PROGRAM ON THE MANAGEMENT OF RESEARCH, DEVELOPMENT, AND TECHNOLOGY-BASED INNOVATION

Organizational Integration on New Technical
Organizational Integration of New Technical
Staff as a Function of the Nature of Work:
Implications for Interorganizational
Technology Transfer

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ABSTRACT

Hiring new staff in R&D provide an important opportunity for a firm to acquire new technological knowledge. It also takes a considerable length of time before new R&D staff become fully integrated into the organization. This study compares the communication patterns of new and veteran R&D staff as a function of their work activities. The results suggest that both the benefits and problems in the hiring and integration of new R&D staff is moderated by the type of research, development or technical service work involved. Particular attention should be paid to the integration of new staff involved in new product or process development, where the benefits of bringing in new people are great, but the communication barriers to overcome are also found to be the most serious.

INTRODUCTION

There are three general ways in which the technical staff of an R&D organization can stay informed concerning technological and scientific developments outside of the organization:

1) through readership of the scientific and engineering literature and other forms of documentation.

2) through contact directly or indirectly with knowledgable individuals, outside of the organization

3) through hiring and assimilation of new technically trained personnel.

The last of these, while having been shown to be of great importance (Cf. Rosenbloom and Wolek, 1970), has been relatively neglected in research (note 1). After all, what better way is there to obtain information than to hire people with that information? A transferring engineer brings in knowledge acquired from his prior employment, including much that might be regarded as proprietary information by his previous employer. This influx of new ideas and concepts is particularly critical in areas of rapid technological change. The parochial nature of technology and organizational barriers to external communication, which tend to isolate the organization, make this a particularly important way of connecting the organization with external technology. The new R&D staff represents new "blood" that can rejuvenate the organization.

Although new employees bring with them a wealth of new knowledge, this knowledge will not be useful unless it is successfully incorporated into the ongoing work of the organization. For their ideas to be useful, the new employees must also learn to understand the operating constraints and to utilize the technology base of the organization. Gerstberger (1971) found that it takes new technical employees approximately two years before they become integrated into the organization's interpersonal communication network. In comparing the communication patterns of new employees and veterans, Gerstberger found that new employees not only have fewer contacts within the organization, they also tend to communicate more among themselves. The weak communication link between new employees and veterans presents a major hurdle and results in ineffective utilization of a potentially valuable resource. This problem is highlighted by Pelz and Andrews' (1966) finding that while creativity is highest for those new members who have been with the organization for less than three years, overall usefulness does not peak until the person has been with the organization for at least four or five years. The successful integration of new employees into R&D organizations is thus an important subject of management concern.

Previous research, by the authors, (Allen, Tushman, and Lee, 1979; Allen, Lee, and Tushman, 1980) has clearly demonstrated the importance of taking into account the nature of the work, when analyzing the behavior of R&D professionals. Communication requirements differ markedly for staff engaged in research, development, or technical service activities. That these task divisions should be taken into account when viewing the integration of new technical employees follows directly from these earlier results. Different types of R&D activities have different information requirements (Allen, et al., 1980; Lee, 1980; Dewhirst, et al., 1978; Whitley and Frost, 1973). Moreover, the individuals working the different R&D areas, generally have different backgrounds and orientations toward work and toward the organization. This paper will investigate differences in communication patterns between veteran and new R&D staff members working in different R&D areas.

RESEARCH SETTING AND METHODS

This study was carried out at the R&D facility of a large American corporation in a specialized branch of the chemical industry. All the company's products are related in that they share a common technology core. The basic technology may be characterized as being relatively mature and the laboratory has been a leading developer of that technology.

The R&D facility employed about 735 people. This study focused on all the technical professionals in the organization (n=345). The laboratory was organized into seven groups or divisions. These divisions were further divided into separate project teams. Project teams were relatively stable in composition over time, since they were organized around product and technology areas, rather than short range problem efforts.

Technical Communication

Scientific and technical communication were sampled over a period of fifteen weeks. Data were collected via questionnaires which were distributed on randomly selected days. The sampling days were chosen so that there would be an equal number of each of the different weekdays in the sample. At the end of each sampling day, every professional was presented with a list of the names of the entire technical staff and was asked to check off those with whom he had discussed a scientific or technical subject that day. External contacts were reported in a similar manner. Check marks were placed in different columns to indicate the content of the conversation (i.e., problem definition or evaluation, idea generation, information location, or administrative matters). The first three of these categories will be aggregated as technical communication for the purposes of the present paper. As a result of travel, absences, etc., there is an average of ten returns per respondent. After accounting for absences, the response rate is about 90 percent. Moreover, 68 percent of all the communications reported within the laboratory were mentioned by both parties.

The sociometric communication data were first aggregated over the fifteen weeks. Missing data (for example, due to vacation, out-of-town, non-returns, etc.) were taken into account by normalizing the reported communications to an average frequency per week. The present study focuses on technical communication within the organization. In order to facilitate the analysis, aggregate measures of communication were classified according to the organizational affiliations of the discussion partners. More specifically, internal communications were categorized according to progressively larger but mutually exclusive organizational units.

> Intralaboratory Communication: Communications with colleagues within the R&D laboratory. Intralaboratory communication is further broken down into three categories: 1) Intraproject Communication (i.e., communications with other project members); 2) Intradivisional Communication (i.e., communications with other colleagues outside of one's project but within the same division); and 3) Interdivisional Communication (i.e., communications with colleagues in other divisions of the R&D laboratory.

> Communications With Corporate Functions: Communications with corporate staff in the operating units of the firm. This is separated further into three categories: 1) Marketing Communication (i.e., communications with marketing staff); 2)

Production Communication (i.e., communications with production staff); and 3) Communications with Other Corporate Areas (i.e., communications with corporate staff in such areas as planning, finance, and regional operating units.

External Communication: Communications with people outside the firm. External communication is broken into three categories: 1) Supplier Communication (i.e., communications with vendors and suppliers); 2) Customer Communication (i.e., communications with customers); and 3) Professional Communication (i.e., communications with outside professionals, consultants, and academicians).

Demographic Data

In addition to the communication survey, another questionnaire asked respondents to indicate the nature of their work (along the spectrum of activities from research, development to technical service) as well as other demographic information. The demographic information collected includes: 1) age, 2) education level, 3) number of years since graduation, 4) number of conferences attended during the past two years, 5) number of papers presented or published during the past five years, and 6) years worked in the laboratory. Returns from this questionnaire were obtained from 243 professionals (70 percent return rate).

Type of R&D Activity

To measure the type along the spectrum of R&D activities, respondents were asked to rate task objectives and percentage time spent in different work activities. Following the definitions used by Pelz and Andrews (1966), similar task categories were developed with the laboratory's management to form a task dimension covering the range of activities in the laboratory.

1) Basic Research: Work of a general nature intended to be applied to a broad range of applications or to the development of new knowledge.

2) Applied Research: Work involves basic knowledge for the solution of a particular problem. The creation and evaluation of new concepts or components but not development for operational use.

3) Development: The combination of existing feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. The applications of known facts and theory to solve a particular problem through exploratory study, design, and testing of new components of systems.

4) Technical Service: Cost/performance improvements to existing products, processes, or systems. Recombination, modification, and testing of systems using existing knowledge. Opening new markets for existing products.

Using these definitions, respondents were asked to rate their task objectives on a 12 point scale, i.e., three degrees of refinement within each task categorization. Similarly, the task effort scale was measured by using an average of task characteristics weighted with the percentage time effort spent in each category of activities. The two scales were found to be highly correlated ($r=0.91$, $p<0.001$). Type of R&D activity was thus measured by simply averaging these two scales. Since only a few respondents reported work of the basic research type, it was combined with applied research to form a single category. Overall, the distribution of task characteristics fell into three categories: research, development, and technical service.

In addition to the measure of work characteristics along the research, development, and technical service dimension, respondents were also asked to rate, on a five point scale, the rapidity with which the demand for their jobs was changing (e.g. due to changes in base technology and/or market conditions). The responses ranged from 1 to 5 with an average of 3.56 ($n=239$). Since the distribution of this score did not have any naturally clear boundary points, it will be split at the median and then used as a nominal variable.

Project Type and Project Performance

To classify projects, individual responses on task characteristics were pooled by project, using Bartlett's M test and a one way analysis of variance to check the appropriateness of pooling. If the variance within a project was significantly greater than a pooled variance (p=0.01), then the project was not included in the analysis. The classification of projects as research, development, or technical service was further validated by checking the written task descriptions from internal documents of the company. Using this procedure, 58 projects were classifed.

Data on project performance were obtained by interviewing the division manager (n=8) and laboratory directors (n=2). They were asked to evaluate all the projects with which they were technically familiar. Each project was thus independently rated by several managers on a seven point scale. A comparison of the rater means and intercorrelations shows one evaluator to differ significantly from the others, so his responses were excluded. The scores of the remaining nine judges were then pooled as a measure of project performance. Each project was rated by at least two judges with an average of 4.7 judges per project.

RESULTS

Veterans and New Employees

Following the findings of Gerstberger (1971), we define a new employee as someone who has been with the organization for less than two years. (Conversely, a veteran is someone who has been with the organization for two or more years). New employees were distributed more or less uniformly by project as well as by division within the R&D laboratory.

Veterans, on the average, have been out of school for a fairly long time (mean = 16.09 years, standard deviation = 10.70 years) (Table I). But the number of years since graduation for the new employees is also higher than expected, with a mean of 8.37 years and a standard deviation of 8.96. About 70 percent of new employees joined the organization after some prior work experience.

TABLE I

Comparison of Age and Experience of New Employees and Veterans

	Age		Number of Years Since Graduation	
	Mean	Std. Dev.	Mean	Std. Dev.
Veterans (n=175)	39.80	(10.44)	16.09	(10.70)
New Employees (n=68)	31.75	(8.18)	8.37	(8.96)
	$t=6.32^{+}$ $p=<0.001$		$t=5.69^{+}$ $p=<0.001$	

$^{+}$2 tailed t-test based on separate variance estimates

Comparing the educational background of veterans and new employees, no significant differences are found (Table II). Whatever differences may exist in the communication behavior of new employees or veterans cannot be attributed to education.

TABLE II

Education of Veterans and New Employees

	Proportion Attaining:				
	no degree	Bachelor of Science	Master of Science	more than Master of Science	N
Veterans	7.4%	60.0%	25.1%	7.4%	175
New Employees	7.4	64.7	19.1	8.8	68
Column Total	7.4	61.3	23.5	7.8	243

Chi Square = 1.06 N.S.

The average number of publications per year for new employees is significantly higher than that for veterans (Table III). The variance is also significantly higher among the new employees, indicating a difference in orientation, on the part of at least some new employees. Nevertheless, the data would indicate a cadre of new employees, who are much more involved in external technical activities than their older colleagues. Conference attendance is particularly surprising since one would expect the veterans to have easier access to travel funds.

TABLE III

Publications and Conference Attendence
By New Employees and Veterans

	Publications Per Year		Conference Attended Per Year	
	Mean	Std. Dev.	Mean	Std. Dev.
Veterans (n=175)	0.16	(0.29)	1.41	(1.45)
New Employees (n=68)	0.43	(1.12)	2.32	(6.55)
	$t=-1.96^{+}$ p=0.05		$t=1.14^{+}$ N.S.	

$^{+}$2 tailed t-test based on separate variance estimates

Generally speaking, new employees do not communicate as much with either their colleagues within the R&D laboratory or with people in other corporate functions (Table IV). Not only are the mean levels for the new employees lower in both cases, but the variances are also smaller. No significant difference is found in the mean level of external communication, despite the higher involvement of new employees. The variance is, however, significantly higher for new employees. Some have very high levels of external contact. Together, the data in Tables III and IV show that new staff members have a tendency toward higher external communication, but they are less integrated into the internal communication network (Note 2).

TABLE IV

Communication Patterns of Veterans and New Employees

	Within the Laboratory		With Other Corporate Functions		External		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Veterans (n=175)	29.4	(17.2)	5.3	(6.0)	2.2	(2.3)	36.8	(20.8)
New Employees (n=68)	24.8	(15.4)	3.3	(4.8)	2.2	(3.1)	30.4	(19.5)
	t=1.90 p=0.06		t=2.59+ p=0.01		t=-.12+ N.S.		t=2.20 p=0.03	

2 tailed t-test based on pooled variance estimates unless indicated by +

+2 tailed t-test based on separate variance estimates used when variables differ significantly, i.e., $p<0.10$

Integration of New Employees in Different Types of R&D

Having examined the overall differences between the communication patterns of veterans and new employees, we turn next to the effect of type R&D activity on the integration of new employees. In Tables V and VI, the average communication frequency between veterans and new employees is compared as a function of the type of activity in which they are engaged.

Looking first at overall communication with colleagues within the R&D laboratory it can be seen that although new employees in all three

TABLE V

Comparison of Communications Within the Laboratory By New Employees and Veterans as a Function of the Nature of Their Work

		Communications Per Person Per Week							
		Within Entire Laboratory		Within Project		Within Division		Inter Divisional	
		Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)
Research	Veterans (n=57)	25.4	(14.5)	12.5	(8.6)	8.0	(8.2)	5.4	(5.2)
	New Employees (n=21)	20.6	(11.2)	9.8	(6.1)	8.8	(8.0)	2.4	(2.1)
		$t=1.27^{+}$ N.S.		$t=1.24^{+}$ N.S.		$t=-0.36$ N.S.		$t=3.60^{+}$ $p=0.001$	
Development	Veterans (n=53)	32.5	(18.5)	13.9	(11.5)	13.8	(13.0)	4.8	(4.5)
	New Employees (n=22)	23.9	(13.9)	11.0	(6.0)	11.4	(12.5)	1.5	(1.5)
		$t=1.97$ $p=0.05$		$t=1.43^{+}$ N.S.		$t=0.73$ N.S.		$t=4.62^{+}$ $p<0.001$	
Technical Service	Veterans (n=57)	30.8	(17.8)	12.8	(8.2)	14.4	(14.1)	3.6	(4.6)
	New Employees (n=23)	29.4	(19.6)	14.8	(11.9)	12.0	(17.1)	2.6	(2.9)
		$t=0.32$ N.S.		$t=-0.73^{+}$ N.S.		$t=0.64$ N.S.		$t=1.18^{+}$ N.S.	

2 tailed t-test based on pooled variance estimates unless indicated by +

$^{+}$2 tailed t-test based on separate variance estimates when variances differ significantly, i.e., $p<0.10$

TABLE VI

Comparison of Communications With Corporate Staff By New Employees and Veterans as a Function of the Nature of Their Work

		Communications Per Person Per Week							
		With All Corporate Functions		Marketing Communication		Production Communication		Other Communication Areas	
		Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)
Research	Veterans (n=57)	2.5	(4.0)	0.68	(1.6)	1.2	(2.8)	0.67	(0.96)
	New Employees (n=21)	2.4	(3.6)	0.91	(2.1)	1.1	(2.7)	0.35	(0.80)
		t=0.15 p=0.88		$t=-0.45^{+}$ p=0.65		t=0.10 p=0.92		t=1.35 p=0.18	
Development	Veterans (n=53)	6.2	(7.2)	2.8	(4.2)	2.8	(5.2)	0.58	(1.1)
	New Employees (n=22)	3.6	(5.0)	1.0	(1.7)	1.8	(4.3)	0.72	(1.3)
		$t=1.84^{+}$ p=0.07		$t=2.65^{+}$ p=0.01		t=0.81 p=0.42		t=-0.49 p=0.62	
Technical Service	Veterans (n=57)	7.1	(5.7)	2.4	(3.7)	3.4	(3.8)	1.2	(1.9)
	New Employees (n=23)	3.9	(5.9)	1.6	(2.6)	2.1	(4.7)	0.29	(0.60)
		t=2.19 p=0.03		$t=1.15^{+}$ p=0.26		t=1.39 p=0.17		$t=3.19^{+}$ p=0.002	

2 tailed t-test based on pooled variance estimates unless indicated by +

$^{+}$2 tailed t-test based on separate variance estimates when variances differ significantly, i.e., $p < 0.10$

areas have fewer contacts with colleagues than veterans, the difference is only statistically significant for those engineers engaged in product and process development (first column of Table V). Communication within the laboratory is examined in more detail by separating intralaboratory communication into three categories: i) intraproject communication, ii) intradivisional communication, and iii) interdivisional communication (columns two, three and four of Table V). For communication with colleagues within the same division (i.e., intraproject and intradivisional communication), no statistically significant differences are found between veterans and new employees. However, the organization boundary that appears at the level of laboratory division seems to present a major barrier to communication for new employees. New employees in research report slightly less than half the amount of communication with colleagues outside their division as veterans. The difference in interdivisional contact between veterans and new employees is even more pronounced in development. New employees in development report fewer than one-third the number of contacts with other divisions that veterans report. While new employees working in technical service also report less interdivisional communication, the difference is not statistically significantly. For all three groups of new employees, it should be noted that not only are the mean interdivisional communication frequencies lower, the variances are also significantly lower.

Next we examine communication between R&D personnel and the personnel of other functions in the corporation, such as marketing and manufacturing. In research, both veterans and new employees reported little communication with these areas, and the differences between the two are not significant (Table V). Among development engineers, however, there are significant differences. Veterans communicate more than new employees, particularly with marketing. In technical service, veterans reported more communication with all functions, but the difference is significant only in the case of what are labelled "other" areas. These include finance, and planning at corporate headquarters, and regional branch offices.

Finally, we compare the external communication behavior of veterans and new employees (Table VII). Here, only one result approaches statistical significance; i.e., the difference in contact with suppliers between veterans and new employees working on technical service projects. Of greater interest is the pattern of results found for external professional contacts (last column of Table VII). New employees working in research and technical service activities, have about the same number of external professional contacts as veterans. In product and process development, the new employees reported about twice as many contacts as the veterans, although the difference is not statistically significant due to the high variance among new employees.

Implications for Organizational Performance

The results have shown significant differences between communication patterns of veterans and new employees who work on different types of R&D project. But what are the implications of these results? In order to answer this question, we have to relate information flow to organizational performance. The focus here is on group performance rather than individual performance because we want to investigate the effect of information flow on organizational outcome; i.e., the achievement of task or project objectives. For the 14

TABLE VII

Comparison of External Communication By Veterans and New Employees as a Function of the Nature of Their Work

Type of R&D Activity		Total External Mean	Total External (Std. Dev.)	With Suppliers Mean	With Suppliers (Std. Dev.)	With Customers Mean	With Customers (Std. Dev.)	With External Professionals Mean	With External Professionals (Std. Dev.)
		Communications Per Person Per Week							
Research	Veterans (n=57)	1.5	(1.5)	0.83	(1.1)	0.20	(0.64)	0.51	(0.81)
	New Employees (n=21)	1.4	(2.2)	0.75	(2.0)	0.21	(0.76)	0.40	(0.80)
		$t=0.41^{+}$ N.S.		$t=0.18^{+}$ N.S.		$t=-0.04$ N.S.		$t=0.68$ N.S.	
Development	Veterans (n=53)	2.3	(2.3)	1.3	(1.5)	0.58	(0.95)	0.47	(0.74)
	New Employees (n=22)	3.1	(3.9)	1.2	(1.3)	0.97	(2.4)	0.94	(1.7)
		$t=-0.91^{+}$ N.S.		$t=0.13$ N.S.		$t=-0.75^{+}$ N.S.		$t=-1.28^{+}$ N.S.	
Techical Service	Veterans (n=57)	2.6	(3.0)	11.3	(1.6)	0.64	(1.3)	0.72	(1.7)
	New Employees (n=23)	2.1	(2.6)	0.75	(1.1)	0.65	(1.2)	0.74	(1.9)
		$t=0.68$ N.S.		$t=1.70$ $p=0.09$		$t=-0.05$ N.S.		$t=-0.05$ N.S.	

2 tailed t-test based on pooled variance estimates unless indicated by +

+2 tailed t-test based on separate variance estimates when variance differ significantly, i.e. $p<0.10$

research projects, a significant positive correlation is found between project performance and frequency of external professional contact (Table VIII). For the 23 development projects, significant positive correlations are found between project performance and consultation with R&D colleagues in other divisions of the laboratory, as well as with corporate staff in both production and marketing. For the 21 technical service projects, only a significant negative correlation is found between project performance and contacts with R&D colleagues in other divisions of the laboratory.

When we combine the results in Tables V, VI, VII and VIII, we find that the type of R&D activity is an important variable that moderates the possible benefits as well as the potential problems of any attempt to promote information transfer through hiring. For those engaged in research, external professional contacts are a critical information source (Table VIII). Quite interestingly, veteran researchers are as able to maintain good external professional contacts as new employees in research (Table VII). Within the organization, although new employees in research have significantly fewer contacts with colleagues in other R&D divisions (Table V), there is no evidence that this has led to any detrimental effect on research project performance. Different results are obtained for development engineers. The results obtained here confirm previous research findings that in the development of new products or processes, engineers rely heavily on colleagues within their own organization (Allen, 1964, 1977; Baker et al., 1967; Goldhar et al., 1976). Performance of development projects are found to be positively related to contacts with R&D colleagues in other divisions of the laboratory, as well as contacts with corporate staff in marketing and

TABLE VIII

Relationship Between Project Performance and Technical Communication

	Correlation Between Project Performance and:								
	Contacts With Other Colleagues Within R&D			Contacts With People in Other Parts of the Firm			External Contacts		
	Intra-Proj. Comm.	Intra-Div. Comm.	Inter-Div. Comm.	Product Comm.	Mktg. Comm.	Other Corp. Comm.	Suppl. Comm.	Custom Comm.	Prof. Comm.
Research Projects (n=14)	0.08+ N.S.	-0.10+ N.S.	-0.31+ N.S.	-0.17 N.S.	-0.01 N.S.	0.14 N.S.	-0.14 N.S.	-0.20 N.S.	0.51 p=0.03
Development Projects (n=23)	0.10+ N.S.	0.05+ N.S.	0.38+ p=0.04	0.35 p=0.02	0.45 N.S.	0.02 N.S.	-0.07 N.S.	0.15 N.S.	-0.16 N.S.
Technical Service Projects (n=21)	-.02+ N.S.	0.12+ N.S.	-.046+ p=0.02	0.06 N.S.	-0.09 N.S.	0.27 N.S.	0.12 N.S.	0.26 N.S.	0.16 N.S.

+Partial correlation controlling for the effect of group size (Note 3)

N.S. Not statistically significant, $p < 0.10$

production (Table VIII). Yet, it is precisely in these areas that we find the new development engineers to be most lacking in their organizational contacts (Tables V & VI). Moreover, the poor internal communication of new development engineers contrasts quite sharply with the findings that they report about twice as many external professional contacts as veterans (although the difference is not statistically significant due to high variance among the new employees). Quite clearly, the new development engineers, with their new ideas and good outside contacts, could provide a critical input to new product or process development. Yet, indications are that they are the least assimilated group within the organization

Finally, few significant differences are observed for engineers, who work in technical service. Technical service is concerned primarily with product adaptations to meet particular market needs. There is less need for technical service engineers to keep abreast of outside technology, or to have very much contact with R&D colleagues in other laboratory divisions (Table VIII). The results indicate that the organizational assimilation of new technical service engineers is not as serious a problem as with other new R&D staff (Tables V & VI).

In the above analysis, the most significant results were obtained for the development engineers. One subgroup of development projects had particular strategic and economic importance for the survival and success of the organization, i.e., those new developments that faced dynamic technologies and/or fast changing market conditions. If development activities are faced with a rapidly changing environment, then the logic would follow that their need for information would be more acute. To examine this proposition and its implications for the integration of new employees, we separate development project into two groups: those facing a stable work environment and those with a dynamic work environment. As expected, significant positive correlations exist between project performance and internal communication, for development projects with a dynamic environment, this is particularly true for contact with R&D colleagues in other divisions, and with marketing (Table IX). This does not hold true for those projects in a stable environment. For external contacts, a significant negative correlation is found between performance and external professional communication for development projects with a stable environment, while a positive but not significant correlation is found in a dynamic environment.

The rate of change of the environment facing the development engineer is an important consideration in integrating new employees (Table X). In particular, new employees working in those development activities with a dynamic environment face the most critical problems of organizational assimilation. New development engineers facing a stable environment also report fewer internal contacts than veterans, but the difference is nowhere near that found for development engineers in a dynamic environment. While this second group has the most contact with external professionals, they do not utilize internal information sources as much. Compared with veterans, new employees in this group report about half as many contacts with colleagues in production, less than half the number of contacts with colleagues in marketing, and only one-sixth the number of contacts with colleagues in other divisions of R&D! These results indicate that new employees in development are lacking most in those types of internal contact that will be most beneficial to their work.

TABLE IX

Relationship Between Project Performance and Technical Communication For Development Projects With Stable vs. Dynamic Environment

Project Type	Correlation Between Project Performance and Communication With: Other Divisions Within R&D	Marketing	Production	Outside Professionals
Development Projects With Stable Environment (n-12)	-0.10^{+} N.S.	0.03 N.S.	0.34 N.S.	-0.47^{+} p=0.06
Development Projects With Dynamic Environment (n=11)	0.83^{+} p=0.002	0.65 p=0.01	0.42 N.S.	0.21 N.S.

+Partial correlation controlling for the effect of group size

N.S. Not statistically significant.

TABLE X

Differences in Technical Communication Between Veteran and New Employees in Development as a Function of Environment Change

Project Type	Type of Employee	Communications Per Person Per Week							
		Other Divisions Within R&D		Marketing		Production		Outside Professionals	
		Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)	Mean	(Std. Dev.)
Development With Stable Environment	Veterans (n=21)	4.2	(4.0)	2.2	(3.0)	2.1	(3.2)	0.70	(1.0)
	New Employees (n=14)	1.9	(1.7)	0.90	(1.3)	1.9	(4.6)	0.60	(0.90)
		$t=2.32^{+}$ $p=0.03$		$t=1.74$ $p=0.09$		$t=0.14$ N.S.		$t=0.30$ N.S.	
Development Projects With Dynamic Environment	Veterans (n=31)	5.2	(5.0)	3.3	(4.9)	3.3	(6.2)	0.71	(0.44)
	New Employees (n=8)	0.67	(1.1)	1.2	(2.3)	1.7	(4.0)	1.5	(2.4)
		$t=4.43$ $p<0.001$		$t=1.70^{+}$ $p=0.10$		$t=0.89$ N.S.		$t=-1.42$ N.S.	

2 tailed t-test based on pooled variance estimates unless indicated by +

+2 tailed t-test based on separate variance estimates when variances differ significantly, i.e., $p<0.10$

DISCUSSION AND SUMMARY

In this study, we have compared the background and communication behavior of veterans and new employees. New employees are, as expected, younger. Some are recent graduates, but a larger proportion (about 70 percent) had prior work experience before joining the present organization. New employees published more than veterans. They also attended more technical conferences than the veterans. Obviously, such new employees, with the knowledge they acquired from recent academic training or previous employment, represent a valuable source of information for the organization. However, new employees are also found to be less integrated into the organizational network than veterans, results which corroborate the findings reported by Gerstberger (1971).

It takes a considerable length of time to integrate new employees into an organization. Moreover, the nature of work in R&D has a moderating effect on both the possible benefits and potential problems of integrating these new employees. To understand this, we must recognize that different types of R&D work have different needs for external technical information and rely on both external and internal information to varying degrees.

Product and process development engineers have the most diverse information needs both within and outside the organization. On the one hand, the development of new products or processes requires new ideas and up-to-date technological information. On the other hand, development activities must operate within the existing standards and capabilities of the organization. Because of the parochial nature of technology and the heavy burden of daily design work, most veteran engineers soon find themselves either incapable or unable to keep abreast of new outside developments. The new employees, with their knowledge and external contacts, can provide valuable information which may be critical for the success of a new development. But the knowledge these new employees possess is of little use to the organization if their ideas cannot be incorporated into actual designs. Again, because of the parochial nature of technology, new employees must also learn the design standards, philosophy, and operating constraints of the new organization. The results indicate that development engineers need diversified internal contact with colleagues in other parts of R&D, as well as with marketing and production. Yet it is also precisely in these areas that we find the new development engineers most lacking in their communication. Moreover, these communication problems appear to be most acute for the subgroup of development activities that face dynamic markets or rapidly changing technologies. Thus, while the, new employees have the potential of providing critical new knowledge and being a stimulus for older engineers, the benefits will not be realized unless the new people are integrated quickly and successfully into the organizational communication network.

In the case of research activities, the benefits and problems of utilizing new employees are somewhat different from those of development engineers. Creativity is a treasured quality for researchers. The new employees, with their fresh outlook and new approaches, are important assets to the organization. However, we would not argue that new employees in research are as crucial as new employees in development. This is because veteran researchers stay in closer contact with external technical knowledge than veteran engineers. This is due to the more universal state of research as opposed to the parochial nature of technological developments. We found in this study that veterans actually reported more external professional contact than new employees in research. Within the R&D organization, new employees in research have significantly fewer contacts with colleagues in other parts of R&D. This lack of contact however, does not appear to bear any relationship to performance. The reasons are actually quite simple. First, researchers do not have the same need for organizationally-based technological information as development engineers. Within the organization, researchers have only to seek out and consult with other researchers who share similar problem interests. Second, a new employee finds little in the way of language barriers because terminologies and standards in research are not as organizationally dependent. The integration of new employees in research is thus a less difficult problem for management.

Finally, technical service activities are aimed at meeting specific customer needs. In this type of work, an understanding of the market and of the organization's operational constraints is more important than creativity. We would thus argue that new employees in technical service activities are not as useful as veteran engineers. On the other hand, since people who work in technical service have quite specific information needs within the organization, the problem for the integration of new employees is less severe in technical service than in development.

Overall, results from this study indicate that impact of manpower flow on technology transfer must be considered within the context of work requirements and the information orientation of the people involved. This is an important point for both managers and social scientists. For managers of R&D organizations, the results suggest that particular attention should be paid to the integration of new staff members in development work where the benefits of bringing in new people are great, but the organizational assimilation problems are also found to be the most serious. For the social scientists, the present study has identified some critical issues and provided a beginning in an important area of interorganizational manpower flow and technology transfer.

NOTES:

1. Even industrial statistics seem to be lacking and are deficient in this regard. Both Allen (1977) and Shapero (1967) believed that the estimated turnover rate of 12.1 percent, given by the Engineering Manpower Commission of the Engineers' Joint Council, is on the low side. There is, however, a wide variation among industries. The high growth, high technology industries are no doubt the leaders in both turnover and addition of new technical staff. In the electronic and computer industries, top executives of several high growth companies have publicly stated the net growth rate in technical personnel for their organizations has been in excess of 30 percent in recent years. Such large movements of technical personnel are bound to produce a significant influx of interorganizational technology transfer.

2. While in this paper we only show the results in terms of communication frequency, very similar results are obtained if communication is measured in terms of number of people contacted. See Lee (1980) for more specific results.

3. Since the probabilities for interpersonal interaction tend to increase (asymptotically) with group size, its effect must be controlled in analyzing internal communication within the R&D laboratory. See Lee (1980, Appendix II) for a more complete discussion of the effect of group size on communication. Note also that since new employees were distributed more or less uniformly by project areas and divisions, it is not necessary to adjust for group size in comparing internal communication between veterans and new employees.

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