Training Effects on Attitudes Toward Divergent Thinking Among Manufacturing Engineers

MIN BASADUR
McMaster University

AND

GEORGE B. GRAEN and TERRI A. SCANDURA
University of Cincinnati

1986

Faculty of Business
McMASTER UNIVERSITY
HAMILTON, ONTARIO

Journal of Applied Psychology
1986, Vol. 71, No. 4, 612–617

0021-9010/86/$00.75

Training Effects on Attitudes Toward Divergent Thinking Among Manufacturing Engineers

Min Basadur
Faculty of Business, McMaster University
Hamilton, Ontario, Canada

George B. Graen and Terri A. Scandura
Center for Strategic Management Studies
University of Cincinnati

In a field experiment, we tested the effects of training on attitudes of 112 manufacturing engineers toward divergent thinking in problem solving. The second group (n = 47) served as the control for the first group (n = 65) in the first part of the experiment, and vice versa in the second part. Measurements of attitudes toward divergent thinking were taken at three points in time (baseline, following the training of the first group, and following the training of the second group). Results showed that the training positively affected engineers' attitudes toward divergent thinking in problem solving. Specifically, the training with intact work groups demonstrated consistent results, whereas training with those from diffuse locations produced mixed results. Implications are discussed.

Many researchers and practitioners in the field of creative problem solving use conceptual models that involve divergent thinking (Guilford, 1967). Attitudes toward divergent thinking are believed to be important antecedents to divergent thinking practice. Kraut (1976) proposed a training model that involved a causal chain of attitudes leading to behavior leading to improved results. Rickards (1975) reported a field experiment in which results using creative problem-solving techniques based on divergent thinking were no better than results using conventional techniques. Rickards attributed the lack of success to an inability of the experimental participants to change their attitudes toward divergent thinking, and concluded that such attitudes may be very difficult to change until procedures adequate to changing long-held beliefs that work against its basic principles are found. In contrast, Basadur, Graen, and Green (1982) found that improvements in attitudes toward divergent thinking accompanied increases in creative performance after appropriate training. The training provided by Basadur et al. (1982) was more intensive than that used in the Rickards (1975) study, and was based on a comprehensive process of creative problem solving. Basadur and Finkbeiner (1985) offered a model describing how attitudinal processes may enhance cognitive processes of divergence in creative problem solving.

Although research suggests the usefulness of training in creative problem solving involving divergent thinking, unless attitudes toward divergent thinking are positive or become positive, such training is not likely to result in changes in behavior back on the job (Basadur et al., 1982). Evidence suggests that many people who work in organizations have negative attitudes toward creativity, divergent thinking, and new ideas (Rickards, 1980; Shore, 1980). Moreover, Kirton (1976) found that people in organizations who have more innovative styles and are more divergent in their thinking incur more negative attitudes and mistrust by others. They encounter greater difficulty in getting their ideas accepted because they tend to propose more unusual solutions and may even redefine given problems in unexpected new ways. Others in the organization tend to have negative attitudes toward such divergent approaches inasmuch as the substantial changes they represent evoke feelings of discomfort and apprehension. Unless improvements in these attitudes toward divergent thinking can be achieved, training efforts in the techniques of problem solving based on divergent thinking may be fruitless. Attitudes of manufacturing engineers tend to be especially negative toward any form of divergent thinking and creative problem solving. They tend to see no place for creativity in their structured, implementation-oriented environment where practicality is so highly valued. There is evidence that engineering training itself contributes to reducing the value of divergent thinking (Altemeyer, 1966; Doktor, 1970).

Changing attitudes of any kind is not an easy task. As noted by McGuire (1969), perhaps no area of research in social psychology has been as active as the formation and change of attitudes. Much theoretical and empirical work has been devoted to the study of the persuasion process through which attitudes can be changed. One approach is the cognitive response approach to the study of persuasion (Petty & Cacioppo, 1981). This approach postulates that attitude-change processes can best be understood by taking into account the thoughts that arise in the persuasion situation. To the extent that the persuasion situation elicits thoughts that are favorable, attitude change in the direction advocated should be facilitated. However, if negative thoughts are elicited, attitude change should be inhibited. Based on this theoretical framework, a person's thoughts during a persuasion attempt regarding a given topic appear to be related to the change that takes place in the attitudes toward the object of the persuasion.

In the current study, the presentation of a process of creative problem solving based on divergent thinking may be seen as an attempt to persuade manufacturing engineers to engage in divergent thinking on their jobs. However, as previously noted, negative attitudes toward divergent thinking may be a barrier to the use of creative problem solving by the engineers. Hence, it is of interest to determine the extent to which the training (as a persuasive communication attempt) was able to effect changes in the attitudes of the manufacturing engineers toward divergent thinking. If attitudes toward divergent thinking can be made more positive, then the manufacturing engineers might be more open to learning to use creative problem solving. Moreover, they might begin to incorporate such processes into their repertoire of job-related skills. The main objective of this study was to investigate the attitudinal changes that follow training of manufacturing engineers in the practice of creative problem solving.

This research focuses on two aspects of divergent thinking: (a) preference for ideation (*active divergence*), and (b) tendency to make premature critical evaluations of ideas (*premature convergence*). For example, a person with a high preference for ideation (active divergence) in problem solving would likely find value in generating many novel and unusual solutions seemingly far removed from the current problem, would enjoy taking multiple points of view about a given situation and generating varied options, would rarely feel a problem is solved but rather would enjoy going back to generate new solutions and improve the problem further, would not be content with standard solutions to a problem but rather would prefer new frames of reference, and would use each solution generated merely as a stepping stone to additional solution possibilities. A person with a high tendency to make premature critical evaluations of ideas (premature convergence) in problem solving would be quick to find a flaw in a solution offered and eliminate it from consideration, would likely display a high need to be decisive, would look for the bad in a new idea rather than the good, would dislike wasting time with apparently nonproductive trains of thought, would feel each solution generated ought to be evaluated sequentially before proceeding to the next one, would not want to risk making a mistake, would believe there is one best way or one right answer to solve a problem, would have a low tolerance for ambiguity, and would prefer to optimize on one solution rather than explore multiple options.

Hypotheses

The purpose of this research was to investigate the effects of training of manufacturing engineers in a process of creative problem solving based on divergent thinking on attitudes that have been associated with the practice of divergent thinking. We hypothesized that training manufacturing engineers in this process will lead to the following attitude changes 5 weeks after the training:

- H_1, an increase in preference for ideation (active divergence);
- H_2, a decrease in tendency to make premature critical evaluations of ideas (premature convergence).

Method

Site and Participants

The participants were drawn from a large, international consumer goods manufacturing company. The organization had an interest in increasing organizational creativity to produce more new thinking by manufacturing engineers. The overall objective of the training was to enable engineers to develop new procedures and processes to increase profitability and improve costs. The organization's top management had requested training in creative problem solving based on divergent thinking. From this manufacturing organization, 65 manufacturing engineers were invited to a 3-day (24-hr) training program in creative problem solving based on divergent thinking. A second group of 47 manufacturing engineers was invited to a second training program 5 weeks later. The only difference between the two groups was that the first group was from eight different locations and the second group was from a single location.

Design

The design is a quasi-field experiment with nonequivalent control groups and pre- and posttests (Cook & Campbell, 1976). The experiment consists of two parts. In the first part, Observation 1 (O_1) to Observation 2 (O_2) is a 5-week time period in which Group 2 acts as control group for Group 1. In the second part, O_2 to O_3 (Observation 3) is a 5-week time period in which Group 1 acts as control for Group 2. In essence, the experiment is repeated twice, letting the experimental group of the first part serve as the control group in the second part. In the second part of the experiment, the treatment is provided to Group 2, which had formerly served as control in the first part, and Group 1 receives no further treatment.

		Part 1			Part 2		
Group 1	O_1	X		O_2			O_3
Group 2	O_1			O_2	X		O_3

The first part tested the effects of the training (X) by comparing the gains from O_1 to O_2 for Group 1 (trained) versus Group 2 (control). The second part tested the effects of the training, comparing the gains from O_2 to O_3 for Group 2 (trained) versus Group 1 (previously trained).

Thus, Group 2 (n = 47) first served as control for Group 1 (n = 65) and then Group 1 served as control for Group 2. Measures were taken (O_1) on both groups just prior to the training of Group 1. The measures were repeated (O_2) 5 weeks later, just prior to the training of Group 2. After an additional 5 weeks, the measures were repeated (O_3) with both groups. Group 2 was not aware of Group 1, and vice versa. All of the participants were told that the questionnaire they were filling out was nonevaluative and was merely to help better understand and improve the training over time. Confidentiality was assured. Questionnaires were always returned directly to the researchers, who were not members of the organization.

Training

The process of creative problem-solving trained contains two major concepts. First, the process is divided into stages: (a) problem finding, (b) problem solving, and (c) implementation. Second, a two-step process called *ideation–evaluation* is included within each of the three critical stages. The first step, ideation, is defined as idea generation without evaluation, and is the divergent aspect of the process. Evaluation, the second step, represents the convergent aspect and is defined as the application of criteria to the generated ideas to select the best one(s). All three stages, with both aspects in each, are believed to be instrumental in creative problem solving (Farnham-Diggory, 1972; Mackworth, 1965; Parnes, Noller, & Biondi, 1977; Simon, 1960). The focus in this study is the problem-solving stage.

The 24 hr of training include a series of diverse tasks that permit and encourage participants to discover new concepts, such as ideation–evaluation and the value of both divergent and convergent thinking. For example, participants individually define a problem from a case and then compare definitions with other participants, discovering that the sample problem can be viewed in many different ways. This process of encouraging divergent thinking is stressed throughout the training (Basadur et al., 1982).

Table 1
Schedule of Events

Day and event	Cronbach reliability estimates: Self-report	Boss report
Day 1 (Time 1)		
Preference for ideation	.72	.94
Premature critical evaluation	.80	.95
Days 1 to 3		
Train Group 1 (n = 65)		
Control Group 2 (n = 47)		
Day 38 (Time 2)		
Preference for ideation	.94	.97
Premature critical evaluation	.94	.97
Days 38 to 40		
Control Group 1 (n = 65)		
Train Group 2 (n = 47)		
Day 75 (Time 3)		
Preference for ideation	.98	.99
Premature critical evaluation	.97	.98

Note. Cronbach alpha coefficient is the average of all possible split-half correlations within a measure and serves as an estimate of homogeneity or internal consistency reliability.

Instrumentation

A six-item "preference for ideation in problem solving" scale was used to measure the "active divergence in problem solving" attitude, and an eight-item "tendency to make premature critical evaluations of ideas in problem solving" scale was used to measure the "premature convergence in problem solving" attitude. Items from the two scales are randomly sorted into one 14-item questionnaire. Each item has a 5-point Likert agreement scale. The items and scales are fully described in Basadur and Finkbeiner (1985). The questionnaire was filled out three times by each trainee (self-report) and by each trainee's immediate superior about the trainee (boss report). The superior's questionnaire about the trainee was developed by altering the self-report questionnaire to make it grammatically compatible with describing someone else. Thus, measures of the two attitudes of all the participants were taken (a) prior to training, (b) 5 weeks after training Group 1, and (c) 5 weeks after training Group 2.

The schedule of events is presented in Table 1. As shown in Table 1, the internal consistency estimates (Cronbach alpha) for the two scales are quite high, ranging from .72 to .98, with all but two at .94 or higher (Cronbach, 1951). Also shown in Table 1, the first observations on the two measures were self-report and boss report before any training had taken place. The training was conducted immediately thereafter (Days 1–3). Group 1 (n = 65) received training in creative problem solving as previously described, and Group 2 (the control group, n = 47) received a 2-hr talk on the theory of the same process. Five weeks later, Group 1 was surveyed back on the job with the second wave of questionnaires and Group 2 was assembled and surveyed. During the next 3 days, Group 2 was trained in the same process with Group 1 serving as control. Finally, 5 weeks after this latter training, both groups were surveyed back on the job.

Analysis

The design of the study was a 2 × 3 repeated measures multivariate analysis of variance (MANOVA; Bock, 1963). The two groups and three measurement periods on two dependent variables (preference for ideation and tendency to make premature critical evaluations of ideas) were the details of the design. A protected procedure was used such that the univariate results were not interpreted unless the multivariate tests were statistically significant (Carmer & Swanson, 1973). Moreover, a priori contrasts were calculated on the gains from Observations 1 and 2 for Group 1 versus Group 2 and on the gains from Observations 2 to 3 for Group 2 versus Group 1. The .05 confidence level was used for statistical significance (the .001 level is reported as well for the reader's convenience). Finally, the patterns of means were examined for compatibility with the hypotheses.

Results

The overall MANOVA demonstrated statistically significant ($p \leq .001$) time and Treatment × Time effects for both self-report and boss report. As shown in Table 2, all gains over both 5-week periods (i.e., the first and second parts) were statistically significant (time effects). In contrast, the differences *between* the gains of the two groups (Treatment × Time effects) were not all statistically significant. The gains in preference for ideation in problem-solving measures taken from both self- and boss reports failed to show statistically significant differences between groups for the first part (Group 1 vs. Group 2, over the period from Time 1 to Time 2). Although these two Treatment × Time effects were not statistically significant, the remaining six Treatment × Time effects in the two parts were statistically significant.

The patterns of means are shown in Figures 1 and 2. As can be seen in Figure 1, in terms of preference for ideation in problem solving, the gains from Time 1 to Time 2 (the first part) showed no statistically significant differences between Group 1 (trained) and Group 2 (control) for either self- or boss report. In sharp contrast, the gains from Time 2 to Time 3 (the second part) revealed statistically significant differences between the two groups from both points of view. Whereas the differences in gains between the two groups were .94 and −.08 for the first part, they were 3.01 and 2.08 for the second part for self and boss, respectively. These positive differences in gains indicate

Table 2
Repeated Measures Mean Square and F Values

Event	First part (Time 1 to Time 2): *MS*	*F* value	Second part (Time 2 to Time 3): *MS*	*F* value
Preference for ideation				
Self-report				
Time	24.25	5.40*	52.41	10.61**
Treatment × Time	12.22	2.72	124.23	25.61**
Boss report				
Time	44.68	17.02**	76.56	15.54**
Treatment × Time	0.07	0.03	59.36	12.04**
Premature critical evaluation				
Self-report				
Time	136.28	14.71**	68.70	4.17*
Treatment × Time	124.09	13.40**	666.36	40.47**
Boss report				
Time	150.34	24.60**	730.15	51.57**
Treatment × Time	28.60	4.68*	240.27	16.97**

* $p \leq .05$. ** $p \leq .001$.

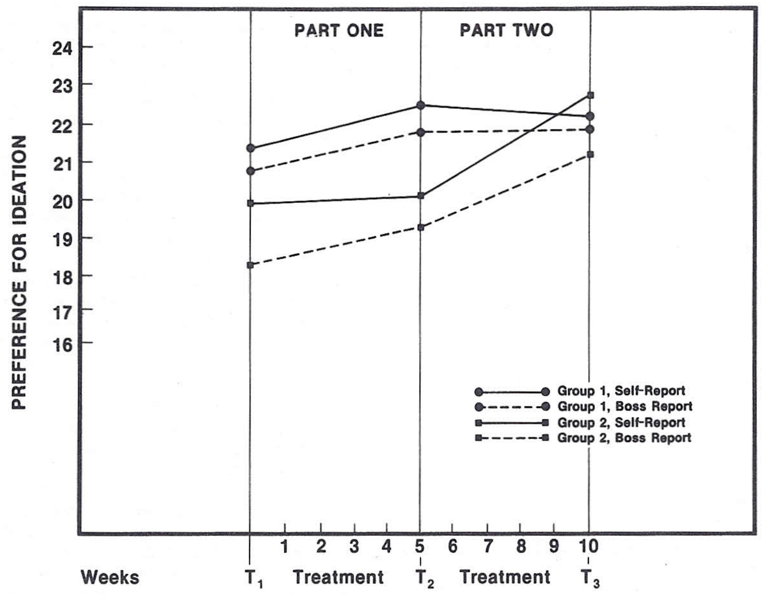

Figure 1. Mean trends for preference for ideation.

the predicted advantage in preference for ideation in problem solving for the trained over the control group in the second part, but not in the first part.

The patterns of means for tendency to make premature critical evaluations of ideas in problem solving shown in Figure 2 reveal that all four differences between groups on gains support the hypothesized training effect. The gain differences were 3.02 and 1.50 for the first part, and 6.99 and 4.20 for the second part. All of these differences between group gains were statistically significant and indicate the predicted advantage for the trained over the control group for tendency to make premature critical evaluations of ideas in problem solving.

Overall, the results in the second part show support for the effectiveness of training after 5 weeks on both preference for ideation and tendency to make premature critical evaluations of ideas. However, in the first part the results are mixed. One feature of this experimental design is that it permits Group 1 to be measured 10 weeks after training. The results displayed in Figure 2 indicate that for Group 1 the positive gain on tendency for premature critical evaluations of ideas washed out.

Discussion

This study documents the effects of training on the attitudes of manufacturing engineers toward divergent thinking. There were statistically significant Treatment × Time effects for both self-report and boss-report measures of engineers' attitudes toward divergent thinking. Specific attitudes hypothesized to be affected were preference for ideation (active divergence) and tendency to make premature critical evaluations of ideas (premature convergence). The training in creative problem solving emphasizing divergent thinking appeared to result in engineers having more positive attitudes both in active divergence and premature convergence. From before to after the training, the engineers increased their preference for generating different solutions to problems and increased their preference for keeping an open mind on solutions generated.

Because of the differences in strength of effect between the first and second parts of the experiment, the following explanation was developed, based on Groups 1 and 2. Groups 1 and 2, although drawn from the same organization, may be considered to represent two different training situations. Groups 1 and 2 differ by the amount of knowledge to be found back on the job about the new techniques. In the first part, the participants who received training were from different and diffuse locations. This we refer to as a *missionary* training situation because the trainees will have to return to work with a large number of nonbelievers (i.e., those who did not participate in the training). In the second part, the participants who received the training were from the same location, and all of the engineers at that location were participants in the training. This we refer to as a *family*

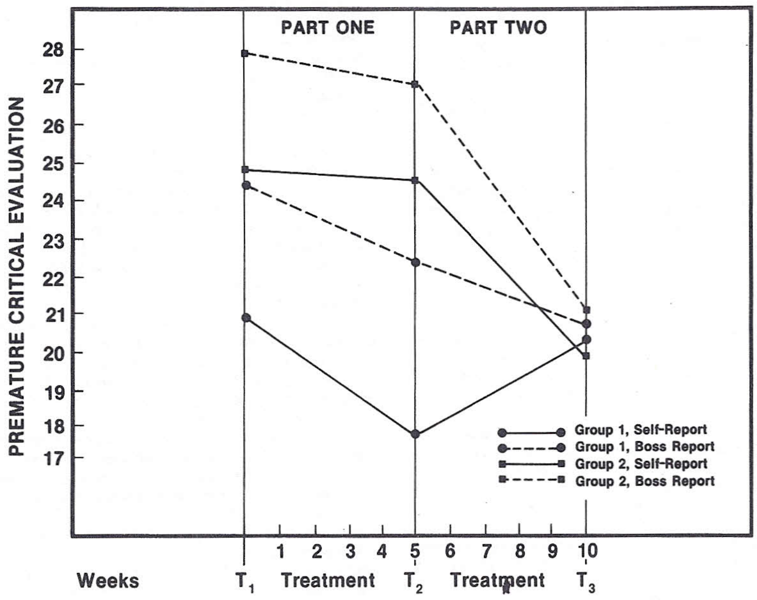

Figure 2. Mean trends for tendency to make premature critical evaluations of ideas.

training situation because the trainees will return to work with all of their fellow workers having been participants, too. Hence, in the first part the participants who received training (Group 1) are more or less alone in their new attitudes upon return to work, whereas, in the second part the participants who received training (Group 2) find common understanding of their new attitudes. In the training literature there is evidence that new learning has greater staying power in supportive environments than in nonsupportive environments (Hinrichs, 1976; House, 1968). The trainees in the second part of the experiment, on return to their location, should find more support for their new attitudes, inasmuch as all of their colleagues were exposed to the same training experience. The trainees in the first part return to a less understanding environment, being a minority on the job among a majority of colleagues who have never experienced the training. There would be far less peer reinforcement and far less concentrated self-support for the newly learned attitudes in the first part. The problem of reentry after training designed to effect attitudinal and behavioral change is well-known in the training literature (Goldstein, 1980; Schein, 1961).

Both measured attitudes toward creative problem solving (preference for ideation, and tendency to make premature critical evaluations of ideas) showed positive change in the family (intact work group) condition (second part of the experiment) after 5 weeks. Only one of the two measures (tendency to make premature critical evaluations of ideas) showed statistically significant positive change for the missionary (diffuse work group) condition (first part) after 5 weeks. Thus, the effects in the second part of the experiment were more comprehensive. Furthermore, there was some evidence of erosion of even the gain on the one measure in the first part after 10 weeks.

Based on these results, it is possible to speculate on what happened in these work groups following the training. Following the training sessions, the engineers trained in intact work groups returned to their jobs along with others who had participated in the training. They provided their own peer support for divergent thinking in problem solving. In contrast, engineers in the diffuse work-group condition returned to various work units throughout the organization following the training. These engineers apparently found less peer support for divergent thinking attitudes.

The results of this field experiment extend knowledge of the effects of training in a process of creative problem solving emphasizing divergent thinking in each stage. First, this research provides a stronger test of the effects of training for two reasons. The research design included three waves of data collection and training interventions at two time points, each 5 weeks apart. This design makes it possible to monitor the effects of the training for a longer duration than did previous studies. Second, participants in the training sessions were manufacturing engineers whose previous professional socialization had reinforced convergence on problem solutions. The fact that the training described in this study was able to positively change the attitudes of these engineers toward the use of divergent thinking shows that appropriate training can result in positive effects even in populations whose attitudes may be difficult to change.

An examination of the effects of training engineers belonging to two different types of work groups during and after the training sessions suggested that the use of intact work groups may enhance the effects of the training. The group having members from various locations in the plant showed mixed results. This study has demonstrated that training can positively influence the attitudes of manufacturing engineers toward divergent thinking in problem solving, and may have suggested an important aspect of the training situation, the use of intact work groups.

References

Altemeyer, R. (1966). *Education in the arts and sciences: Divergent paths.* Doctoral dissertation, Carnegie Institute of Technology.

Basadur, M. S., & Finkbeiner, C. T. (1985). Measuring preference for ideation in creative problem solving training. *Journal of Applied Behavioral Science, 21*(1), 37–49.

Basadur, M. S., Graen, G. B., & Green, S. G. (1982). Training in creative problem solving: Effects on ideation and problem finding and solving in an industrial research organization. *Organizational Behavior and Human Performance, 20,* 41–70.

Bock, R. D. (1963). Programming univariate and multivariate analysis of variance. *Technometrics, 5,* 95–117.

Carmer, S., & Swanson, M. (1973). An evaluation of ten multiple comparison procedures by Monte Carlo methods. *Journal of American Statistical Association, 68,* 66–74.

Cook, T. D., & Campbell, D. T. (1976). The design and conduct of quasi-experiments and true experiments in field settings. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology* (pp. 223–326). Chicago: Rand McNally.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297–334.

Doktor, R. (1970). *The development and mapping of certain cognitive styles of problem solving.* Doctoral dissertation, Graduate School of Business, Stanford University.

Farnham-Diggory, S. (1972). *Cognitive processes in education.* New York: Harper & Row.

Goldstein, I. L. (1980). Training in work organizations. *Annual Review of Psychology, 32,* 229–272.

Guilford, J. P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Hinrichs, J. R. (1976). Personnel training. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology* (pp. 829–860). Chicago: Rand McNally.

House, R. J. (1968). Leadership training: Some dysfunctional consequences. *Administrative Science Quarterly, 12,* 556–571.

Kirton, M. J. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology, 61,* 622–629.

Kraut, A. I. (1976). Developing managerial skills via modeling techniques: Some positive research findings—a symposium. *Personnel Psychology, 29,* 325–328.

Mackworth, N. H. (1965). Originality. *American Psychologist, 20,* 51.

McGuire, W. J. (1969). The nature of attitudes and attitude change. In G. Lindsay & E. Aronson (Eds.), *The handbook of social psychology* (2nd ed., pp. 136–314). Reading, MA: Addison-Wesley.

Parnes, S. J., Noller, R. B., & Biondi, A. M. (1977). *Guide to creative action.* New York: Scribner's.

Petty, R. E., & Cacioppo, J. T. (1981). *Attitudes and persuasion: Classic and contemporary approaches.* Dubuque, IA: Brown.

Rickards, T. (1975). Brainstorming: An examination of idea production rate and level of speculation in real managerial situations. *R&D Management, 6(1),* 11–14.

Rickards, T. (1980, April). Facing the need to renovate. *International Management, 35,* 40–42.

Schein, E. H. (1961). Management development as a process of influence. *Industrial Management Review, 2(2),* 59–77.

Shore, S. (1980, October). Getting the creative juices flowing again. *International Management, 35,* 23–29.

Simon, H. A. (1960). *The new science of management decision.* Englewood Cliffs, NJ: Prentice-Hall.

Received August 28, 1985
Revision received January 27, 1986 ■