DEMOGRAPHY AND DESIGN: PREDICTORS OF NEW PRODUCT TEAM PERFORMANCE

DEBORAH GLADSTEIN ANCONA
AND
DAVID E. CALDWELL

September 1989 WP #: 3078-89
BPS

ABSTRACT

Using 409 individuals from forty-five new product teams in five high-technology companies, this study investigates the impact of group demography on group performance. Results show that functional and tenure diversity influence performance both directly and through their effects on internal process and external communication. Functional diversity influences external communication which, in turn, influences managerial ratings of innovation and overall performance. Tenure diversity influences internal processes which, in turn, influence team ratings of performance. However, while diversity produces processes that facilitate performance, it also directly impedes performance.

An increasing body of evidence suggests that the demographic characteristics of cohorts within a population can significantly influence a wide range of variables. For example, sociologists have observed that the size of age and sex cohorts within a population can influence diverse outcomes, including economic wellbeing (Easterlin, 1980), mobility patterns (Reed, 1978; Stewman & Konda, 1983), crime rates (Maxim, 1985), and marriage practices (Guttentag & Secord, 1983). Recently, this same general concept has begun to be applied to organizational phenomena. For example, the demographic composition of organizations or groups has been related to turnover among university faculty (McCain, O'Reilly & Pfeffer, 1983), top managers (Wagner, Pfeffer & O'Reilly, 1984), and nurses (Pfeffer & O'Reilly 1987); to performance ratings of subordinates (Tsui & O'Reilly, 1989); to executive succession (Pfeffer & Moore, 1980); to firm level performance (Wagner, Pfeffer, & O'Reilly, 1984); and to innovation in organizations (O'Reilly & Flatt, 1989). All of these studies suggest that it is the distribution of people within a group across variables such as age or tenure that influences behavior, rather than simpler descriptions of the same variables, e.g., the mean age of the group or the proportion of the group with a particular tenure.

Processes That Mediate the Demography-Performance Relationship

Although numerous studies have examined the relationship between demography and various outcomes, fewer have examined the processes through which demographic variables have their effect. However, two recent studies suggest how demographic variability influences behavior. O'Reilly, Caldwell, and Barnett (1989) demonstrate that within a sample of work teams, homogeneity of tenure on the job is positively related to the group's social integration. They further show that the aggregate social integration of the group is related to individual turnover. This suggests that at least one process by which demography influences turnover is through the development of cohesive groups, which, in turn, reduce the likelihood of individual departure. Although this was not part of the model they tested, O'Reilly et. al. speculate that tenure similarity facilitates social integration by increasing both the opportunities for interaction and the attractiveness of members to one another. They propose that people with similar entrance dates may undergo similar experiences and develop a common perspective.

Zenger and Lawrence (1989) offer further evidence of the process by which group demography affects outcomes. In a study of research teams, they found that the frequency of technical communication among team members was related to similarity of age, but that technical communications between team members and engineers not assigned to the project was related to similarity in organization tenure. Thus this research provides direct evidence that demographic composition can influence communication both within the group and between the group and outsiders.

Taken together, these two studies suggest that demographic variables influence group outcomes through their effects on the group's initial communication patterns and processes. Zenger and Lawrence further demonstrate that demographic patterns can influence how the group interacts with outsiders. These general conclusions suggest that when group performance is somewhat dependent upon the group's process and upon its interactions with others, demographic variables should be related to group performance.

New Product Development Teams

New product development teams are particularly dependent on communication patterns and processes both inside the group and with other groups. These teams must obtain information and resources from other parts of the organization, interact internally to create a viable product, and transfer their work to other groups who will build and market the product (Ancona & Caldwell, 1987; Burgleman, 1983; Quinn & Mueller, 1963). Their success is thus dependent both on team members' ability to communicate with outsiders, and to communicate and work with one another. A number of studies have tested this general idea and examined the communication patterns of these groups (Allen, 1984; Ebadi & Dilts, 1986; Ebadi & Utterback, 1984; Katz, 1982; Tushman, 1977, 1979). In general, these studies have concluded that the amount and patterns of communication (particularly technical communication) within the team and between the team and outside groups are related to team performance. For example, more communication between team members and others in the organization occurred in high-performing development teams than in low-performing teams (Allen, 1984). Tushman (1979) found that communication in high-performing development teams followed a two-step process; communication "stars" first obtained information from outside the group, then transmitted it to the rest of the group.

Given the general relationships between group demography and communication and group process (O'Reilly, Caldwell & Barnett, 1989; Zenger & Lawrence, 1989) and between communication patterns and development team performance (c.f. Tushman, 1979), it is possible that demographic composition of the research team would be related to its performance. Although they do not test this idea, Zenger and Lawrence (1989) expect "projects whose members are demographically similar to show relatively high rates of communication and thus relatively high performance."

The Study

The purpose of this study is to investigate the impact of the a new product team's demography on its performance. As previously noted, demography can affect the internal process of a group and the way its members communicate with outsiders. In addition, both internal and external behaviors can influence the performance of new product of groups (c.f. Allen, 1984). Finally, group researchers have long noted that input factors such as group composition can have both direct and indirect (mediated by group process) effects on group performance (Gladstein, 1984, Shaw, 1971). This study then investigates two things: the direct effects of group homogeneity on new product team performance, and the indirect effects of homogeneity attributable to internal group process and to communication with organization members outside the group boundaries.

Only one other study has investigated the effects of the demographic composition on R & D groups. In that study, Zenger and Lawrence (1989) observed that age similarity was positively related to the frequency of communication among members of research team. They observed different pattern for communications with individuals outside the team, but in the same functional area. Here, similarity of tenure was more highly related to frequency of communication than was similarity of age. Many studies of group demography have used both age and tenure measures; time of entry into an organization is thought to shape communication patterns and values while age shapes the pattern of cohorts that develop (Ryder, 1965; Wagner, Pfeffer & O'Reilly, 1984).

For product development teams, however, the most important diversity variable may be the functional mix. Teams may differ in terms of the proportion of individuals from each functional area. At one extreme, a team might be made up entirely of individuals from research and development. At the other extreme, one-third of a team's members might be from research and development, one-third from marketing, and one-third from manufacturing. The use of cross-functional teams has been proposed as a method of speeding the product development process (c.f. Calantine & Cooper, 1981; Cooper, 1979; Voss, 1985). These teams offer two potential advantages. First, the team has direct access to expertise and information that would not be available if all team members were from the same area. Second, since the team includes representatives from the manufacturing and marketing areas, product transfer will be facilitated. Despite these advantages, teams made up of individuals from different functional areas or "thought-worlds" may find it difficult to develop a shared purpose and an effective group process (Dougherty, 1988). This suggests that the structure of the team as defined by the functional diversity of team members may be an important variable for understanding both the group's processes and its outcomes.

This study differs from most other research on group demography in a number of important ways. First, it investigates the intervening processes between demographic patterns and outcomes. The O'Reilly, Caldwell, and Barnett (1989) study did so as well but this goes a step further by looking at processes inside the group and also at interactions with outsiders. Second, this research examines the demographic composition of groups in terms of two variables. One of these, the coefficient of variation of tenure among team members, has been widely used as an index of the variability of group members' tenures within an organization. The second variable we use is the group diversity as defined by individual members' functional assignments. This second variable has not been widely used, but it seems important to new product development teams. Third, in contrast to many previous studies that have looked at individual outcomes (e.g., turnover, communication frequency) and in some cases aggregated them to obtain a group outcome, this study looks at a group-level measurement of performance. Finally, this study uses performance measures from both top management and team members and discusses whether they are predicted by the same relationships among demography and process.

Complex Relationships

The link between demography and performance may not be straight forward, since we have complicated its examination by considering two different demographic variables - tenure homogeneity and functional diversity - and two mediating process variables - internal processes and external communications - across multiple performance indicators. For example, a high level of homogeneity within a group is likely to increase the cohesiveness and communication within the group (Festinger, 1954; Hoffman, 1985; Newcomb, 1961; Ward, LaGory & Sherman, 1985), but this same homogeneity may act to retard external communication (Ancona, 1987; Katz, 1982). If both internal and external communications are positively related to performance, then homogeneity may be simultaneously improving and dampening performance. Similarly, functional diversity may positively influence performance through its impact on external communication, but simultaneously have a negative direct impact. Finally, variables that have a large impact on one aspect of performance, such as achieving budgets and schedule, may have no impact on other performance measures, such as innovation. The inclusion of these multiple indicators of demography, process, and performance should allow us to gain further insight into the complex mechanisms through which demography affects performance.

Although our expanded set of variables adds complexity, many important variables have been left out. For example, ample research has documented the effect of size and resources on group process and outcomes (Gladstein, 1984; Hackman, 1982; Thomas & Fink, 1963). In addition, studies of research and development teams have documented the impact of task and product characteristics on performance (c.f. Charrabasti & O'Keefe, 1977; Katz & Tushman, 1978). Including all of these variables would make testing of our key relationships too complex, while omitting them runs the risk of mis-specifying our model (James, Mulaik & Brett, 1983). To deal with this dilemma, we run the models with only size as a control variable, and run separate analyses to determine what impact these other variables would have if they were included.

METHOD

This section describes the research design and analytical procedures used to examine the relationships among group demography, internal group process, communication with outsiders, and ratings of the groups' performance. All analyses were at the group level and conducted using a sample of product development teams.

Sample

This study involved the leaders and members of 47 new product teams in five high-technology companies in the computer, analytic instrumentation, and photographic industries. All of the teams were actively working on the development of new products as opposed to basic research. Each was responsible for developing a prototype product and transfering it to the groups responsible for manufacturing and marketing. For example, one team was developing a product to automate the sampling process used in liquid chromatography, and another was developing a new publishing device that combined photographic and computer imaging processes. Thus each team was actively engaged in technological innovation, yet responsible for ensuring the manufacturability and marketability of the new product.

Each organization was asked to provide access to a set of teams that had the following characteristics. First, all the teams had to be working on new product development (defined as a major extension to an existing product line or the start of a new product line). Second, to ensure some broad consistency in the complexity of the products, all teams had a development cycle of one and one-half to three years. Third, all the teams had to be located within a single division to assure comparable performance evaluations. Finally, organizations were asked to provide teams that ranged from high to low in performance; however, company executives did not reveal how teams were initially classified until all other data had been collected. Once the sample of teams was identified, a list of team members was obtained from company records and verified with team leaders. The average was approximately 10 (s.d. 6.2).

Of the 450 questionnaires distributed to team members and leaders, 409 were returned, yielding a response rate of approximately 89 percent. Response rates were approximately equal across companies; total responses per company varied from 39 to 129. Since this study investigated group characteristics and outcomes, we aggregated individual questionnaire items focusing on team attributes at the group level. To ensure that individuals had a common referent, team members' names were printed on each questionnaire. Because we were analyzing at the group level, teams were included in the final sample only if at least three-fourths of the members responded. This reduced the number of teams in the final sample to 45.

The average age of the individuals in the sample was 38.6; 88 percent were male; and 75 percent possessed at least a four-year college degree. Approximately 77 percent of the sample were engineering or research and development; the remaining 23 percent were primarily from manufacturing or marketing.

Measures of Group Demography

As Pfeffer (1983) has argued, group demography needs to be assessed in ways that capture the compositional and distributional characteristics of the group rather than by using simple descriptors such as the mean tenure of group members or the proportion of engineers in a group. This study uses two measures of the demographic homogeneity of product team groups: the coefficient of variation of team members' tenure in the organization, and the amount of diversity among the functions to which team members are assigned.

Coefficient of variation of tenure. For interval data such as age or tenure, Allison (1978) and Pfeffer and O'Reilly (1987) suggest that the coefficient of variation (the standard deviation divided by the mean) provides the most direct and scale in-variant measure of dispersion. Thus to assess the relative homogeneity of the tenure of each team's members, each group's standard deviation of tenure was divided by the group mean. The mean coefficient of variation of tenure across the sample of teams was .68 (s.d. = .30).

Functional diversity. When data are categorical or the utility of values is irrelevant, a different form of diversity index is appropriate. Both Taagepera and Ray (1977) and Teachman (1980) recommend an entropy-based diversity index. This measure is defined by Teachman (1980) as:

(1) $$H = \sum_{i=1}^{s} P_i \ (\ln P_i).$$

As Pfeffer and O'Reilly (1987) show, if there are N possible states in which system can be P_i is the probability that the system will be found in state i, then this formula can be used to index the heterogeneity in the system. For our purposes, P represents the fractional share of team members assigned to the functional areas of marketing, manufacturing, or engineering. The only exception to this occurs when a particular area is not represented on the team. In that case, the value assigned that particular state is zero. Using this formula, if a team was made up of nine individuals from engineering, one individual from marketing, and no one from manufacturing, the functional diversity index for that group would be .32. If the group consisted of five engineers, three marketing specialists, and two individuals from manufacturing, the functional diversity index would be 1.02. Thus, the greater the distribution across functional area, the higher the functional diversity score. For the sample of teams, functional diversity scores ranged from 0 to 1.10 (mean - .40, s.d. = .38).

Group Measures

Two measures of group activities were obtained: internal group process and communication with external groups. Both of these measures were obtained from questionnaires completed by team members.

Group process. Three items were used to measure members' perceptions of the team's work-related group process. These items related to the perceived effectiveness of the team in defining goals, developing workable plans, and prioritizing work. Although the demography literature most often specifics group cohesiveness or social integration as the mediating group process, for work teams the argument has been made that processes related to task accomplishment may be more important to performance then those reflecting affect within the team (Goodman, Ravlin & Schminke, 1985). The three process items were assessed with 5-point Likert scales; high scores indicated high levels of perceived effectiveness. These items were formed into a single scale (alpha = .86) by averaging them; these scale scores were averaged across the members of the group to arrive at a team score. The scores averaged 3.69 (s.d. = .43) across the sample of teams.

Communication with other groups. Each member of the team was asked how often he or she communicated with non-team individuals in marketing, manufacturing, engineering, and product or division management. The separate 6-point scales were anchored by 1 = Not at all and 6 = Several times per day. Since these functional groups had different names in the companies, the questionnaires were modified to ensure that company-specific terminology was used. Because these four groups represented every one with whom team members would normally communicate in their work, these responses were averaged. Team scores were computed by averaging the individual scores (mean = 2.54, s.d. = .78).

Measures of Team Performance

Top division managers in each company were asked to assess the teams in their company; using 5-point Likert scales, they rated each team's efficiency, quality of technical innovations produced, adherence to schedules, adherence to budgets, ability to resolve conflicts, and overall performance. When more than one manager made these evaluations, their ratings were averaged. Although the sample size was relatively small, the performance measures subjected to a principal components analysis to identify an underlying pattern. Two factors emerged: ratings of quality of technical innovations, ability to resolve conflict, and efficiency clustered together, as did adherence to schedules and adherence to budgets. Overall performance related to both. Based on this analysis, three measures of management-rated performance were developed. Overall performance was measured by a single item, adherence to budgets and schedules was measured by averaging the two relevant items (alpha = .87) and efficiency in developing technical innovations was defined as the average of the remaining three questions (alpha = .76). The ratings of overall performance averaged 3.35 (s.d. = 1.03); adherence to budgets and schedules averaged 3.05 (s.d. = .98); and efficiency in developing technical innovations averaged 3.31 (s.d. =n .83). Although these measures were highly correlated, discussions with the evaluating managers suggest that they represent conceptually distinct definitions of performance.

Team members were also asked to rate the performance of their teams on eight dimensions including efficiency, quality, technical innovation, adherence to schedules, adherence to budgets, coordination, work excellence, and ability to resolve conflicts. These items were completed by all individuals, so a principal components analysis of the items was conducted. Since this analysis yielded a single factor, the eight items were averaged to form an overall measure of each individual's perception of the team's performance (alpha = .88). A score was assigned to each team by averaging individual responses (mean = 3.64, s.d. = .38).

Control Variables

One important variable that has been established in group research is group size. Since size indirectly influences the potential magnitude of the coefficient of variation and may affect group process and communication, it was included in the analysis (mean = 9.56, s.d. = 6.27).

Many other factors can affect either group process or performance. In structured interviews with the leaders of each team, we assessed a number of these in an attempt to eliminate alternative interpretations. It should be noted that this set of control variables is not complete and that the sample size prevents the simultaneous testing of even this limited set of variables.

The first of these variables is the availability of resources. In an environment where resources are highly constrained, a different process or pattern of communications may develop than in one where resources are widely available. Also, the amount of resources may directly influence a team's performance (Gladstein, 1984). To assess this, team leaders were asked to describe the availability of financial, personnel, and equipment resources on separate 5-point scales. An overall measure of resource availability was obtained by averaging these three questions (mean = 2.90, s.d. = .86).

The second variable is the extent to which the product under development is a revolutionary development, as opposed to an incremental improvement of an existing product. As Dewar and Dutton (1986) have observed, different models may be necessary to explain radical and incremental innovations. When a product is revolutionary, the team may have different patterns of communication with other groups than when a product uses a known technology (Brown & Utterback, 1985). This was measured with a single 5-point question (mean = 2.96, s.d. = 1.18).

The third variable is the extent to which the new product will face competition. High levels of competition may reduce predictability and increase uncertainty (Abernathy & Clark, 1985; Duncan, 1972), thereby influencing process. A single 5-point question was used to assess this variable (mean = 4.12, s.d. = 1.14).

The final control variable is the experience of the company in developing similar products or using similar technologies. Previous experience may shape both the composition of a team and the nature of the group's work. As with the previous control variables, this was assessed with a single 5-point question asked during the team manager interview (mean = 3.00, s.d. = 1.48). For all interview questions, high scores indicate high levels of the particular variable.

Analysis

We used path analysis to examine the direct effects of group demography and group process on performance, and the extent to which process variable mediate the relationship between demography and performance. The model being tested posits a causal relationship from: (1) the demography variables to performance; (2) the process and communication variables to performance; and (3) the demography variables to process and communication. Drawing from Duncan (1971) and James, Mulaik, and Brett (1983), we adopted the following equation for decomposing the association between demography and performance:

(2) r(demography, performance) = Direct effect + Indirect effect + Unanalyzed spurious relationship

The total association between the demographic variables and performance measures is given by their zero-order correlations. The direct effect of demography on performance is the part of the total effect that is not transmitted via the mediating variables of process and communication. The indirect effect of the group demography variable on performance is that part of the total effect that is mediated either by process or communication. The spurious (i.e., non-causal) effect of each demographic variable is due to its unanalyzed correlations with all remaining independent variables (James, Mulaik & Brett, 1983; Prescott, Kohli & Venkatraman, 1986).

This analysis involves three steps. The first step entailed computing the correlation between the demography and performance variables to ascertain the total association between each combination. In the second step, we performed two sets of ordinary least squares regressions. In the first set, each process variable was regressed against the coefficient of variation of tenure (c.v. tenure) and functional diversity. The resulting standardized beta values represent the path coefficients of the paths from the demographic variables to the process variables. In the second set of regressions, each performance measure was regressed against the two demography variables (c.v. tenure and functional diversity) and the two group process variables (internal process and external communication). The standardized beta values represent path coefficients showing the direct paths from demography to performance and from process to performance. The third step in the analysis involved decomposing the correlations between demography and performance variables. Once the direct and indirect effects were obtained, we calculated the spurious effects by subtracting the causal effects from the correlation coefficients. This analysis allows us to identify the specific nature of the relationships between the two demography variables and performance.

RESULTS

Table 1 shows the correlations among group demography, group process, and performance variables. Several factors are worth noting. First, the management ratings of team performance are highly correlated. Not surprisingly, ratings of overall team performance was strongly related to ratings of efficiency in developing technical innovations ($r = .81$, $p < .001$) and ratings adherence to budgets and schedules ($r = .71$, $p < .001$). The relationship between ratings of efficiency in developing technical innovations and adherence to budgets and schedules was strong ($r = .42$, $p < .01$), albeit weaker than the correlations with overall performance. Despite the high correlations among the three management rated measures of performance, we retained all three in later analyses because of their conceptual distinctiveness. Of some interest, the team-member ratings of team performance showed only insignificant positive relations with the management ratings.

The two demographic measures, c.v. tenure and functional diversity, were negatively related ($r = -.33$, $p < .05$). High scores on these variables indicate greater heterogeneity; thus this correlation suggests that groups with individuals from diverse functions had greater homogeneity of tenure than groups with less functional diversity, and vice versa. There was also a small, insignificant negative relationship between the two process variables. The measures of group demography were related to the process variables. The coefficient of variation of tenure was related to reports of effective process within the group ($r = .30$, $p < .05$) but not to external communication. The opposite pattern emerged for functional diversity; high levels of functional diversity were associated with high levels of external communication ($r = .40$, $p < .01$), but were unrelated to process. Group size was positively related to functional diversity ($r = .29$, $p < .05$), but not to c.v. tenure, the process variables, or the measures of performance.

A number of relationships between the group demography and process variables and group performance are shown in Table 1. Functional diversity was negatively related to management ratings of technical innovations ($r = -.27$, $p < .05$). In addition, functional diversity was negatively related to team-rated performance ($r = -.35$, $p < .01$). Variation of group tenure was negatively related to management ratings of adherence to budgets and schedules ($r = -.27$, $p < .05$).

There were also some relationships between the process variables and performance. Internal group process was highly related to team-rated performance ($r = .51, p < .001$), but not to the other measures of performance. The frequency of group member communication with outsiders was related to management's ratings of overall team performance ($r = .32, p < .05$), and marginally related to the ratings of teams' efficiency in introducing innovations ($r = .21, p < .10$).

We used path analysis to more fully explore the relationships among group demography, group process, and performance variables. We ran separate models for each of the four performance measures. Figures 1 through 4 show the results. Regression equations testing the full models indicate that significant variance was explained in management ratings of efficiency at developing technical innovations ($R^2 = .27, p < .05$) and overall performance ($R^2 = .28, p < .05$), but not in adherence to budgets and schedules ($R^2 = .18$, n.s.). The equation explaining team ratings of performance was also significant ($R^2 = .43, p < .001$). The path coefficients tell us more about the nature of these effects and show that the influence of demography is, in part, mediated through group process and external communication.

The path coefficients between the demography and process variables shown in the figures are consistent with the zero-order correlations. Significant path coefficients were found between c.v. tenure and internal process ($P1 = .35, p < .05$) and between functional diversity and external communication ($P4 = .44, p < .01$). The indirect influence of the demographic variables on performance is realized only if the process variables, in turn, are related to the performance variables. Internal process is positively related to team-rated performance (Figure 4: $P5 = .56, p < .001$). Amount of external communication is positively related both to management ratings of a team's technical innovations (Figure 1: $P6 = .42$,

$p < .05$) and to management ratings of overall performance (Figure 3: P6 = .50, $p < .01$). This suggests that c.v. tenure indirectly influences team-rated performance through its impact on internal processes, while functional diversity indirectly influences innovation and overall performance through its impact on external communications.

The pattern of direct and indirect relationships is shown in Table 2, which breaks down the covariance between each demographic and performance variable into direct, indirect, and spurious effects. These results show that, although demographic variables have indirect effects on performance, these are often dwarfed by direct effects. Furthermore, the direct effects are often in the opposite direction of the indirect effects. For example, functional diversity has an indirect, positive effect through external communications, but this indirect effect is overshadowed by the direct, negative effect (P8 = - .53, $p < .01$) of functional diversity on innovation. So while diversity is positively associated with external communication, which in turn, is positively associated with innovation, functional diversity is related to lower ratings of innovation, either through a direct effect or through some other process not included in this model.

As shown in Figure 3 and Table 2, this same pattern holds for ratings of overall performance. The direct and negative effect of functional diversity on overall performance (P8 = -.47, $p < .01$) is much larger than the product of the indirect and positive effects of diversity on external communication (P4 = .44, $p < .01$), and of external communication on performance (P6 = .50, $p < .01$).

Figure 4 shows a direct, negative effect of functional diversity on team-rated performance (P8 = -.323, $p < .05$) with only a small indirect effect mediated by the other variables.

The coefficient of variation, unlike functional diversity, makes its major contribution to performance through its indirect effect on internal processes.

However, c.v. tenure does have a small direct negative effect on overall performance (Figure 3: P7 = -.30, $p < .10$), suggesting that tenure-homogeneous groups have higher overall performance ratings.

Table 2 also shows that some demography-performance variables are better explained than others. For example, the covariance between functional diversity and innovation, and between functional diversity and team-rated performance, are well explained by both direct and indirect effects. In contrast, the unexplained variance between functional diversity and overall performance (.12) is high compared to the causal variance (-.24). It is interesting that, in this case, the small correlation between functional diversity and overall performance ($r = -.12$) masks a large negative direct causal relationship (Figure 3: P8 = -.47, $p < .01$) that is diluted by a positive indirect causal relationship through external communications (.22).

As previously noted, a number of other variables could influence the relationships among demography, process, and performance. While we included size in all the analyses because of its obvious effects on c.v. tenure and functional diversity, we did not include resource availability, the degree to which the product was revolutionary, the degree of competition the product will face, and the experience of the company in developing similar products. As seen in Table 3, none of these variables displayed a pattern of strong relationships with the variables included in the model. When the analyses were repeated using each of these control variables in place of size, the results were generally consistent with those reported. The one exception to this pattern occurred when resource availability was included in model predicting budgets and schedules. In that analysis, the model predicting rated adherence to budgets and schedules explained 26 percent of the total variance ($p < .10$). After controlling for resource availability, the path coefficient of c.v. tenure is negatively and directly associated with achieving budgets and schedules ($P = -.43$, $p < .05$), suggesting that homogeneity in tenure is associated with acheiving budget and schedule.

DISCUSSION

The increasing reliance on teams to develop new products raises a variety of questions. One important set of questions relates to how the teams should be formed. For example, should they be formed completely of engineers, or should they include a range of specialists from other functional areas? Similarly do teams perform best when they are made up of people who have long tenure in the organization, or when they are made up of people who represent a wide range of experience?

This study attempts to answer some of these questions by extending the application of theories of group demography to product development teams. It moves beyond previous research by examining both the direct effect of group demography on group performance and the indirect effects of demography created by its influence on group processes. Results show that demographic variables influence performance both directly and through their effects on internal process and external communication.

Before discussing the relationships between group demography and the other variables, the links between process and performance are worth noting. As in other studies of work groups, internal process is related to team ratings of performance (c.f. Gladstein, 1984). That is, teams that rate themselves as having clear goals and priorities also rate themselves as innovative, efficient, good at adhering to budgets and schedules, and as good overall performers. A number of explanations for this connection are possible. Members may be labeling their team as high performing if it exhibits the processes thought to be linked to performance (Calder, 1977; Gladstein, 1984). Alternatively, members who view their team as effective may attribute effective processes to it. This relationship between process and performance does not hold when external measures of performance are used.

In contrast, top management ratings of overall team performance are related to the frequency of team members' external communications. External communications may be of a technical nature, allowing the team to improve the quality of their product (Allen, 1984). Alternatively, they may be geared toward profile management, whereby team members try to influence key outsiders to promote and support their product (Ancona & Caldwell, 1988). Finally, it may be that teams that know they have the support of top management may be more willing to communicate with others.

Although this study provides evidence that group process mediates the demography-performance relationship, interestingly, each demographic variable seems to operate in a distinct way. The more heterogeneous the group in terms of tenure, the greater the clarity of the group's goals and priorities. In turn, this clarity is associated with high team ratings of overall performance. In contrast, greater functional diversity is associated with more external communication. The more external communication team members have with other groups, the higher the managerial ratings of team innovation and overall performance.

The links we identify between the demographic and process variables complement those previously identified. At first glance, the relationship we observed between heterogeneity and process is not consistent with that reported by O'Reilly, Caldwell, and Barnett (1989). They found that homogeneity was positively associated with the group process variable of social integration, while we found it was negatively associated with a different measure of process, one more related to an ability to define and prioritize goals. On reflection, these different effects of diversity of tenure are not surprising. Individuals who enter an organization at the same time are likely to share a common perspective and to have undergone a similar set of experiences. These factors are likely to increase the frequency of communication among members and the attraction the members have for one another (Festinger, 1954; Hoffman, 1985; Ward, Lagery & Sherman, 1985). However, when it comes time to define goals and assess priorities, a group may do better with multiple experiences and perspectives that help it to define goals more in line with complex demands placed upon it. This is particularly likely with groups such as product development teams, which must operate in complex environments and respond to frequently conflicting demands.

Our finding that the functional diversity of a team is related to the frequency of external communications is not surprising. One would expect representatives of a functional group to have more contacts and greater ease of communication with members of that same group given their shared language, socialization, and worldview (Dougherty, 1988; Lawrence & Lorsch, 1969). This result complements those of Zenger and Lawrence, (1989) who found that within a single functional area, homogeneity was associated with communication, even across team boundaries.

Taken together, these findings show the complexity with which the demography of a group can influence outcomes. Further, they suggest that our models of group demography have to become more clearly specified with respect to type of diversity, the nature of the group's task, and type of group process or communication under investigation.

Although there is evidence of demography's indirect effect on performance through group process, this study presents even stronger evidence of demography's direct effect on performance. High levels of functional diversity were directly associated with lower levels of performance, particularly for management ratings of innovation and overall performance, and for teams' ratings of their own performance. Diversity of tenure shows a similar, albeit less strong, negative relationship with performance. These results are consistent with those of O'Reilly and Flatt (1989), showing a direct relationship between homogeneity and an organizational measure of innovation.

What can account for this contradictory effect of diversity? On the one hand, it produces processes that facilitate performance, and on the other hand it directly impedes performance. One possibility is that diverse teams are able to develop goals and priorities, but not implement them because of the conflict different perspectives create. A second possibility is that diversity allows for high levels of external communication but also reduces the social integration to such a level that the group cannot effectively make use of the information and resources obtained from others.

This pattern of results is quite consistent across contexts. That is, irrespective of technological uncertainty (degree to which the product is revolutionary), market uncertainty (degree of competition), organizational uncertainty (extent of the company's experience with the product), and size of the team, these relationships hold. Once exception to this pattern is the level of resources available to the team. By controlling for resource availability, we find a positive relationship between tenure homogeneity and the team's ability to meet budgets and schedules.

In interpreting the results of this study, certain limitations must be kept in mind. It should be noted that the sample of teams is limited to product development teams working with state-of-the-art technology. Therefore, although there is variance on the control variables, this sample of teams faces rather high uncertainty relative to other kinds of groups. In addition, the processes and demographic variables shown to be influential in these teams may not be the same as those needed for less complex tasks in more certain environments. The study is further limited by its use of subjective performance ratings and of crosssectional data. While managerial ratings of performance may be those used to make budget and promotion decisions we have no idea whether these ratings, or team ratings for that matter, are related to new product sales or actual product quality. Furthermore, we do not know whether current ratings reflect current processes or prior processes, which could raise questions about the causal direction among the sets of variables. We have assumed that demography influences process and that both demography and process influence performance. However, other causal patterns are possible. We have noted that the relationship between process and performance could flow in either direction. Similarly, performance could influence the composition of a team. For example, it may be that a team with performance problems is assigned new members in the hopes that those new members can resolve the team's problems. This new assignment roster would account for the negative relationship between performance and diversity.

Despite these limitations, this study demonstrates the importance of more fully understanding how the demography of a group can influence its performance. This and other studies like it may provide important clues about how teams can best be formed to facilitate the development of new products.

TABLE 1

CORRELATIONS AMONG GROUP DEMOGRAPHY, GROUP PROCESS AND PERFORMANCE VARIABLES

	1	2	3	4	5	6	7	8	9
1. C.V. Tenure	-								
2. Functional Diversity (FUNCDIV)	-0.33*	-							
3. Group process	0.30*	0.01	-						
4. External Communication	-0.04	0.40**	-0.13	-					
5. Technical innovations (INNOV)	0.07	-0.26*	0.13	0.21+	-				
6. Adherence to budgets and schedules (BSCHED)	-0.27*	-0.01	0.13	0.11	0.42**	-			
7. Overall performance (OVERALL)	-0.09	-0.12	0.05	0.32*	0.81***	0.71**	-		
8. Team reated performance (TEAMPERF)	0.12	-0.35**	0.51***	-0.16	0.25+	0.15	0.18	-	
9. Group size	0.03	0.29*	-0.05	0.19	0.13	-0.06	0.14	-0.16	-

+p<.10
*p<.05
**p<.01
***p<.001

TABLE 2

DECOMPOSITION OF ASSOCIATION BETWEEN DEMOGRAPHIC VARIABLES AND PEFORMANCE

Bivariate Relationships	Total Covariance	Causal Effects				Spurious
		Direct Effect	Group Process Indirect Effect	Communi-cation Indirect Effect	Total	
	A	B	C	D	E=B+C+D	F=A-E
CVTENURE-INNOV	0.07	-0.17	0.08	0.04	-0.05	0.12
FUNCDIV-INNOV	-0.26*	-0.53**	0.01	0.18	-0.34	0.08
CVTENURE-BSCHED	-0.27*	-0.43*	0.11	0.02	-0.30	0.03
FUNCDIV-BSCHED	-0.01	-0.23	0.01	0.10	-0.12	0.11
CVTENURE-OVERALL	-0.09	-0.30+	0.07	0.05	-0.18	0.09
FUNCDIV-OVERALL	-0.12	-0.47*	0.01	0.22	-0.24	0.12
CVTENURE-TEAMPERF	0.12	-0.19	0.20	0.01	0.02	0.10
FUNCDIV-TEAMPERF	-0.35**	-0.32*	0.02	-0.05	-0.35	0.00

+p<.10
*p<.05
**p<.01

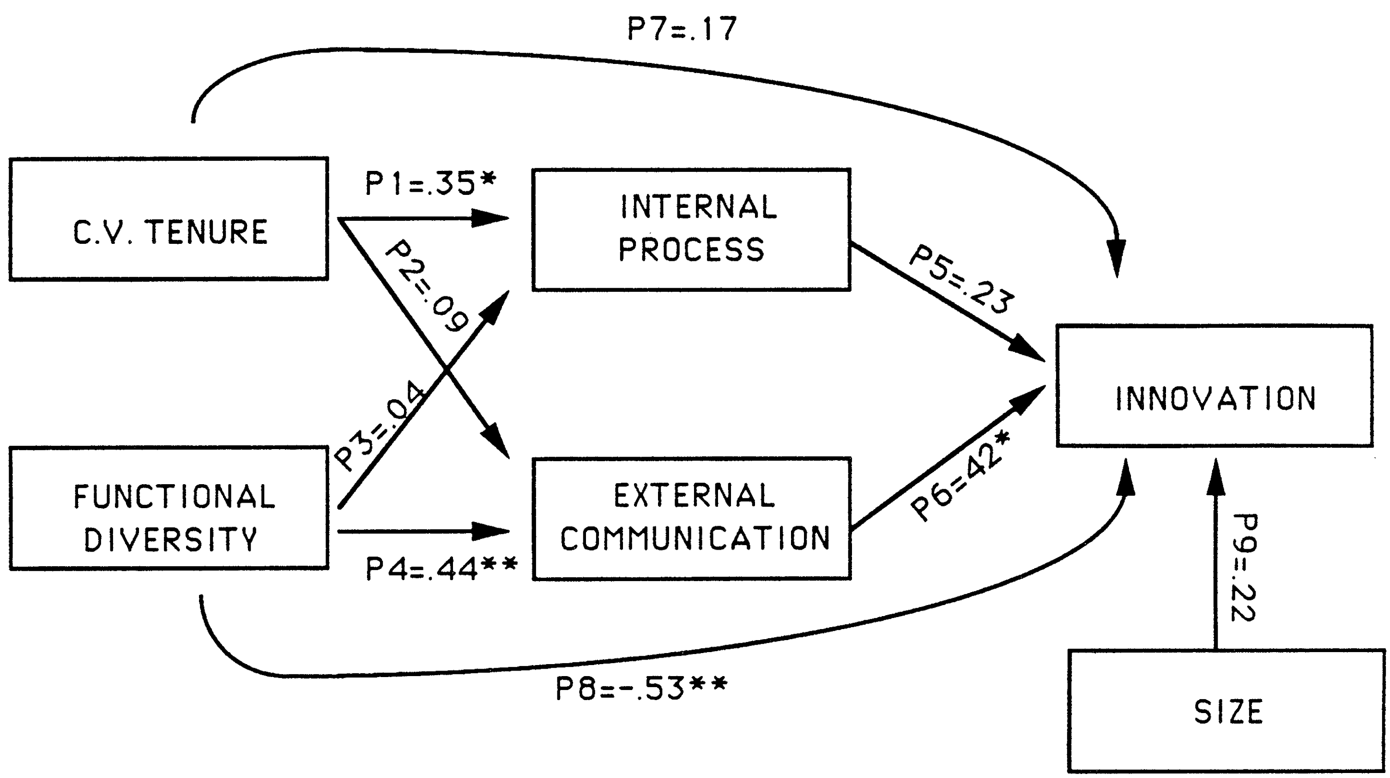
TABLE 3

CORRELATION WITH CONTROLS

	MEAN	S.D.	C.V. TENURE	FUNCTIONAL DIVERSITY	GROUP PROCESS	EXTERNAL COMMUNI-CATION	TECHNICAL INNOVATION	ADHERENCE TO BUDGET & SCHEDULE	OVERALL PERFORMANCE	TEAM-RATED PERFORMANCE
SIZE	9.56	6.27	0.03	0.29*	-0.05	0.19	0.13	-0.06	0.14	-0.16
RESOURCE AVAILABILITY	2.90	0.86	0.05	-0.06	0.11	-0.24	-0.22	-0.30*	-0.29*	0.20
REVOLUTIONARY NATURE OF PRODUCT	2.96	1.18	0.01	0.09	0.19	0.27*	0.25	0.13	0.19	0.13
COMPETITION	4.12	1.14	-0.01	0.09	-0.25	-0.09	-0.05	0.06	0.03	-0.17
EXPERIENCE	3.00	1.48	0.15	-0.15	-0.09	0.18	0.09	-0.19	-0.03	0.00

+p<.10
*p<.05
**p<.01

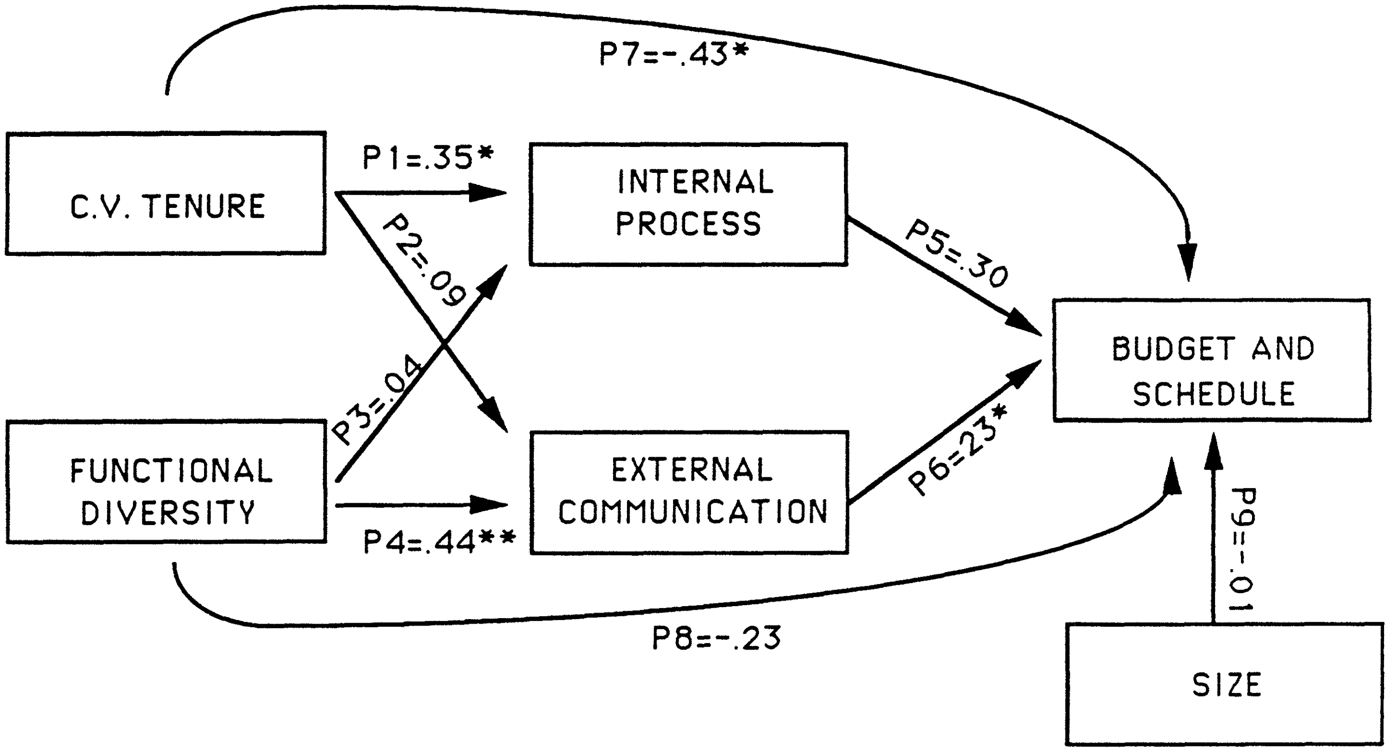
FIGURE 1: PATH DIAGRAM OF DEMOGRAPHY - PROCESSS - INNOVATION RELATIONSHIPS



OVERALL MODEL R^2 =.27*

+P<.10
*P<.05
**P<.01

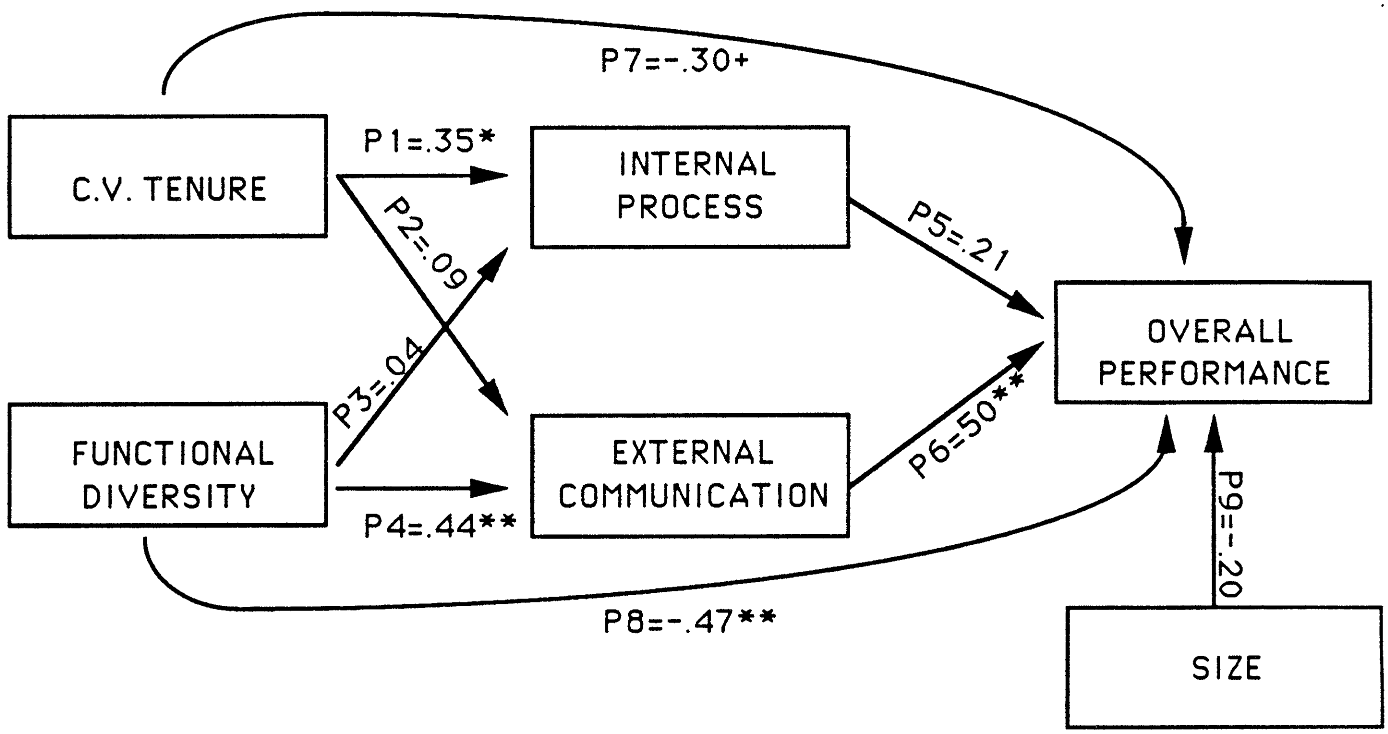
FIGURE 2: PATH DIAGRAM OF DEMOGRAPHY - PROCESSS - BUDGET AND SCHEDULE RELATIONSHIPS



OVERALL MODEL R^2 =.18 N.S.

+P<.10
*P<.05
**P<.01

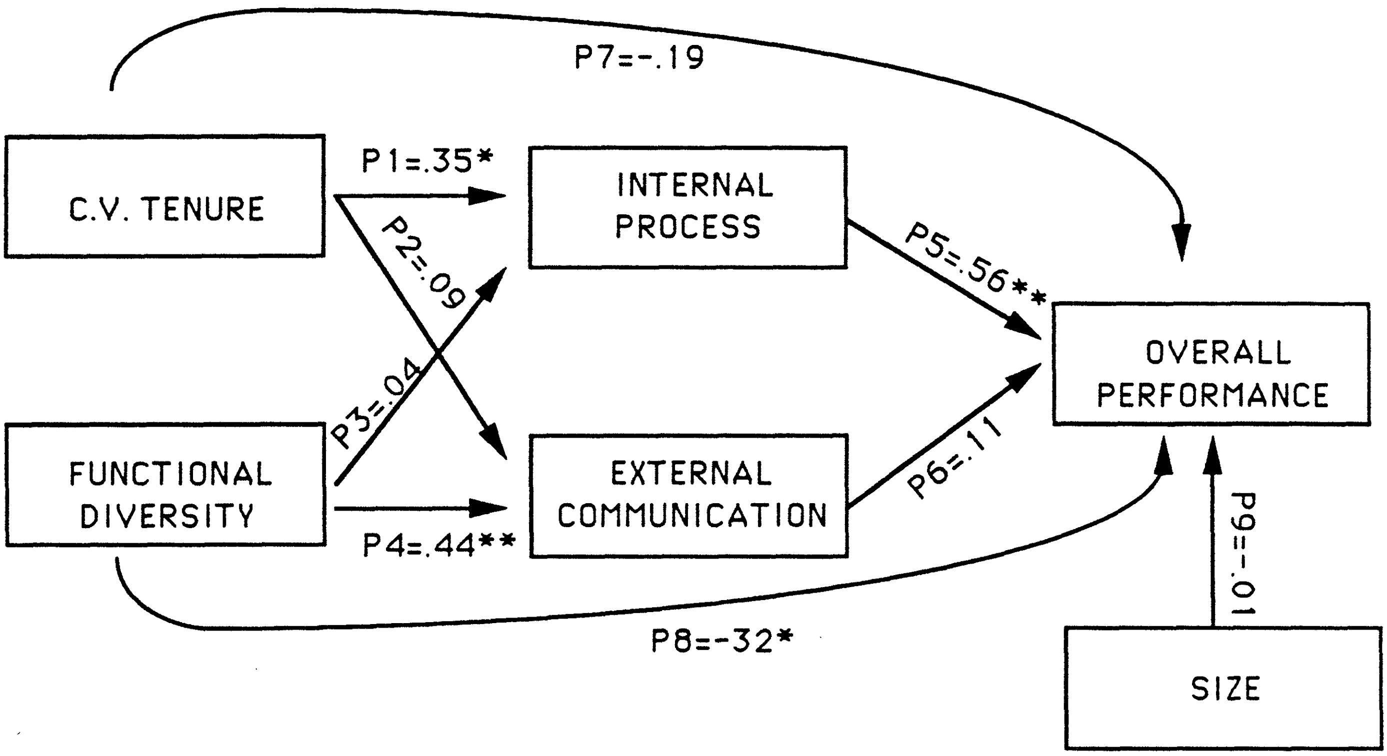
FIGURE 3: PATH DIAGRAM OF DEMOGRAPHY - PROCESSS - OVERALL PERFORMANCE RELATIONSHIPS



OVERALL MODEL R^2 =.28*

+P<.10
*P<.05
**P<.01

FIGURE 4: PATH DIAGRAM OF DEMOGRAPHY - PROCESSS - TEAM-RATED PERFORMANCE RELATIONSHIPS



OVERALL MODEL ^{2}R =.43***

+P<.10
*P<.05
**P<.01
***P<.001

REFERENCES

Abernathy, W.J. and Clark, K. (1985). Innovation: Mapping the winds of creative destruction. Research Policy, 14: 3-22.

Allen, T. (1984). Managing the flow of technology: Technology transfer and the dissemination of technological information within the R&D organization. Cambridge, MA: M.I.T. Press.

Ancona, D.G. (1987). Groups in organizations: Extending laboratory models. In C. Hendrick (Ed.), Annual review of personality and social psychology: group and intergroup processes. Beverly Hills, CA: Sage.

Ancona, D.G. and Caldwell, D.F. (1987). Management issues facing new-product teams in high technology companies. Advances in Industrial and Labor Relations, 4, Greenwich, Ct: JAI Press.

Brown, J. and Utterback, J. (1985). Uncertainty and technical communication patterns. Management Science, 31: 301-311.

Burgelman, R. (1983). A process model of internal corporate venturing in the diversified major firm. Administrative Science Quarterly, 28: 223-244.

Chakrabarti, A.K. and O'Keefe, R.D. (1977). A study of key communicators in research and development. Group and Organization Studies, 2: 336-346.

Calantone, R. and Cooper, G. (1981). New product scenarios: Prospects for success, Journal of Marketing, 45: 48-80.

Cooper, R.G. (1979). The dimensions of industrial new product success and failure. Journal of Marketing, 43: 93-103.

Dougherty, D. (1987). New products in old organizations: The myth of the better mousetrap in search of the beaten path. Ph.D. Dissertation. Sloan School of Management, M.I.T.

Duncan, R. (1972). Characteristics of organizational environments and perceived environmental uncertainty. Administrative Science Quarterly, 17: 313-327.

Easterlin, R.A. (1980). Births and fortune: The impact of numbers of personal welfare. New York: Basic Books.

Ebadi, Y. and Dilts, D. (1986). The relation between research and development project performance and technical communication in a developing country. Management Science, 32: 822-830.

Ebadi, Y. and Utterback, J. (1984). The effects of communication on technological innovation. Management Science, 30: 572-585.

Festinger, L. (1954). A theory of social comparison processes. Human Relations, 1: 117-140.

Gladstein, D.L. (1984). Groups in context: A model of task group effectiveness. Administrative Science Quarterly, 29: 499-517.

Goodman, P.S., Ravlin, E., & Schminke, M. (1987). Understanding groups in organizations. In L.L. Cummings & B.M. Staw (Eds.), Research In Organizational Behavior, 9: 1-71.

Guttentag, M. and Secord, P.F. (1983). Too many women: The sex ratio question. Beverly Hills, CA: Sage.

Hackman, J.R. (1983). A normative model of work team effectiveness. Technological Report #2, School of Organization and Management, Yale University. Research Program on Group Effectiveness (November).

Hoffman, E. (1985). The effect of race-ratio composition of the frequency of organizational communication. Social Psychological Quarterly, 48: 17-26.

James, L.R., Mulaik, S.A. and Brett, J.M. (1983). Causal Analysis: Assumptions, Models, and Data. Sage Publications, Inc.

Katz, R. (1982). The effects of group longevity on project communication and performance. Administrative Science Quarterly, 27: 81-104.

Katz, R. and Tushman, M.R. (1979). communication patterns, project performance, and task characteristics: An empirical evaluation and integration in an R&D setting. Organizational Behavior and Human Performance, 23: 139-162.

Maxim, P.S. (1985). Cohort size and juvenile delinquency: A test of the Easterlin hypothesis. Social Forces, 63: 661-681.

McCain, B.E., O'Reilly, C.A., and Pfeffer, J. (1983). The effects of departmental demography on turnover: The case of a university. Administrative Science Quarterly, 26: 626-641.

Newcomb, T.M. (1961). The acquaintance process. New York: Holt, Reinhart & Winston.

O'Reilly, C.A., Caldwell, D.F., and Barnett, W.P. (1989). Work group demography, social integration, and turnover. Administrative Science Quarterly, 34: 21-37.

O'Reilly, C.A. and Flatt, S. (1989). Executive team demography, organizational innovation, and firm performance. Working Paper, University of California, Berkeley.

Pfeffer, J. and O'Reilly, C. (1987). Hospital demography and turnover among nurses. Industrial Relations, 36: 158-173.

Prescott, J.E., Kohli, A.K. and Venkatraman, N. (1986). The market share-profitability relationship: An empirical assessment of major assertions and contradictions. Strategic Management Journal, 7: 377-394.

Quinn, J.B. and Mueller, J.A. (1963). Transferring research results to operations. Harvard Business Review, 41 (January-February): 44-87.

Reed, T.L. (1978). Organizational change in the American Foreign Service, 1925-1965: The utility of cohort analysis. American Sociological Review, 43: 404-421.

Ryder, N.B. (1965). The cohort as a concept in the study of social change. American Sociological Review, 30: 843-861.

Shaw, M.E. (1981). Group dynamics: The psychology of small group behavior. New York: McGraw-Hill.

Stewman, S. and Konda, S.L. (1983). Careers and organizational labor markets: Demographic models of organizational behavior. American Journal of Sociology, 88: 637-685.

Thomas, E.J. and Fink, C.F. (1963). Effects of group size. Psychological Bulletin, 60: 371-384.

Tsui, A.S. and O'Reilly, C.A. (1989). Beyond simple demographic effects: The importance of relational demography in superior-subordinate dyads. Academy of Management Journal, 32: 402-423.

Tushman, M.L. (1977). Special boundary roles in the innovation process. Administrative Science Quarterly, 22: 587-605.

Tushman, M.L. (1979). Work characteristics and solo unit communication structure: A contingency analysis. Administrative Science Quarterly, 24: 82-98.

Voss, C.A. (1985). Determinants of success in the development of application software. Journal of Product Innovation Management, 2: 122-129.

Ward, R.A., La Gory, S., and Sherman, S.R. (1985). Neighborhood and network age concentration: Does age homogeneity matter? Social Psychological Quarterly, 48: 138-149.

Wagner, W.G., Pfeffer, J., and O'Reilly, C.A. (1984). Organizational demography and turnover in top-management groups. Administrative Science Quarterly, 29: 74-92.

Zenger, T.R. and Lawrence, B.S. (1989). Organizational demography: The differential effects of age and tenure distributions on technical communication. Academy of Management Journal, 32: 353-376.