialized supporting research group.

The Machinery of Communication.--An outstanding impression gained in comparing the relative use of communication mechanisms available to the research supervisor is the informality of much of his technical communication. As Figure 3 shows, "informal conversation, face-to-face" is in a class by itself as a major means of technical communication, about 85 per cent. of the respondents so rating it. This is in agreement with similar conclusions by Herner[2] and by Hertz and Rubenstein.[3]

Fig. 3.--The Communication Mechanisms Used by the Research Supervisor.

Communication Mechanism	% Respondents Rating Importance as: Major	Moderate	Negligible
Informal Conversation, face-to-face	85	15	0
Periodic Research Progress Reports	55	35	10
Memoranda or Letters	55	40	5
Formal Reports	50	35	15
Telephone Conversations	45	45	10
Scheduled Conferences	45	50	5
Instruction Forms, etc.	20	30	50
Marginal Jottings, etc.	10	45	45

Following this category an almost equal grouping for: Periodic Research Progress Reports, Memoranda and Letters, Formal Reports, occurs. It is interesting to note all these are written communication techniques, and that as such none seems to have a significant lead over the others as the vehicle through which written communication is conducted.

Following is a natural group of two spoken vehicles of communication: Telephone Conversations, Scheduled Conferences. These vehicles rank as a strong third category.

A weak fourth category consists of: Instruction Forms, etc., Marginal Jottings, etc. Instruction forms and other types of form reports probably are too rigidly stylized to meet the continually changing demands of research communication, accounting for their low utilization. Marginal jottings probably receive such

a low usage because most of the serious technical communication of the research supervisor requires more time, study, and detailed presentation than the use of this vehicle implies.

Effect of Supervisor Level.--On several points the use of these communication vehicles varied according to the supervisory level of the respondent. For example:

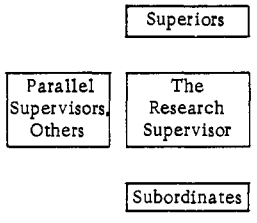
1. High-echelon supervisors showed lower usage of informal conversations and significantly higher usage of the telephone, compared with low-echelon supervisors. This is doubtless due to the considerably wider geography the high-echelon supervisor must span, even if he is communicating with only his immediate superiors and subordinates.
2. High-echelon supervisors use formal reports more and progress reports less than do low-echelon supervisors. This might result from a different functional use of these reports by the two classes of supervisors. For example, the low-echelon supervisor may be using these reports as tools for the technical administration of his group, where the week-by-week records are of primary value to him. In contrast, the high-echelon supervisor may be conducting his technical administration by memoranda and telephone and using the formal report primarily to evaluate the project accomplishments after the work itself has been completed and an integrated record is available.
3. High-echelon supervisors show a significantly higher use of jottings on clippings and similar marginal notes as a communications vehicle. This may imply either that their function permits them to transmit requests, instructions, and comments in broader terms or that they are under greater pressure and use stop-gap communication methods rather than not communicating at all. Perhaps both are implied.

Effect of Geographic Concentration.--Few geographic influences were noted in the relative use of communication vehicles. There was some evidence that compact organizations made greater use of form reports (possibly because informal communications vehicles such as the local telephone were readily at hand to supplement) and the telephone rate is higher in diffuse organizations (possibly through use of long-distance as the equivalent of face-to-face conversations). For the other vehicles, no geographic bias was apparent.

The Research Supervisor's Communications Roles.--To determine how significant a personal role the research supervisor played in the technical communication of his organization, the four roles defined in Fig. 4 were described to the respondent. He was asked to mark on a symbolic organization diagram the communication patterns through which he played each role in significant technical communication with his superiors, his subordinates, and "others" parallel in the chain of command or in other parts of the organization.

Fig. 4.—The Research Supervisor's Roles in the Communications Network.

% Respondents---	With Role of:	Defined as:
60	Dispatcher	Receive information, determine to whom it should go, and pass it on. Do not materially change its form or content in transmittal, and do not transmit it with directive instructions or recommendations.
80	Translator	Receive information, interpret it, and transmit appropriate portions phrased in the framework of the receiver's functional interests.
80	Advocate	Receive information, judge it, and draw conclusions and make decisions that you transmit as recommendations or instructions.
85	Source	From information you already have and/or which you collect for the purpose, an organized assemblage of information is created and transmitted. This may be in response to a request or through personal initiative required by the position.



The Symbolic Organization Diagram Definition:

For each role described above the respondent was asked to depict his role by arrows on this symbolic organization diagram showing origin and routing of his technical communication linkages.

The role of "Dispatcher" was intended to define a simple mechanical function in which no operation was performed on the content of the information.

The role of "Translator" was intended to define a function required by a "crossroads" position such as the research supervisor is thought to occupy. The translator converts information from one frame of reference to another, but he does not edit, interject his own emphasis, or otherwise introduce a bias to what he receives.

The role of "Source" was intended to characterize the act of technical creativeness, where information is not merely processed in transmission but new correlations and new data are generated and communicated.

The role of "Advocate" was intended to describe the "judge and persuade" function where judgment is brought to bear on just what is to be emphasized in transmittal, and indeed whether it is appropriate to transmit anything at all.

The multifunctional communications activity of the research supervisor was revealed again in the replies to this section. Functions checked by the respondents averaged more than three. The higher-activity roles dominated with 80 to 90 per cent. response with the essentially

mechanical "Dispatcher" role a poor fourth at about 60 per cent.

The respondent was not asked the relative frequency with which he played the roles he sketched out on the symbolic organization diagram. However, certain patterns repeated themselves frequently enough that some descriptive observations of apparent flow directions compared with the supervisor's functional role appear justified:

The Dispatcher role primarily occurs with information flowing down the line supervisory chain. It seldom occurs with information coming to the supervisor from parallel units in the organization.

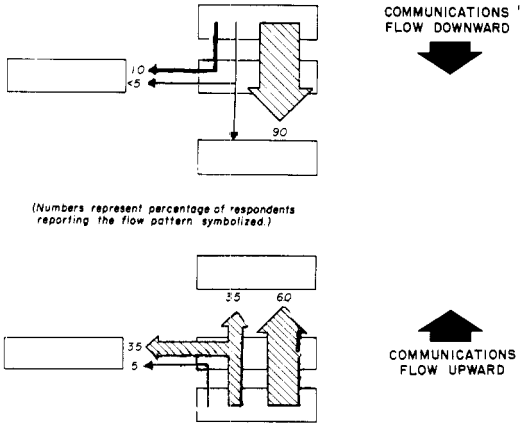
The Translator role is played primarily for the benefit of those up and down the line supervisory chain, with the information originating almost equally from above, from below, and from parallel units.

The Advocate role largely operates up the chain of command on information coming from below.

The Source role reveals the research supervisor as a radiating point feeding information in all directions. While the largest single flow is up the chain, the second largest is across, suggesting that the research supervisor is utilized personally by his superiors as a working "scientist" when inter-divisional needs require special analysis of research in progress.

One contrast of flow pattern was so striking as to deserve special mention. It was noted that when the 3-block and 4-block flow patterns for all roles were sorted out, those patterns in which the flow originated with superiors were almost without exception straight-line downward to subordinates. In vivid contrast, patterns originating with subordinates showed over one-third of the flow branching out to terminate with other units of the organization. This comparison is shown in Fig. 5.

Fig. 5.—Differences in Pattern of Communications Flow* Upward and Downward in the Organization.



*Comparison of technical information flow patterns where patterns (1) originated with "superiors" and (2) originated with "subordinates."

Two speculative explanations for this difference are ventured:

1. A person receiving information from above assumes that his fellows in other arms of the organization also have been contacted through their common supervisor. He may logically contend that he would reflect on the ability of his superiors, or contravene their intentions, by instituting cross-flow from his desk. For information flowing upward, he knows that he is the first person in a position to alert parallel units concerning matters of mutual interest.
2. The mechanics of his communication vehicles may account for the difference--at least in part. For communication flowing downward he will seldom receive spare copies of a written communication, and in communicating in turn to his subordinates he seldom needs to do more than supplement it with his own instructions. Furthermore, he may be expected to receive oral instructions from superiors and transmit oral instructions to subordinates, more customarily than is his practice for his communication upward. His written communication upward is more likely to be self-contained--not just an adjunct to another document. In such circumstances, the ease of communicating via carbon copy encourages a cross-flow to parallel units.

It is almost self-evident that the branched pattern created by the "upward" communication should produce quicker organizational response and more rapid executive action than a system where all information moves in strict line-of-supervision channels. More definitive studies would appear desirable to fix the reasons for this observed difference, and perhaps to evolve communication-downward techniques with branched-flow characteristics, or equivalent "knowledge permeation" potential.

The Research Supervisor's Attitude toward his Communications.--The questionnaire form employed gave the respondents ample opportunity to express any opinions or volunteer comments if they had the urge to do so. They seemed to feel the urge, as the replies contained an average of two write-in comments per questionnaire.

Almost without exception, the research supervisor appeared to accept the need for successful communications as a requirement for the proper performance of his function. He revealed that he has devoted some introspective thinking and personal observation to the specific subject of his communications with comments such as:

"Dependence upon informal conversation expedites work but tends to leave loose ends."

"Inward communications are more frequently oral; outward communications are more frequently written."

"General communications are excellent. Detailed information on such things as process details must very often be uncovered by personal contacts, etc."

The research supervisor in general is also pretty well satisfied with the communication situation in which he finds himself. He does, of course, have some ideas for improvement. Several of the respondents expressed a desire for more adequate direct communication from top management and other departments, especially manufacturing and sales. Over a third of them would like more information than they get now, but otherwise are satisfied (e.g., they do not think excessive information demands are made on them, or that the information channels are too formal, or that the information they transmit is not channelled adequately to the ultimate user).

In fact, the picture evoked by the survey replies is of a person with several most admirable qualities. He recognizes his place and function in a working team situation and gracefully accepts the responsibilities he must discharge to contribute his share to the team operation. He displays an intellectual appreciation of the techniques at his disposal for performing his function and exhibits some of the craftsman's pleasure in selecting the right technique for a given task. To let a typical research supervisor say it in his own words:

> "As I am a pilot plant group leader, the technical communications process is quite critical. General development programs for superiors must be broken down into ways and means for subordinates. Information from subordinates must be thoroughly reviewed so as to pass on the correct conclusions and recommendations to superiors."

These are the words of a man who clearly appreciates his communications functions. They are also the words of a man who shows he possesses the capacity to communicate effectively. Both qualities are unquestionably essential ingredients in the makeup of the successful research supervisor.

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