Positive Motivational Safety Training in Underground Salt Mines

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ABSTRACT

Applied Behavior Analysis is described in terms of management policies and practices and their impact on worker on-the-job safety behavior. Injuries at each of five mines are categorized and correlated to management programs and behaviors. Applied Behavior Management through Positive Motivational Safety-Training is then described. Program effectiveness is described both statistically and narratively, and projections of project reliability are presented.

The experiment at the salt mines was implemented as a time series design with an experimental group (treated) of five mines matched against a control group of five mines. Injuries were tracked for one year prior to treatment and for one year posttreatment. Statistical treatment will consist of differences in injuries between the experimental and control groups. In addition, differences between subsequent frequency rates and injury rates in the two groups will also be computed, and all results will be presented and discussed.

INTRODUCTION

The Salt Institute selected a combination of ten mines and refineries for use in the study as experimental and control sites. The five experimental sites were given a thirty-hour training program in the use of positive reinforcement—specifically, social reinforcement (SR)—to shape safe work behaviors. In addition, first-line supervisors were asked to submit monthly reinforcement schedules. Injury reports were submitted by both the experimental and control sites.

The research focused on the effects of social reinforcement, praise, for safe work to reduce work-related injury frequency and severity rates. First-line supervisors were the focus of the training program, but all management was encouraged to participate in the training phase.

This report contains four aspects of the study: 1) A description of the five experimental plants, 2) A discussion of applied behavioral analysis, 3) A discussion of the applied behavioral management approach used, positive reinforcement training and 4) A statistical analysis of the effects of the training program on certain injuries.

Finally, the report makes specific recommendations for expanded use of positive reinforcement.

PARTICIPATING FIRMS—EXPERIMENTAL AND CONTROL

Under the terms of the study, the Salt Institute, through membership discussions, selected five firms who would use one of their plants for the experimental aspects of the study. The selection was based on the following criteria: The sites should a) have high injury frequency and severity rates; b) be of similar size; c) have similar production rates; d) include at least two mines; e) be willing to let all plant management participate in the training phase of the study; f) provide data as needed; g) agree to implement the training program. Five other sites were selected to be controls. The criteria for their selection included: That they a) be in close proximity to the experimental site (cultural control); b) have similar accident/injury severity and frequency rates; c) produce similar amounts of salt by tonnage; d) report monthly accident/injury data; e) not be owned by the same firm as the experimental plant for which they are the control.

The experimental sites and their controls were:

1. Experimental Plant: Cargill Salt Company, Hutchinson, Kansas, Evaporative Refinery. Control Site: Carey Salt Company, Hutchinson, Kansas, Evaporative Refinery.

2. Experimental Plant: Diamond Crystal Salt Company, Jefferson Island, Louisiana, Mine and Packaging Plant. Control Site: Morton Salt Company, Week's Island, Louisiana, Mine and Packaging Plant.
3. Experimental Plant: Hardy Salt Company, Manistee, Michigan, Evaporative Refinery. Control Site: Morton Salt Company, Manistee, Michigan, Evaporative Refinery.
4. Experimental Plant: International Salt Company, Watkins Glen, New York, Evaporative Refinery. Control Site: Morton Salt Company, Silver Springs, New York, Evaporative Refinery.
5. *Experimental Plant: Morton Salt Company, Fairport, Ohio, Mine and Packaging Plant. Control Site: International Salt Company, Detroit, Michigan, Mine and Packaging Plant.
6. *Experimental Plant: Leslie Salt Company, Newark, California, Solar Salt Refinery. Control Site: Morton Salt Company, Hayward, California, Solar Salt Refinery.

*In mid-1977, the Morton Fairport Plant experienced labor problems. At that time less than half of the thirty management people scheduled for training had been trained in social reinforcement techniques. Management requested a delay in further training until issues (not related to the experiment) were settled. After three months, it was decided that another plant site would be used for experimental purposes. In January, 1978, Leslie Salt agreed to participate. Morton, however, continued to send HPDC monthly injury data and participated as a quasi-experimental site.

Each experimental plant received training according to a schedule which permitted them to maintain production. There were some occasions when two full days were set aside for training, others where only half days were permitted. When conducting a field demonstration for a company which has volunteered to participate, it is very difficult to make any demands relative to the scheduling of personnel to attend training sessions. The companies are, after all, in business to produce a product and, although the training is in their best interest and at a minimal cost, the product is still their primary priority. Numerous trips to each plant were necessary to get all training completed.

RESEARCH DESIGN

The study followed a time series before and after intervention design. The intervention was training plant management in the systematic application of positive reinforcement techniques, specifically, social rewards—praise—to increase the frequency of safe work behaviors to reduce injury frequency and severity rates. A pre-training baseline was determined for each experimental plant identifying accident/injuries by category. Changes in these categories were inferred to be a result of the intervention training. The baseline pre-dated training by eighteen months.

The first-line supervisor was the focus of the training program since it is believed that he is the "key man" in the employee-job relationship; however, it was expected that all management would go through the training program. Where they didn't, the effects on the supervisor were noticeable, suggesting that we take another look at the influence upper management has on the supervisor's safety performance. This is discussed in depth in the section entitled "Supervisory Styles."

At the outset of the study it was necessary to visit each experimental and control plant to determine the availability of data, explain the program to management, and obtain their cooperation.

Several field visits were made to each experimental plant to: a) observe work in progress; b) interview supervisors; c) accompany supervisors as they directed their workers—to determine their use of praise, awareness of safety practices, and the conditions under which they supervise (noise, dust, fumes, heat, etc.); d) take photographs, where possible, of work conditions, work methods, and unsafe acts; e) review company safety programs and enforcement procedures. The determination of behaviors needing shaping was based on this information.

It was found that the plants varied in their use of safety device requirements and/or their enforcement. An analysis of the baseline injury data indicated a significant proportion of eye, head, hand, and back injuries. Even though most plants have some mandatory requirement to use eye, head, and foot safety devices, as well as others, supervisors do not, as a rule, enforce these policies. Therefore, the initial training focused on shaping workers to wear such devices. We knew (based on prior experimentation in a shipyard setting) that a first-line supervisor understands the principles of applied behavioral analysis more readily when the behaviors to be shaped are more obvious and their frequency more quantifiable. As a supervisor became more skilled in behavior shaping he was asked to focus on more complex worker behavior. Examples of the former are: Getting workers to a) wear safety devices; b) lift correctly; c) drive safely; d) use tools properly; e) maintain housekeeping standards. Examples of the latter are: Getting workers to a) suggest better work methods; b) identify unsafe conditions; c) self-enforce safety practices; d) assist fellow workers who need help lifting, driving, loading, etc.

At first, some plant managers expressed resistance to focusing on the wearing of safety devices. They saw no need to spend valuable training time teaching supervisors how to get workers to wear devices that either were not required or necessary, or were already established as a mandatory work practice. Once they had an opportunity to see for themselves that a considerable number of workers do not regularly wear such devices—even though mandatory—and/or that the supervisors were not enforcing such practices, their resistance diminished. Supervisors were also asked to identify other behaviors they considered to be troublesome. On the safety side: lifting, carrying, and setting; use of tools; use of lockout devices; various underground behaviors; use of manlifts; forklift driving; palletizing salt bags; sewing and bagging; and the misuse of forklifts for maintenance, carrying, or moving purposes. On the general work behavior side: absenteeism, rate of production, housekeeping, tardiness, and poor quality work were among those listed as troublesome worker behaviors.

ANALYSIS OF BEHAVIOR

An important aspect of the experimental analysis of behavior is to study the work environment and determine if/how the ways in which work is performed contributes to accidents and injuries. It is part of the concept of positive reinforcement that events precede behavior as well as follow behavior. These preceding events are technically called antecedents.

Anything that influences a worker to behave in a certain way can be an antecedent. Examples of antecedents that influence unsafe behavior in this study are a) the speed in which salt bags move down a conveyor, *causing* the worker to reach, strain, and/or load a pallet carelessly; b) orders from a supervisor to speed up the loading of a boxcar, *causing* workers to drive too fast, dump and break bags, jam their hands, strain to lift or toss bags; c) replacing a burned-out lightbulb, which is too high to reach, when a ladder is not available, *causing* them to expedite the bulb change by using whatever is handy, such as a forklift; d) repairing jammed equipment without first shutting it off and locking it out, *causing* the worker to get a limb or hand caught when someone inadvertently turns the machine on. All of these antecedent conditions were found at one time or another in the plants; many of them were found to be part of an accident/injury event.

The supervisor who realizes that many work behaviors and injuries are a function of antecedents and consequences makes good use of positive reinforcement modalities.

When all the outer layers are stripped away, many of the behaviors we saw come to rest at the interface between the workers and the tasks they do. People do the tasks they are given: how well they do them, and how safely, depends on many factors, including how the tasks are designed. We saw several instances of short people reaching and working off-balance, lifting salt bags off a high conveyor and placing them on pallets already loaded above waist level. Ironically, a tall worker could be on the other side of the conveyor, stooping and straining to do the same job. It appears that no matter how tasks are designed, people will try to adapt and do them. Faulty work station design will cause people to alter behavior to fit the tasks and therefore alter their attitudes about the job, the supervisor, and the company.

The literature seems to be fairly conclusive that jobs which are designed with an awareness of worker needs for physical comfort as well as for recognition, responsibility, and variety tend to contribute to higher worker satisfaction and improved work quality—including safety performance. We found many instances where workers were performing physically stressing and repetitive tasks that are improvable through work station redesign. The pallet operations are examples of areas where more thought needs to be given to work station redesign. The high incidence of back injuries, muscle strains, and other injuries related to refinery operations can be corrected through more effective worker-to-job matching, job rotation, and equipment modernization.

Relative to job assignment, the assignment of individuals to jobs should be based on the similarity between the psychological and physical requirements of the job and the measured characteristics of the worker. Those plants that attempt to increase this similarity also increase the likelihood of positive organizational outcomes; such as, increased worker satisfaction, improved work quality and quantity, and improved safety performance.

Certainly, individuals vary in terms of a number of different attributes: abilities, physical characteristics, interest, and needs. Correspondingly, jobs vary in terms of other characteristics: ability and skill requirements, and their potential for satisfying worker interests and needs. The foremen in the experimental plants, while limited by union agreements relative to job assignments, can give more relief time to workers being stressed at the bagging and loading operations (high source of back complaints). An occasional reassignment will reduce muscle stressing and improve worker attitudes towards the company and management.

Considerable progress has been made in recent years in the field of ergometrics: the measurement of work variables (Cunningham, 1971). A number of approaches have been developed for making estimates of the aptitude, interest, and need profiles that are most appropriate for the kinds of tasks we observed (Jeanneret and McCormick, 1969; Neebs, Cunningham, and Pass, 1971; Borgen, Weiss, Tinsley, Davis, and Lofquist, 1968; Campbell, Borgen, Eastes, Johansson, and Pearson, 1968; Fugill, 1971). By using systematic job analysis procedures, organizations can derive estimates of the human attribute requirements of jobs in the organization.

Once human attribute requirement profiles are established for jobs it is important to compare those profiles with the characteristics of present workers.

The assumption underlying the approach is that by better matching of individuals with jobs and tasks, according to the compatibility of the psychological and physiological requirements of the job and the individual's characteristics, desirable organizational outcomes will result. This result has been tested and supported with regard to employee job satisfaction (Tuttle and Cunningham, 1972; Betz, 1968). Consequently, it would seem that if individuals are placed into jobs which "fit" the individual's characteristics, accidents that are symptomatic of fatigue, boredom, low job satisfaction, and psychological withdrawal should be reduced.

It appears obvious that praise goes a long way in attacking the low job satisfaction and psychological withdrawal aspects of the injuries being experienced. But until the industry focuses on the work fatigue and stress aspects, injuries will continue even under the most active positive reinforcement environment.

We experienced many incidences of foreman uncertainty, extreme time pressure, and conflicting or excessive job demands, all of which are components of job stress. It stands to reason that the workers, too, must be feeling the same thing. Such stressors tend to lead to disruptions of job performance, thereby increasing the probability of accidents. We believe many of the injuries we reviewed and the behaviors identified by the supervisors as focus for POMOST are stress manifestations. Since job stress seems related to undesired outcomes—health problems, injuries, back complaints, and reduced work performance—it is desirable to reduce stressors wherever they are present. Some methods by which the industry might reduce worker stress and improve safety performance include:

1. Clearly defining the foreman and worker work roles.
2. Ensuring that equipment and machinery are maintained and are reliable.
3. Providing workers with necessary tools, supplies, and materials on time and in quantities needed.
4. Providing information to workers concerning the adequacy of their performance.
5. Providing timely information to the workers (and foremen) about work schedules and daily output expected.
6. Providing mechanisms in the organization for resolving interpersonal conflicts and for providing feedback as to their performance.
7. Minimizing excessively long periods of time spent in heavy, physically-demanding work, and rotating shift systems.
8. Providing workers with an opportunity to redesign how they perform their jobs.
9. Scheduling two 15-minute work discussion meetings each week—permitting workers to share their feelings relative to working conditions, safety problems, and equipment maintenance.
10. Setting uniformly enforced safety procedures, with no exceptions, relative to the use of safety devices: lockouts, safety lines, manlift procedures, use of hard hats, etc.

POSITIVE MOTIVATIONAL SAFETY TRAINING (POMOST)

The principles upon which POMOST is based have their genesis in B.F. Skinner's theories of operant conditioning and learning. Skinner defined types of behavior according to the manner in which they are learned and maintained. Paraphrased simply: if we are rewarded for the way we behave we will continue to behave that way, seeking the same reward. Further rewards maintain (reinforce) that behavior. Skinner identified two forms of operant learning which affect behavior: reinforcement and punishment. Reinforcement is defined as any consequence which strengthens or increases a behavior which it follows. Punishment is defined as any consequence which weakens, decreases, or reduces a behavior which it follows. An example of punishment in the work place is when a supervisor acts to reduce inappropriate behaviors by threatening, disciplining, or fining an employee.

In POMOST, the use of punishment is not emphasized; rather, emphasis is placed on the supervisor focusing the employee's attention on the appropriateness of his behavior. The existence of inappropriate behavior is not ignored in POMOST, but perceived as a training problem. All behavior is considered to be learned. If an employee behaves inappropriately, the problem is seen as one of inadequate training. POMOST, then, focuses on the extinction of inappropriate behavior by emphasizing appropriate behavior.

For example, coming to work on time is appropriate and reinforced through praise. The fact that the worker is slow to start work is seen as a rate-of-going-to-work problem. The supervisor praises the worker for being on time, then suggests that he try to get to work a little earlier so that he starts work on time. The emphasis is on the positive aspects of performance while correcting the negative aspects through a step-by-step (shaping) approach.

Behavior is of two types: internal and external. POMOST is concerned with influencing both types of behavior. Internal behavior includes all those responses and reactions that occur within and may not be observed. External behaviors are, of course, all those responses that may be observed by someone else. Internal behavior includes all those feelings, emotions, thoughts, attitudes, or other reactions to events in our lives that remain as private events. These internal activities are not commonly thought of as behavior: behavior, to most individuals, refers to that which can be observed. But internal behavior is more similar to external behavior than most people imagine. Emotions and thoughts are also learned, and are subject to many of the same principles of learning as external behavior.

POMOST trains supervisors to be concerned with external behavior and to recognize that the two kinds of behaviors are interwoven; both behaviors occur concurrently and interact. Thus, POMOST provides supervisors (all management) with an understanding about behavior and a process by which we can improve performance; increase safe work behaviors; help the employee feel better about himself, the company, and his job; and generally establish a work environment which is positively supportive.

The principal reinforcer used in POMOST to shape behavior is social reinforcement—praise. It is generally understood that employees expect to be told about their performance. Unfortunately, most people have come to expect that the only feedback they receive is critical. The good things are what we get paid for . . . the bad things are what we lose our jobs for! Feedback has been used as a management tool for years. The reason feedback has been recognized as important in the work setting is that it influences behavior. When feedback results in an increase in the rate of behavior, it is, by definition, a reinforcer.

Feedback is generally defined as information about past performance presented to the person who has performed. The more immediate the feedback, the more powerful it is as a reinforcer. Praise for doing a job well is sought by most employees. The supervisor, acting from his position of authority, is an excellent source for feedback and, thus, a strong influence on behavior. Knowing when to give positive feedback (schedules of reinforcement), how to give it sincerely and express it constructively is, perhaps, one of the more influential techniques learned by POMOST participants.

TRAINING PLAN

The study focused on the testing of a positive reinforcement technique known as social reinforcement—praise. While other positive reinforcement techniques are also useful to shape appropriate or desirable behaviors—money, time off from work, awards for performance, to name but a few—they represent costs in money and administration. The use of praise costs nothing and is considered to be a good management style. While the value of the use of praise to reward workers for appropriate behavior and as a means to shape new behaviors is obvious to progressive management as a basic sound management style, knowing how and when to use it to systematically change behavior is a complex concept.

Under a previous government-funded study (NIOSH, 1975), HPDC developed a sixteen-hour training program for first-line supervisors in the use of praise. The program was entitled "Positive Motivational Safety Training" (POMOST). The program was found to be beneficial in reducing accident severity and frequency rates but fell short of being sufficient in depth to fully train supervisors to be effective change agents.

For this study, it was decided to lengthen the program content and time to at least forty hours. More emphasis was placed on understanding interpersonal relationships, effective communication, and on the scheduling of the use of praise. An additional sixteen hours of on-the-job consultation with each supervisor was envisioned to help the supervisor develop shaping plans for less generalized behaviors. The program content, by subject matter, is as follows.

The POMOST program teaches supervisors the concepts and skills necessary to establish the right kind of psychological climate in which to introduce and establish safe work behaviors. The program is taught in twenty-two to forty hours, depending on need, and has several behavioral objectives.

1. How to recognize unsafe behavior. (1 HOUR).
   Supervisors learn skills in observing how a worker works.
2. How to develop behavioral baselines. (20 HOURS).
   Learning to count and record behavioral observations to provide measurements of change.
3. How to determine what behaviors to change. (2 HOURS).
   Learning to be specific about behavior permits the supervisor to reinforce appropriate behaviors while he alters an inappropriate one.
4. How to communicate behavioral change to workers. (11 HOURS).
   Developing an awareness of interpersonal relationships, the communication process, and positive expression is the key to a successful change.
5. How to shape behaviors. (4 HOURS).
   Blending all the above skills to make the supervisor skillful in bringing about new behaviors.
6. How to maintain a safe work behavior program. (2 HOURS).
   What to say and how to maintain the new behaviors.

A supervisor's POMOST workbook, to be used in the training phase, was developed and submitted to the Salt Institute and the Bureau of Mines for distribution.

SUPERVISORY LEADERSHIP STYLES

Supervisory styles may be defined as the prevailing manner of expression or thought and the prevailing attitude by which a manager organizes available resources for the achievement of certain objectives.

We have observed differing styles by which supervisors lead their employees—ranging from highly autocratic to chummy—sometimes in the same plant. The behavior of supervisors exerts an especially powerful control on the employees directly under them. It is assumed that the way the supervisor acts is the way upper management wants him to act. The employees, therefore, often imitate their supervisors. The manner in which a supervisor gives instructions, provides feedback, offers encouragement, and criticizes denotes his leadership style. Wherever we found a highly supportive supervisor we found low incidences of injuries.

POMOST is based on the assumption that supervisors can affect the motivation of workers to perform their jobs safely by a) encouraging workers to "buy into" explicit safety performance goals that are consistent with organizational objectives: b) arranging conditions so that workers can accomplish goals; c) determining rewards that workers desire and making these rewards contingent on high levels of safety performance; d) ensuring that employees understand the relationship between safety performance and the receipt of rewards.

One significant outcome from POMOST is a guideline for establishing a supportive style of leadership with clear objectives about its concern for safety.

The objectives of an organization, whether or not formally stated, have an impact on the way employees perceive the organization. The perceptions of the organization that employees develop depend to a large degree upon a) the manner in which organizational objectives are reflected in company policies; b) the priorities of the organization, as revealed by the timing and consequences of decisions; c) organizational attitudes towards workers, as reflected in personnel practices; d) organizational concern for the welfare of workers, as reflected by the physical working conditions (Likert, 1967; Litwin and Stringer, 1968; Schneider and Dachler, 1972). The way workers perceive the organization is important, since it is assumed that these perceptions underlie worker decisions regarding appropriate and inappropriate job safety behavior.

Employee perceptions of organizational objectives are based on numerous events and experiences. Thus, the salt plants cannot rely on a single action (an annual safety campaign, for instance) to convince employees that the organization values safety. Rather, company policies and practices throughout the year should support safety as an organizational objective. If the events and experiences of workers in the organization suggest that safe behavior is appropriate behavior and that safe job performance will lead to valued consequences for the worker, the organization will be viewed as one which values safety.

All of this assumes that a supportive, open, and honest relationship exists between supervision and employees. At the outset of the study we found this condition to be rare—even among supervisors and upper management. All of the participating companies have come a long way in establishing a management climate that is supportive of the need for safety along with high production rates.

RESEARCH RESULTS

The study was originally intended to be a before/after control group design. However, the control groups selected showed significant differences from their matched experimental groups. Consequently, this type of design was abandoned in favor of a before/after time series design. Each of four experimental sites (because of insufficient time after training to observe and collect data, Leslie Salt is not included in this report) reported their eye, hand, and back injuries from January 1, 1976. When the programs were begun (different dates for each site) the periods were divided into the pre and post measures. Thus, all the months prior to the onset of training represent the total number of pre measures; those subsequent to training represent all the measures of the post period. The number of post training measures differs for each experimental group.

Much injury data was collected in addition to that enumerated above. For example, severity and frequency rates were collected which accounted for days lost and injury frequency by man hours worked. This data was unusable, however, for the following reasons: 1) Man hour data as such was unavailable from one of the experimental sites. 2) Where the rates were available they were computed on all injuries and not for those specific types to which this study was directed. 3) The variance in the rates was unrelated to the variance in the injury categories studied. 4) The month-to-month rates were not always independent. Consequently, these analyses were not used as evidence of "effect" of POMOST.

Some of the same rationale may be applied to the use of productivity data. One of the original predictions of the study was that productivity would increase as a function of the application of POMOST. However, it was subsequently found that production is more geared to sales and market conditions than it is to manpower availability and practices. Therefore, it was not possible to determine that portion of productivity which was associated with POMOST and that portion associated with market conditions.

For the first analysis all of the monthly measures of number of injuries were arrayed and an overall mean was computed. Each monthly total of injuries was then compared for both the pre and post period to determine whether each was above or below the mean. Thus, a 2×2 chi square contingency table was constructed which compared the pre and post periods for the number of months in which the totals were above and below the means. Then, a pre training mean was computed separately for each site. Each post training total was then compared to determine the number of monthly totals which were above or below the pre training mean. This data analysis is next presented, by site.

Cargill—Hutchinson, Kansas. The monthly raw frequencies of eye, hand, and back injuries and training dates are presented in Table 1.

The mean of the total distribution of monthly injuries is 2.2. Using this as a base, a contingency table was constructed and is represented as Table 2. For a 1 df table the obtained chi square is not significant. Consequently, we must assert that there is no difference between the pre and post periods in the number of months above or below the overall mean.

The mean monthly injury frequency for the pre training

TABLE 1

Injury Frequency, Cargill-Hutchinson, Kansas

	Month	Eyes	Hands	Back	Total
1976	January		2	1	3
	February				—
	March		3	1	4
	April		1	3	4
	May			1	1
	June		1	1	2
	July			1	1
	August	1	3	1	5
	September	1			1
	October		2	1	3
	November	2			2
	December				—
1977	January	1	3	3	7
	February		1		1
	March	2		3	5—Training
	April		3		3
	May		2	1	3
	June		1	1	2
	July		2	1	3
	August		1		1
	September		2	1	3
	October				—
	November		2		2
	December			1	1
1978	January			1	1
	February		2		2
	March		1	1	2
	April				—
	May		2	1	3
	June		1	1	2
	July		3		3
	TOTAL	7	38	25	70

TABLE 2

Contingency Table for Monthly Injuries in the Pre and Post Periods

	Above Mean	Below Mean
Pre Period	7	8
Post Period	4	5
		Chi Square = .77

period was 2.6, or above the overall mean. When the post period monthly plots were compared against 2.6 the results were as follows: above mean 4, below mean 9, chi square = 1.92.

From the figures listed above it is obvious that no difference exists between the number of months above or below the mean. It should be noted, however, that in both cases the results are in the predicted direction. That is, a trend of gradually lowering numbers of monthly injuries may be discerned.

Diamond Crystal—Jefferson Island, Louisiana. The monthly raw frequencies of eye, hand, and back injuries and training dates are presented in Table 3.

The mean for the entire distribution is 3.5. Comparing this mean with each monthly post training total provides the following in Table 4. As was the case with Cargill, the results are not significant. Therefore, no effect can be asserted.

The pre training mean for this group is 3.15, somewhat smaller than the overall. When that mean was compared to each month in the post training period the following resulted: above mean—10, below mean—6. This chi square was not significant, thus no difference can be discerned for Diamond Crystal.

International—Watkins Glen, New York (ISCO). The monthly raw frequencies of eye, hand, and back injuries and training dates are presented in Table 5.

For ISCO, a gradual decline in injury frequency may be

TABLE 3

Injury Frequency, Diamond Crystal—Jefferson Island, Louisiana

	Month	Eyes	Hands	Back	Total
1976	January			2	2
	February		1	2	3
	March		2	3	5
	April		1	2	3
	May				—
	June	1			1
	July	1		2	3
	August	1		1	2
	September		4		4
	October		2	1	3
	November	1	2	2	5
	December	1	1	4	6
1977	January	1	2	2	5—Training
	February	1	1	1	3
	March	1	2	2	5
	April				—
	May		1	2	3
	June		2	5	7
	July		2		2
	August	1	2	3	6
	September		2	4	6
	October		1	1	2
	November		3	4	7
	December	1	3	1	5
1978	January	1		3	4
	February				—
	March		2	3	5
	April	1	2	2	5
	May	1	2	1	4
	June		2		2
	July				—
	TOTAL	13	42	53	108

TABLE 4

Contingency Table for Monthly Injuries in the Pre and Post Periods

	Above Mean	Below Mean
Pre Period	5	8
Post Period	9	7
		Chi Square = .8

seen. The overall mean was computed as 31 injuries per month. The comparison of this mean to each month of the pre and post period resulted in the contingency table, Table 6.

This data shows a significant decrease in the number of injuries following the training period at the 5% level of confidence. It would seem, therefore, that training had an effect on the number of injuries that occur monthly. The pre training mean was 33.5 injuries per month. When that was compared to the post training period injuries the following resulted: above mean—1, below mean—11.

The difference between 1 and 11 was found to be significant at the 1% level of confidence on a "goodness of fit" (50%–50%) chi square test. Once again it would seem that a relationship exists between training and subsequent injury frequencies.

Hardy—Manistee, Michigan. The monthly raw frequencies of eye, hand, and back injuries and training dates are presented in Table 7.

For Hardy Salt, a generalized decreasing slope is evident. The overall mean injury frequency is 3.5 injuries per month. Comparing this to each month of the study, pre and post, reveals the following (Table 8).

The obtained chi square is not significant. Therefore, no effect of training on subsequent injuries may be inferred. Nevertheless, it should be noted that the data trends in the predicted direction.

The pre training average is 4.05 injuries per month,

TABLE 5

Injury Frequency, International—Watkins Glen, New York

	Month	Eyes	Hands	Back	Total	
1976	January	9	14	11	34	
	February	6	19	1	26	
	March	6	18	6	29	
	April	7	16	6	29	
	May	7	14	4	25	
	June	4	17	5	26	
	July	4	25	9	38	
	August	7	20	7	34	
	September	11	26	6	43	
	October	5	24	8	37	
	November	9	21	6	36	
	December	3	11	9	23	
1977	January	8	22	12	42	
	February	6	18	6	30	
	March	7	27	12	46	
	April	2	32	5	39	
	May	1	25	7	33	—Training
	June	1	23	4	28	
	July	1	23	4	28	
	August	4	25	4	33	
	September	3	11	3	17	
	October	3	16	5	24	
	November	1	21	9	31	
	December	2	15	3	20	
1978	January	7	24	4	35	
	February		18	12	30	
	March	5	15	6	26	
	April	3	22	3	28	
	May	3	17	8	28	
	June	3	15	6	24	
	July	2	11	4	17	
	TOTAL	140	605	194	939	

TABLE 6

Contingency Table for Monthly Injuries in the Pre and Post Periods

	Above Mean	Below Mean
Pre Period	10	7
Post Period	2	10
		Chi Square = 5.07

TABLE 7

Injury Frequency, Hardy—Manistee, Michigan

	Month	Eyes	Hands	Back	Total	
1976	January			2	2	
	February		3	3	6	
	March		1	1	2	
	April		1	3	4	
	May		1	2	3	
	June		1	2	3	
	July		1	1	2	
	August		1	1	2	
	September	3	2	2	7	
	October		2	3	5	
	November		1	2	3	
	December		1	1	2	
1977	January	1	4	6	11	
	February		1	3	4	
	March	1	1	1	3	
	April	1	2	1	4	
	May			1	1	
	June		1	3	4	
	July	1	3	3	7	—Training
	August	2	2		4	
	September	1	2	1	4	
	October		1	1	2	
	November		1	2	3	
	December		1	3	4	
1978	January			3	3	
	February		1	2	3	
	March		1		1	
	April	1			1	
	May			4	4	
	June	2	1	2	5	
	July		1		1	
	TOTAL	13	38	59	110	

TABLE 8

Contingency Table for Monthly Injuries in the Pre and Post Periods

	Above Mean	Below Mean
Pre Period	10	9
Post Period	4	6
		Chi Square = .44

which is somewhat larger than the overall mean. When this was used as the base of comparison for each post training month the following was obtained: above mean—0, below mean—10.

This figure is significant at beyond the 1% level of confidence. Consequently, a relationship may be said to exist between training and a decreasing frequency of injuries at Hardy.

In sum, three experimental sites have shown a decrease in injury frequency from pre to post training periods while the fourth showed an increase. It should be noted that the raw injury frequencies for ISCO are higher in magnitude than the other sites. This state of affairs is caused by a different record-keeping system than at the other locations. Nevertheless, each site maintained its own records in the same manner from the pre through the post periods.

When one considers the picture of all sites combined, the effect of training on injuries may be simpler to understand. This data is displayed in Figure 1. For this figure the mean injuries of each site for the pre and post periods have been combined and an average of those means were computed. Thus, the mean of the means for the pre period can be compared with that computed for the post period. It is clear from Figure 1 that when the data is combined a drop in injuries may be associated with the onset of training. A general effect which is consistent with the initial hypothesis may thus be substantiated.

When all four experimental sites are considered, it is clear that Hardy and ISCO have shown significant decreases in injuries, Cargill has shown a trend in the direction of decrease, and Diamond Crystal no decrease in

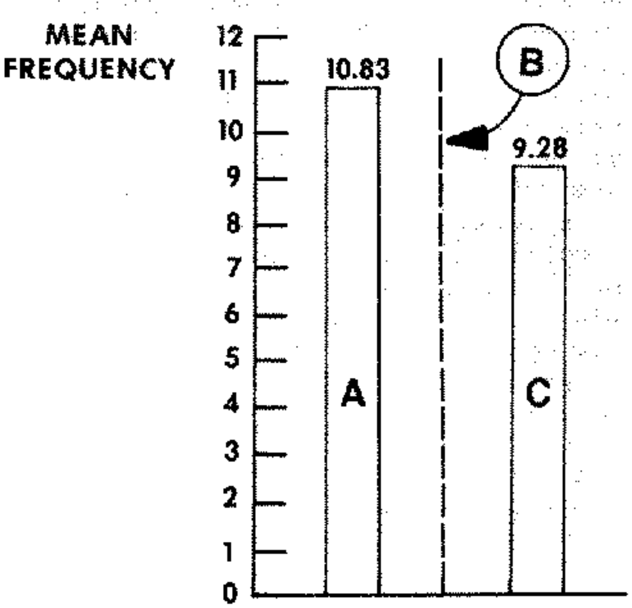

Figure 1. Comparison of injuries Pre- and Post-training periods for all sites, all experimental sites are combined.

Mean frequency is a combination of means from separate sites. A) Pre-training. B) Training line. C) Post-training.

injuries. The logical question becomes why are decreases evident at some sites and not at others?

An examination of the raw data at each site suggests the possibility that the number of productive hours at each site has increased in the same period that observations were being recorded for injuries in the post training periods. Consequently, the man hours worked in the pre training periods was computed and then contrasted to those man hours expended in the post training period. These results appear in Table 9.

The negative differences indicate that more man hours were used at each experimental site. These differences range from an average of 700 hours per month more at Cargill to almost 3,000 hours more at Hardy than the pre training period. This data seems to suggest that there was an increase in opportunity for accidents and injuries concomitant with measurements and observations concerned with decreases in injuries. If one were to add hypothetically the greater opportunity for injuries associated with increases in man hours, the data previously analyzed might have shown far more significance.

Since increases in man hours have occurred at every experimental location, the present research must account for an increased opportunity for accidents and injuries. Consequently, each monthly injury total for each site was divided by the man hours expended for the corresponding month. The resultant for each month was an injury rate per one-thousand man hours. Table 10 provides the descriptive statistics for those injury rates.

An inspection of Table 11 reveals a decline in injury rates at Cargill and Hardy and an increase in the rate at Diamond Crystal.

When the pre training average rate was compared to each monthly rate in the post training period, the following resulted:

TABLE 9

Average Monthly Man Hours in Thousands Expended at Each Experimental Site*

Site	Mean (000) Pre Training Hours	Mean (000) Post Training Hours	Difference (000)
Cargill	15.01	15.73	− .72
Diamond Crystal	39.03	41.16	−2.13
Hardy	33.97	36.88	−2.91

*No production data available for ISCO.

TABLE 10

Pre and Post Average Injury Rates for Experimental Sites*

Site	Mean Pre Rate	Mean Post Rate	Difference
Cargill	.143	.118	+.025
Diamond Crystal	.078	.100	−.022
Hardy	.153	.071	+.082

*Man hour data is not available for ISCO.

Thus, the rates at Cargill and Hardy show significant decreases in injury rate frequencies, while Diamond Crystal shows no change.

From the analysis of raw frequencies at each site, coupled with those corrected for man hours, it is evident that significant declines have occurred at three sites, while Diamond Crystal remained constant. This is interpreted as evidence for the assertion that the POMOST program had an effect on injuries and injury rates.

The previous sections indicated that a relationship probably exists between the application of POMOST and subsequent reductions in injury frequencies and rates. As noted earlier, however, it was not possible to compare these results with selected control sites. However, each site is ranked monthly by the Salt Institute, based upon the frequency and severity (lost time) experienced that month. The highest rankings are the lowest number, with 1 representing the least number of injury and severity and so forth. Using this data will permit a comparison of the experimental sites with all others. For this analysis average ranks were computed for the pre training period and post training separately for group-wide and industry-wide sites. Table 12, presents that data.

For the industry-wide average rankings, each experimental site experienced a rise in rankings with two sites averaging over a six place rise with two sites showing an average rise of less than one place. For the group comparisons only one site showed a rise of almost three places, while three of the sites lost ranks. It should be noted that the rankings were based upon total injuries and not only eye, hands, and back injuries—to which this study was directed. Consequently, one must expect some ambiguity in interpretation of results.

Nevertheless, when group and industry ranks are combined, some 15.73 ranks were increased. Thus, all sites combined averaged an increase of almost two full ranks from the pre training period to those following training. Again, this data is interpreted as support to the assertion that POMOST affected subsequent performance.

TABLE 11

The Number of Months Above and Below the Pre Training Average Rates for the Experimental Sites

Site	Months Above	Months Below	Chi Square
Cargill	2	10	* 5.14
Diamond Crystal	9	7	2.50
Hardy	0	10	**10.00

*Significant at .05.
**Significant at .01.

SUPERVISORS' BEHAVIORAL OBSERVATION DATA

The need to pinpoint behaviors to be shaped was emphasized in the training program. Each supervisor was trained to count appropriate and inappropriate behaviors for two weeks prior to applying Social Reinforcement (SR). Praise (SR) for working safely was to be applied immediately upon observing the desired behavior. Each supervisor was free to specify the behavior(s) he sought to shape or extinguish. The two-week period prior to SR application was used to form the baseline by which the effect of praise was to be measured. Supervisors were asked to mail their observations to us on a weekly basis until notified otherwise.

A sample of the form used is included in the Appendix of this report. A detailed explanation on the use of the form is contained in the Supervisor's POMOST Workbook, available from the Bureau of Mines, U.S. Department of Interior.

Within a short time after training, it became apparent that many supervisors were not reporting accurate pre SR observations. Independent observations showed that some employees were not wearing safety glasses when the supervisor was conducting his observational tours, yet the supervisor recorded that they were. In spite of repeated attempts by the POMOST researchers to impress upon supervisors and plant management the need for accurate data reporting, supervisors continued to send us data showing high incidences of safe behavior for both before and after SR application. Based on our private discussions with supervisors we learned that many of them felt threatened by reporting workers who were working unsafely; hence, they "covered up" by showing that employees were performing safe work.

While we were getting some accurate observations from some supervisors, the number was not sufficient—even within a single experimental plant—to use the data in a meaningful way in our research.

Figure 2 is an extrapolation of observations for one employee taken from an accurately prepared supervisor's

TABLE 12

Average Ranks of Pre and Post Periods for the Experimental Sites

Site	Pre Average Group	Post Average Group	Diff.	Pre Average Industry	Post Average Industry	Diff.
Cargill	19.47	16.50	+2.97	49.67	43.12	+6.55
Diamond Crystal	8.9	12.5	−3.60	25.1	24.3	+ .80
ISCO	17.71	18.3	− .59	52.1	45.8	+6.3
Hardy	24.2	24.8	− .6	59	55.1	+3.9

weekly observational report. It shows before SR application and the results of the shaping approach using SR for two weeks following application. (The form used by supervisors lists the names of all employees in their crews.)

As can be seen, the incidences of the wearing of safety glasses increased after the application of SR. The supervisor shaped the desired behavior using a continuous reinforcement schedule for three days (M–W) of SR Week 1, then moved to an intermittent schedule for the next seven working days.

Independent observations were made during the same weeks to verify the supervisor's input, Figure 3. Note that the time periods are not always the same. This was done to minimize the "Hawthorne effect" of observer impact and to test whether or not the employee wore safety glasses when the supervisor was not present. The time periods are approximate in that the observer varied his visits ±1–15 minutes; hence, there was no fixed routine by which the employee could predict when someone would be around.

EMPLOYEE: Joe Collins | SUPERVISOR: Herb Latour

LOCATION: Refinery/Bagging | DATE: July, 1977 | PLANT: ———

BEHAVIOR: Safety Glasses Wearing | INDEPENDENT OBSERVER: ———

OBSERVATION		BASELINE NO SR										SR APPLIED									
		WEEK 1					WEEK 2					WEEK 3					WEEK 4				
TIME	NO.	M	Tu	W	Th	F	M	Tu	W	Th	F	M	Tu	W	Th	F	M	Tu	W	Th	F
7:30	1	–	–	+	–	+	+	–	–	+	–	+/R	+/R	+	+/R	+	+/R	+	+	+	+
8:30	2	–	–	–	+	+	–	+	+	+	–	+/R	+/R	+/R	+/R	+	+	+	+	+	+/R
10:00	3	+	–	–	+	–	+	–	+	–	+	+/R	+/R	+	+/R	+/R	+	+/R	+	+	+
10:30	4	–	+	–	–	–	+	–	+	–	+	+/R	+/R	+/R	+	+/R	–	+	+	+	+
1:00	5	+	+	+	–	+	–	–	–	+	–	+/R	+/R	+/R	+	+	+	+	+/R	+	+
2:00	6	+	+	–	+	–	+	+	–	+	–	+/R	+/R	+/R	+/R	+	+	+	+	+	+
3:00	7	–	–	–	–	–	–	–	+	+	–	+/R	+/R	+	+	+/R	+/R	+/R	+	+/R	+/R
SAFE BEHAVIORS(+)		3	3	2	3	3	4	2	4	5	2	4	6	6	5	7	7	7	7	7	7

TOTAL(+): 31 S|R TOTAL(+): 63

\+ WEARING GLASSES

– NOT WEARING GLASSES

+/R WEARING GLASSES PLUS REINFORCED

Figure 2. Sample of observations for one employee taken from supervisor's weekly observational report.

EMPLOYEE: Joe Collins | SUPERVISOR: Herb Latour

LOCATION: Refinery/Bagging | DATE: July, 1977 | PLANT: ———

BEHAVIOR: SAFETY GLASSES WEARING | INDEPENDENT OBSERVER: J. Oslan

OBSERVATION		BASELINE NO SR										SR APPLIED									
		WEEK 1					WEEK 2					WEEK 3					WEEK 4				
TIME	NO.	M	Tu	W	Th	F	M	Tu	W	Th	F	M	Tu	W	Th	F	M	Tu	W	Th	F
7:00	1	–	–	+	–	+	+	–	–	+	–	–	+	+	+	+	+	+	+	+	+
9:00	2	–	–	–	+	–	–	+	+	+	–	–	+	+	+	+	+	+	+	+	+
9:30	3	+	–	+	+	+	+	–	+	–	+	+	–	+	+	+	+	+	+	+	+
11:30	4	–	+	–	–	–	+	–	+	+	+	+	+	–	+	+	+	+	+	+	+
1:00	5	–	+	+	–	+	–	–	–	+	–	–	+	+	–	+	+	+	+	+	+
2:00	6	+	+	–	+	–	–	+	–	+	–	+	+	+	+	+	+	+	+	+	+
3:30	7	–	–	–	–	–	–	–	+	–	–	+	+	+	+	+	+	+	+	+	+
SAFE BEHAVIORS(+)		2	3	3	3	3	3	2	4	5	2	4	6	6	6	7	7	7	7	7	7

TOTAL(+): 30 S|R TOTAL(+): 64

\+ WEARING GLASSES

– NOT WEARING GLASSES

+/R WEARING GLASSES PLUS REINFORCED

Figure 3. Sample of observations for one employee taken from independent observer's report.

CONCLUSIONS AND RECOMMENDATIONS

The value of using positive reinforcement—specifically, social reinforcement (praise)—to reduce accident frequency and severity rates by increasing safe work behavior has been demonstrated to be effective. If further research is supported, we recommend that it be directed toward the development of a study wherein hourly employees are the focus of a positive reinforcement behavioral change program.

Our experience in the salt companies tells us that the unions influence the bargaining unit employees' attitudes toward their supervisors and can help hinder or contribute to the adherence to safety rules and regulations. These attitudes are often negative, with the employee arguing over the wearing of safety devices or performing work in a safe manner. Of the dozens of grievances which we reviewed, many focused on the employees' refusal to wear safety glasses, shoes, or a respirator. The unions supported these grievances and thereby reinforced employee resistance and apathy in regard to health and safety. We believe that the unions are approachable and that they would support a program which would give their members insight into their behavior.

Another outcome of this study relates to the need for all management of a plant to go through the POMOST program. In the two sites where less than total management was trained the results were not nearly as dramatic as in those plants where all management went through the program. It is our opinion that supervisors need praise for their performance—especially as it relates to safety improvement—because safety is often less of a priority item to upper management than is production. Management trained in POMOST develops a supportive or reinforcing relationship, best described as team-like.

Perhaps the single most important question to be answered is how to get POMOST established as a management tool in the remaining salt mines and refinery operations.

Our recommendation is the establishment of a training program in which representatives of the twelve member companies of the Salt Institute would be trained in POMOST and become in-company POMOST trainers. Those trained need to have good verbal skills and knowledge of production processes. They need not be educated in sophisticated psychological concepts, or even be college graduates. Their credibility as trainers would be based on their knowledge of their industry and plant operations.

In anticipation of this recommendation becoming a reality, Human Potential Development Corporation has prepared an instructor's guide. It is our opinion that no more than eighty hours of training would be required to prepare an in-company representative to be an effective POMOST trainer.

Finally, in each of the POMOST workshops this question was asked: "How long should we continue the POMOST program?"

Our answer is, "Forever. Why would you stop doing something that is producing a lower injury frequency rate and higher salt output?" POMOST should not be viewed as a program; rather, it should be viewed as good management.

ACKNOWLEDGEMENTS

This report was prepared by Salt Institute, Alexandria, Virginia, and Human Potential Development Corporation, Canoga Park, California, under USBM Contract J0166137. The contract was initiated under the Metal and Non-Metal Mining Health and Safety Research Program. It was administered under the technical direction of the Pittsburgh Mining and Safety Research Center with William Wiehagen acting as Technical Project Officer. Howard R. Evelan was the contract administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period July 1, 1976, to September 30, 1978. This report was submitted by the authors on September 30, 1978.

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