GEORGIA INSTITUTE OF TECHNOLOGY
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SPONSORED PROJECT INITIATION

Date: 1/18/79

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Project Director: Judi Komaki

Sponsor: DHEW/PHS/NIH - National Institute for Occupational Safety and Health

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Sponsor Contact Person (s):

Technical Matters

Dr. Benjamin H. Bruckner
Project Officer
National Institute for Occupational Safety & Health
Rockville, Maryland 20852

Contractual Matters
(thru OCA)

Mr. Joseph W. West
Grants Management Officer

National Institute for Occupational Safety & Health
Rockville, MD 20852
(301)443-3122

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Assigned to: Technology & Development (School/Laboratory)

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B-11-137

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 1/22/81

Project Title: A Behavioral Approach: Motivational/Financial Impact

Project No: B-530

Project Director: Judi Komaki

Sponsor: DHEW/PHS/NIH - National Institute for Occupational Safety and Health

Effective Termination Date: 12/31/80

Clearance of Accounting Charges: 12/31/80

Grant/Contract Closeout Actions Remaining:

_ Final Invoice and Closing Documents
_X Final Fiscal Report (Report of Expenditures)
_X Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other _____

Assigned to: EDL (~~School~~/Laboratory)

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B-530

A BEHAVIORAL APPROACH:

MOTIVATIONAL/FINANCIAL IMPACT

Final Report

Principal Investigator

Judi Komaki, Ph.D.

Georgia Institute of Technology

Sponsored by

National Institute of Occupational Safety and Health

Grant No. 1 R01 OH00777-01

January 1, 1979 - June 30, 1980

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Special Thanks to

Plant Personnel

Chet Austin

Jimmy Burruss, Jr.

Willard Bowden

William Lamanac

Maguar Rush

Evelyn DeLong

Consultants

Milton Blood

Thomas Coates

Observers

William Warzak

Michael Cole

James Barnett

Judi Gerhardt-Cox

Technical Monitor

Kent Anger

I. SUMMARY

Crisp strides have been made in eliminating physical hazards from the workplace and ensuring a safe working environment. Efforts to influence the behavior of workers, however, have proceeded haltingly. Solutions for handling the "people" aspects of safety are negligible.

The present study focused on a select psychological technique, the behavior analysis approach, which has recently been demonstrated to facilitate the safety practices of workers on the job. In a recent study, for instance, the principal investigator and her associates successfully implemented a behavioral safety program in a wholesale bakery, which resulted in a substantial reduction in injuries. Desired safety practices were specified and assessed approximately three times a week for six months. Employees received instruction in avoiding unsafe practices and their safety performance level was recorded on a graph for all to see. The results: from performing safely 70% and 78% of the time, employees in two of the most accident-ridden departments substantially improved their performance to 96% and 99%, respectively. When no feedback was provided, performance dropped back to the original level (71% and 72%). As a result, it was concluded that the behavioral safety program was responsible for the improvements in performance.

Despite the positive results, some questions have arisen about the relative contribution of the training and feedback components of such behavioral programs. Was it necessary to provide feedback? Wouldn't it be sufficient simply to provide safety training?

To answer these important questions, the present research compared the relative contribution of these components. To rule out the effect of supervisory participation, each component contained the same frequency of supervisory involvement.

Desired safety practices were specified for four departments in a poultry processing plant in the state of Georgia. Subsequently, on-site observations were conducted approximately three times per week over a 46-week period. A multiple-baseline design across groups was used in which the following conditions were introduced: 1) Antecedent Control (safety rules explained, illustrated, and displayed; new rule posted 3 times per week; weekly supervisor meeting discussing rules), and 2) Consequent Control (feedback graph explained, interpreted, and displayed; feedback posted 3 times per week; weekly supervisor meeting discussing feedback).

Employees showed only slight improvements during the Antecedent Condition, but performance increased significantly during the Consequent Condition in all groups. Employees were performing 85% of the items safely; in three departments the mean scores were over 90%. Furthermore, employees reported they preferred the Consequent Condition. Personnel noted they particularly liked obtaining information <u>following</u> their performance. The results demonstrate that even though employees were reminded frequently and supervisors discussed safety weekly, the addition of a consequence such as feedback was more effective in sustaining safe practices and was better received by workers than the rules and reminders.

Although feedback is readily accepted, questions often arise about its long-term effects: will such a benign consequence be effective over an

extended period of time? Are other back-up reinforcers necessary? Thus, the second purpose of the present research was to assess whether feedback would be effective in maintaining performance over an extended period of time. The study under discussion was continued for another 29 weeks, for a total duration of 75 weeks, making possible the assessment of feedback effectiveness over a six month period in all four departments.

The results showed that thrice weekly feedback, in combination with a weekly supervisory meeting and the posting of safety rules, was capable of maintaining safety performance for an extended period of time. The results also highlight the importance of one dimension of feedback: the frequency with which it is provided. Performance declined and became more variable in two departments when feedback was provided only once a week. When the frequency was returned to thrice weekly, however, performance improved once again.

Countless safety programs fail, however, not because of faulty conception, but because of a lack of top management commitment. One of the proposed ways to obtain this commitment is to show how safety affects the bottom line: profits. Although safety and health should not be promoted from a financial point of view alone, it is generally agreed that management is more likely to enthusiastically endorse, fund, and implement efforts which have an effect on company profits. Thus, the third purpose of the present research was to assess the financial impact of a behavioral safety program on workplace accidents by taking into consideration both direct and indirect costs. The direct costs included both medical and indemnity payments made by the insurance carrier. The indirect or uninsured costs were determined

by identifying the events triggered by injuries (e.g., time spent by supervisory personnel) and then determining the cost associated with each event (e.g., average amount of time spent per accident x average hourly wage). To determine the cost savings, if any, that occurred as a result of the behavioral safety program, the costs attributable to injuries were assessed for the three conditions during the first 46-week period and then for the same periods during the preceding four years, 1975-1978. Although no clear cut conclusions could be drawn about the cost savings resulting from the program, this portion of the research illustrated a methodology for assessing the financial impact of workplace accidents.

Complete descriptions of each of the three research questions concerning a) the relative contribution of the training and feedback aspects of behavioral safety programs, b) the long-term effects of feedback, and c) the financial assessment of workplace accidents are included below. For any further questions, please contact Judi Komaki, Ph.D., Georgia Institute of Technology, Engineering Experiment Station, Atlanta, Georgia 30332.

Comparison of Antecedent and Consequent Control Approaches to Occupational Safety

Although safety in the workplace has recently received an enormous amount of attention, solutions for handling its "people" aspects are still negligible. In contrast to the strides made in eliminating physical hazards from the workplace, efforts to influence the behavior of workers have proceeded haltingly. Ellis (1975) concluded in a review of the safety performance literature that "the quality and intensity of research necessary to draw firm conclusions...were found to be remarkably inadequate" (p. 180).

Several recent studies have demonstrated the effectiveness of the behavioral approach in improving the safety and health of workers on the job (Smith, Anger & Uslan, 1978; Sulzer-Azaroff & de Santamaria, 1980; Sulzer-Azaroff, 1978; Zohar, 1980). The senior author and her associates, for instance, successfully implemented a behavioral safety program in a food manufacturing plant (Komaki, Barwick & Scott, 1978). Desired safety practices were specified and assessed approximately three times a week for six months. The program consisted of a brief training session followed by regular feedback on the safety performance level. Employees substantially improved their safety performance, and the injury frequency rate declined.

Even with the positive results of such behavioral programs, the relative contribution of the antecedent and consequent components has been questioned. Was it necessary to provide feedback? Perhaps workers improved because they finally knew what to do. Why not just provide safety training?

The belief in safety training is fervent and longstanding (e.g., Anderson, 1975; Leslie & Adams, 1973; Milutinovich & Phatak, 1978). To illustrate: The fact that the industrial trucking accident rate has not declined in spite

of the availability and use of excellent training materials led to the conclusion that "the failure lies--not in the training programs--but in how they are taught" ("Operator Training," 1975, p. 45).

In response to this issue, the senior author and her associates recently compared the relative effectiveness of training and feedback for employees in a vehicle maintenance facility (Komaki, Heinzmann & Lawson, 1980). The antecedent training component was presented alone. Its effects were assessed before the introduction of the second feedback component. Safety training and rules alone resulted in slight but insignificant improvements; only with feedback did performance improve substantially.

Close analysis of the above study, however, revealed that at least two factors differed between the components in addition to the feedback: stimulus changes and supervisory involvement. As in many training programs, the information was provided on a one-shot basis; safety was the subject of one training session but was not necessarily mentioned again. In contrast, the graphs were updated three or more times a week. More importantly, perhaps, supervisors provided the feedback. Thus, the greater effectiveness of the feedback procedure may have been due to the greater frequency of stimulus changes and/or supervisor participation rather than the feedback per se.

Thus, the present research compared the relative contribution of the antecedent and consequent control components of the previous behavioral safety program. Each component contained the same frequency of supervisory involvement and stimulus changes. The heavy reliance on such antecedent techniques as training and reminders in the area of safety and the widely acknowledged role of supervisors in the success of any safety program make this a particularly significant issue.

Method

Subjects and Setting

The study was conducted in a poultry (hens, broilers, roosters, and leg-horns) processing plant in the southeastern portion of the United States. The plant employs approximately 275 persons and contains eleven departments: Live Dock, Picking, Evisceration, Chill and Pack, Cut-up and Bagging, Shipping, Clean Up, Route Drivers, Maintenance, Office Personnel, and Management. Employees are primarily involved in hanging, trimming, eviscerating, sorting, cutting, and packing operations. The major portion of work is on processing lines which run at the rate of 2,000 to 6,000 birds per hour.

The Chill and Pack, Cut-up and Bagging, and Evisceration departments were selected for study. The largest of these departments, Evisceration, was divided, for the purpose of the study, into two approximately equal groups, labelled Evisceration I and II. Employees, in the four departments numbering approximately 200, earned from $3.10 to $3.26/hour at the beginning of the study. As is typical in the processing industry, turnover was high (209%). That is, an average of two persons were hired for every position during the course of a single year.

These four departments were selected because in the year preceding the study 79% of the lost workday cases had occurred in them. The injury incidence rate for the plant as a whole, however, was relatively low. There were an average of 7 lost workday cases per year for the three years prior to the study, and an injury and illness incidence rate of 2.6 lost workday cases per 100 full-time employees. The comparable rate for the poultry and egg processing industry (9.3) is over three times that much (Bureau of Labor Statistics, 1980).

At the beginning of the research, the plant management arranged for a voluntary safety and health audit, a recent service supported largely by federal funds. Examination of the physical plant showed relatively few safety hazards. With the exception of one item, all hazards that were found were classified "other than serious". All hazards were corrected during the first month of the research.

Measure

Specification of safe peformance. The first step in the research was to define the desired behaviors and outcomes. Two primary sources of information were used: a) the accident/injury experience over the last three years, and b) interviews with supervisors and selected employees.

All plant accidents were first grouped by department (e.g., Evisceration) and then by employee position (e.g., gizzard peelers). Each group of accidents was then analyzed to determine whether they were preventable, (i.e., whether workers could avoid having similar incidents by altering their behavior). Preventable accidents were further examined to determine critical actions that would avoid future injuries. Researchers asked on-site personnel to describe, or preferably to model, what an employee should do to perform the operation safely.

Written descriptions of each operation spelled out the desired actions. Interrater reliability checks determined if the descriptions were clear and the observational procedures feasible. If one observer noted an observation was done safely and the other observer recorded it was done unsafely, the wording or procedures were changed, where appropriate. Revisions continued until a minimum of 80% agreement was consistently reached. Table 1 displays sample items.

Table 1

Sample Safety Items

Department	Position	Duration of Observation	Activity to be Categorized
Chill & Pack	Trimmer	Entire sharpening episode	When sharpening, use only top 2/3 of steel.
Evisceration I	Gizzard cutter	5 birds per employee	When cutting, look toward cutting area.
Evisceration II	Craw puller	5 birds per employee	When pulling craw, pull straight down, not toward trough edge.
Cut-up & Bagging	Racker	At point of arrival	When racking, wear protective head gear.

Observational procedures. Circumstances dictated the conditions under which items were observed. Some activities were observed until they had been completed a fixed number of times (e.g., trimming five chickens). In these cases, one occurrence of an unsafe act was sufficent to score the entire activity as unsafe. Other items were observed as soon as the observer entered the department (e.g., wearing protective hard hats while packing frozen hens). Finally, some infrequently occurring activities were scored when they occurred in the presence of the observer (e.g., operating a pallet jack). Each item was scored as either safe, unsafe, or not observed. The percentage of items scored as safe for each department was computed by dividing the number of items scored safe by the total number of items scored safe and unsafe. This percentage constituted the dependent measure for the study.

Data Collection

A total of 124 observations were made approximately three times a week (2.7) over a 46-week period. Observations began in February and ended in January of the next year. Each observation session took 20 to 30 minutes in each department, for a total time of approximately 90 minutes.

Interrater Reliability

During the formal data collection period, interrater reliability was assessed 16 times, for an average of one reliability check every 8 observations. The percentage agreement method was used in which the number of agreements is divided by the number of agreements and disagreements and then multiplied by 100.

Because of the relatively high percentage of items scored safe, reliability was computed separately for safe and unsafe items. For the unsafe

items, for instance, an agreement was scored when both observers independently marked the item as unsafe. A disagreement was scored when the primary observer marked the item unsafe and the other observer failed to mark the same item unsafe. If only an overall reliability score were presented, the preponderance of safe items could overshadow the unreliability of the relatively few unsafe items.

Reliability for the safe items exceeded the reliability for the unsafe items, as expected. Observers agreed on 1,029 out of 1,076 of the safe items, for an average reliability of 96%. For the unsafe items, however, observers agreed on 198 out of 254 items, for an average reliability of 78%.

Conditions

The study included two different conditions. In the Antecedent Control Condition, the safety rules were explained and illustrated via 35 mm. slides at an initial meeting; the rules were displayed in each department; a new rule was highlighted three times a week; and supervisors discussed the rules at a weekly safety meeting. In the Consequent Condition, the feedback graph was explained and interpreted at an initial meeting; the graph was posted; feedback was provided three times a week; and each supervisor discussed the feedback at a weekly safety meeting.

Table 2 outlines how both stimulus changes and supervisory involvement were held constant in the two conditions. The posters were changed three times a week and supervisors held weekly safety meetings throughout.

Antecedent condition. A meeting with the personnel in each department began the Antecedent Condition. Although personnel were performing relatively safely, further improvements were pointed out that could reduce the occurrence

Table 2

Description of Antecedent and Consequent Control Conditions

	Antecedent	Consequent
Supervisors' initial involvement	Supervisor present at initial meeting in which rules explained and slides shown.	Supervisor present at initial meeting in which feedback graph explained and shown.
Posting of display	Rules displayed in each department.	Feedback graph displayed in each department.
Frequency of display changes	"Rule of the day" changed 3 times per week.	Feedback posted 3 times per week.
Supervisors' ongoing interaction	Supervisor conducts weekly meeting, lasting 5-10 min., in which "rule of the day" discussed.	Supervisor conducts weekly meeting, lasting 5-10 min., in which feedback discussed.

of accidents. Slides depicted supervisors performing various operations unsafely. After each unsafe action was shown, personnel were asked to point out why the action was unsafe. A slide displaying safe performance was then shown and the safety rule emphasized. Finally, a poster listing the safety rules was presented and employees were encouraged to abide by the rules.

After the initial meeting, the poster was mounted on a wall, in a conspicuous place, in the respective departments. In addition to the list of rules, this poster also contained an open space at the top, where one rule was highlighted as the "rule of the day." This rule was accompanied by photographs of the safe and unsafe methods of performing the task. Observers changed the "rule of the day" and the corresponding photographs approximately three times a week.

Beginning the week after the initial meeting, each supervisor held a safety meeting approximately once week. During these meetings, which lasted five to ten minutes, the supervisor emphasized the importance of safety, pointed out the "rule of the day," reminded employees of safe and unsafe ways of performing the highlighted rule, and answered questions regarding other safety rules.

Consequent condition. During the Consequent Control Condition, the observers continued to change the posters three times a week and the supervisors held the safety meetings each week. The content of each of these changed, however. The top section on the poster which had been used to highlight a safety rule was replaced with a graph. It showed the data points plotted during the Baseline and Antecedent Condition and included an unplotted section for the Consequent Condition.

At the first meeting of the Consequent Condition, the information pre-

sented in the graph was described. It was pointed out that safety performance was already at a reasonably high level but that improvements could further decrease the likelihood of accidents. Personnel were informed that the observers would continue to collect information on their safety performance but that following each observation, the observers would post the results on the graph. Personnel could then determine how safely they had performed their operations.

Three times a week observers updated the graphs. In addition, photographs depicted safe and unsafe ways of performing one of the items scored unsafe in that observation. If all items were scored safe (100%), a photograph showing the supervisor smiling was posted.

During the subsequent weekly meetings, which also lasted approximately five to ten minutes, the supervisor emphasized the importance of safety. However, instead of reminding employees about the safety rules, the supervisor reviewed the safety scores since the last meeting, and noted some of the items that were consistently safe or improving, as well as items that had been scored unsafe for the week.

Design

A multiple-baseline design across groups allowed comparison of the effectiveness of the two conditions. Baseline data were collected repeatedly in all four departments, after which the Antecedent Condition was introduced in the first department. Approximately five weeks later, the Antecedent Condition was introduced in the second department. Again following a five week period, the Antecedent Condition was introduced in the third department and so on. In the same staggered fashion, the Consequent Condition was introduced to each of the four departments.

Figure 1

Safety Level Under Antecedent and Consequent Control Conditions

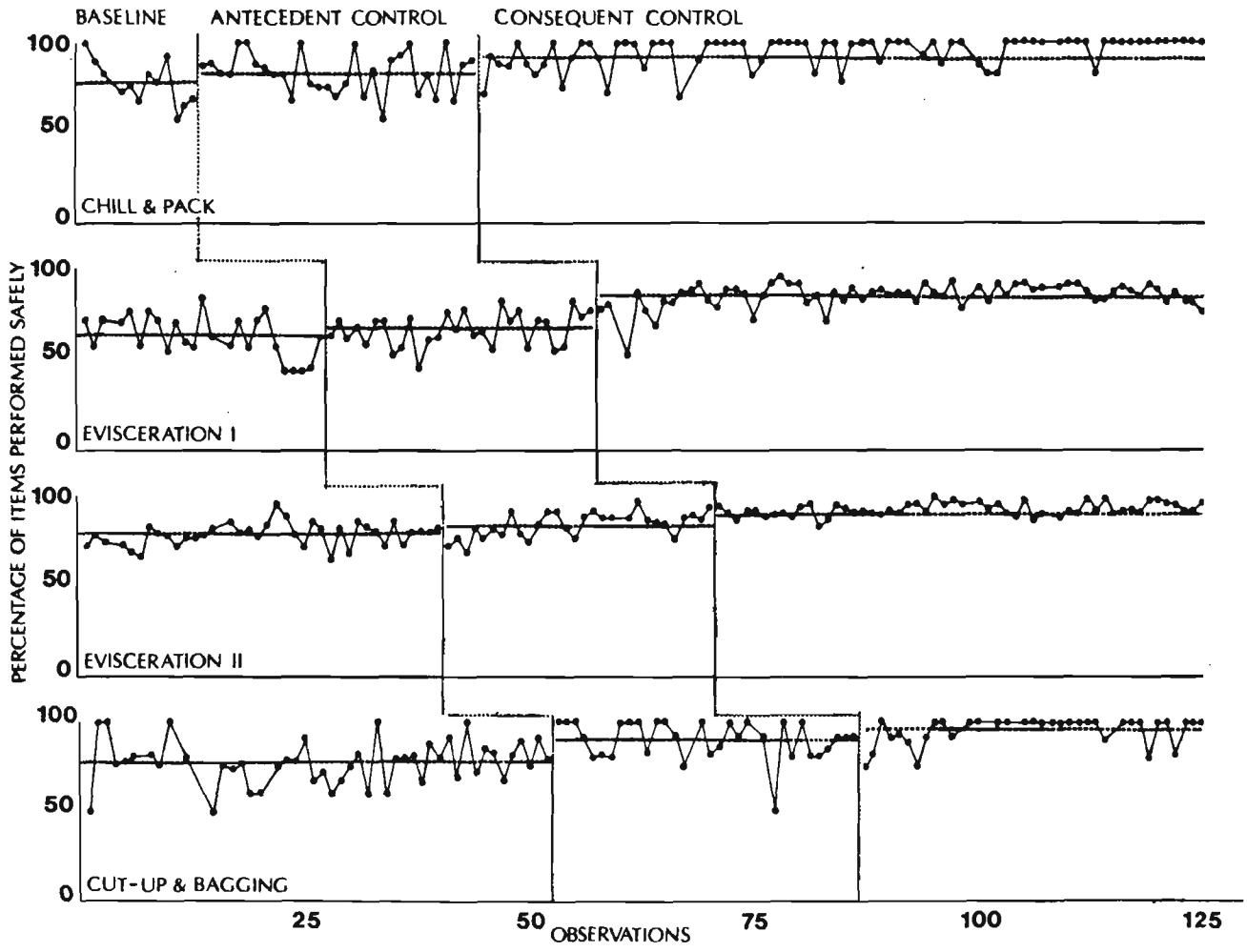


Table 3

Mean Safety Level (and Standard Deviations)

and Net Improvements

	Condition Means			Improvements		
Departments	Baseline	Antecedent	Consequent	Antecedent over Baseline	Consequent over Baseline	Consequer over Anteceder
Chill & Pack	78 (12)	83 (12)	95 (8)	+ 5	+ 17	+ 12
Evisceration I	63 (11)	66 (9)	85 (7)	+ 3	+ 22	+ 19
Evisceration II	79 (7)	84 (7)	92 (4)	+ 5	+ 13	+ 8
Cut up & Bagging	78 (13)	90 (11)	96 (7)	+ 12	+ 18	+ 6

Results

Condition effectiveness. Figure 1 shows the percentage of items performed safely on an observation-by-observation basis during the two conditions. Table 3 lists the means and standard deviations for each condition, as well as the net improvements obtained from condition to condition.

During Baseline employees performed safely from three-fifths to four-fifths of the time. The Evisceration I department had the lowest baseline mean of 63%, whereas the remaining three departments obtained baseline means of 78% or 79%.

The Antecedent Condition had mixed results. For two departments (Chill and Pack and Evisceration 1), the Antecedent Condition did not result in either an increase or a decrease. One department (Cut-up and Bagging) improved from a Baseline mean of 78% to an Antecedent Condition mean of 90%. Another department (Evisceration II) increased only 5%, however, the improvements were stable.

During the Consequent Condition, the results were clear. All departments improved their safety level for an average increase of 18% over Baseline. In addition, average increases of 11% were obtained over and above those which occurred during the Antecedent Condition. At the end of the Consequent Condition, employees in all four departments were performing at least 85% of the items safely; the mean scores of three departments were over 90%.

Autoregressive integrated moving averages analysis. In addition to a visual analysis, the data were analyzed statistically using an analysis developed for time-series data called an Autoregressive Integrated Moving Averages (ARIMA) analysis. This analysis transforms the data, using the least squares solution, to remove serial dependencies within the data and

performs a t-test on the transformed data to compare changes in the slope and level of scores across conditions. It can assess whether there is a significant and immediate change in level from one phase to another. For further details, refer to Box and Jenkins (1970), Glass, Wilson, and Gottman (1975), and Jones, Vaught, and Weinrott (1977).

The results of the ARIMA analysis (Table 4) confirmed the interpretations based on a visual inspection of the data. There were no statistically significant changes in two departments (Chill and Pack and Evisceration I) and significant changes in two departments (Evisceration II and Cut-Up and Bagging) between Baseline and the Antecedent Condition. Significant effects were shown in all departments, however, when comparisons were made between Baseline and the Consequent Condition, as well as the Antecedent and Consequent Condition. This verified the fact that during the Consequent Condition employees not only improved over their Baseline level, but also over their Antecedent level.

Condition preference. Employees were polled about their preferences after they had a minimum of six weeks experience with both the Antecedent and the Consequent Control Conditions (between observations 90 and 96). They were asked to indicate on a card (Fig. 2) which of the two conditions, dubbed the "rules" or the "graph" they liked better. To make their choice meaningful, they were told that management had agreed to implement the choice of the majority for at least one month. In addition to the polling, a random sample of workers (21) was interviewed to see why they preferred one condition over another.

Almost three quarters of the workers polled (72%) reported that they preferred the "graph." Many who preferred the Consequent Condition noted

Table 4

Results of the Autoregressive Integrated Moving Averages Analysis

Comparison	Departments in Processing Plant							
	Chill & Pack		Evis.I		Evis.II		Cut-up & Bag.	
	Level Change[a]	df	Level Change[a]	df	Level Change[a]	df	Level Change[a]	df
Baseline vs. Antecedent	1.22	44	1.15	53	3.09**	65	5.09***	76
Baseline vs. Consequent	5.28***	86	9.21***	87	11.49***	88	7.87***	78
Antecedent vs. Consequent	6.62***	105	9.28***	92	5.12**	79	2.47**	62

[a]Probability of the observed change as determined by a t-test comparison.

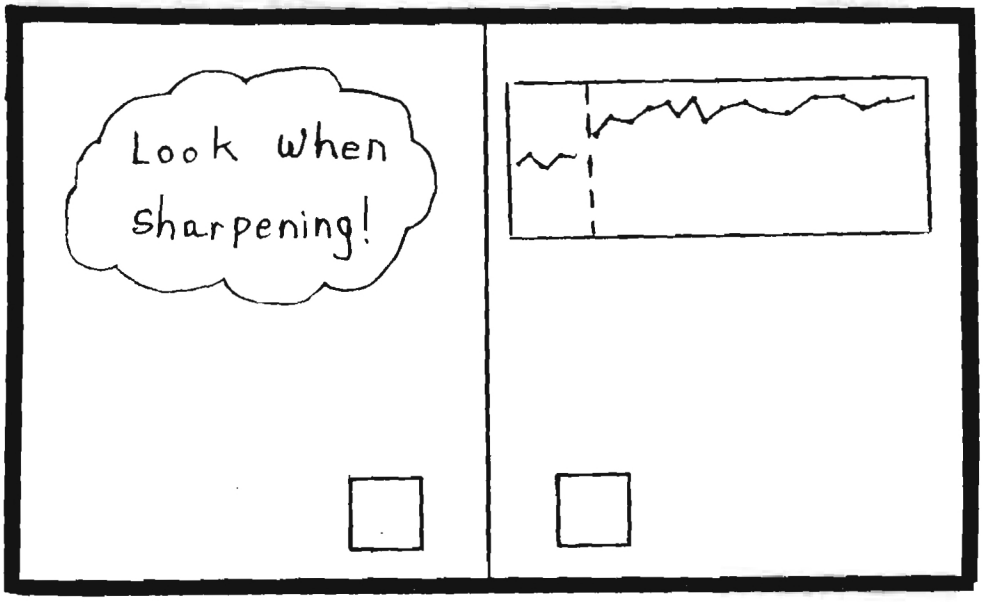
*p < .05

**p < .01

***p < .001

Figure 2

Illustration of Preference Ballot



they that liked the feedback better because they could "see how well they were doing." Several employees noted that people paid more attention to the graph than to the rules. No negative comments were made about the Consequent Condition per se even by persons who preferred the Antecedent Condition. In fact, the only reason that workers gave for liking the rules better than the graph was a lack of knowledge about graphs. One worker simply stated that she "liked the rules best because I don't know nothing about the lines." Based on the above findings, the supervisors reexplained how to read the graph at the next meeting, and the Consequent Condition was continued for the remainder of the study.

Prior to the polling of employees, supervisors were asked to predict which condition their employees would prefer and why they would prefer it. All supervisors correctly judged that the majority of employees would favor the graph, with all mentioning the fact that employees could see how they were doing. The supervisors themselves either had no preference for one condition or the other or they preferred the graph over the rules. One supervisor noted that the rules would help in training new people but that after a while the rules would just be there and employees would adapt to them.

Supervisory and management participation. During the construction of the observational code, supervisors and management willingly described and modelled critical actions for avoiding future accidents, and they made additional suggestions. During the Antecedent Condition, supervisors had little problem reminding employees of one or more of the safety rules. During the Consequent Condition, there was a tendency to dwell on what had been done wrong rather than what had been done right, even though the researchers emphasized the importance of recognition for a job well done. One

supervisor, for instance, questioned whether he needed to have a meeting since his department had obtained three 100%'s the previous week! Eventually, supervisors began pointing with pride to improvements shown on the graphs. As adjacent departments obtained graphs, informal competition arose with supervisors checking to see which department had scored higher or had the longest string of 100%s.

The researchers encouraged management to recognize supervisors for their role in the safety program and for improvements in the safety level. One supervisor noted after one such mention that it was virtually the only time that anyone had ever said a positive word to him about his performance in his nine years of working at the plant.

To ensure that the weekly meetings were held, management was encouraged to attend the meetings in conjunction with, or separate from, one of the researchers each week. This was done for approximately five months. As management attendance dropped during the last three months, the frequency of the meetings also wavered. In an attempt to bolster the supervisor's meetings, management instructed supervisors to complete a card noting the date, time, length, and subject of each meeting. However, there was little follow-through on management's part.

Accident/injury experience. There was a reduction in the number of lost workday cases from an average of 7 per year for the three years prior to the study to 5 for the year of the study. Because of the relatively low initial incidence rate, however, it is difficult to judge the magnitude of this reduction.

Discussion

The present research demonstrated the importance of consequences as a

source of change in work settings. With frequent reminders and weekly discussions, performance either remained the same or improved slightly. With the addition of consequences in the form of feedback, employees upgraded their performance over and above the changes which occurred after the rules and reminders. Thus, it is concluded that antecedent strategies alone are not sufficient. Consequent control is the crucial component in substantially improving and maintaining performance.

In addition to its increased effectiveness, feedback was better received by workers. Personnel indicated that they particularly liked obtaining information following their performance. The preference of employees for a consequent rather than an antecedent control strategy further encourages the use of feedback in work settings.

The relative effectiveness of these two components is particularly relevant to the occupational safety field, in which the emphasis is often placed on the provision of safety training and the posting of rules and reminders. This study suggests that although proper training is essential, safety training and reminders alone are inadequate; more attention should be devoted to the provision of consequences; and feedback is an effective and readily accepted motivational strategy.

Several aspects of the behavioral safety program were particularly noteworthy. A unique contribution was made by the behavioral measurement system. It provided an accurate, representative, and objective view of desired performance. Workers, supervisors, and management better understood what and how workers were expected to perform. The measurement system allowed the collection of information about the level of safe performance. Most importantly, this information motivated workers to improve and maintain

their performance.

The effectiveness of feedback in changing safety performance is particularly interesting in that group rather than individual feedback was provided. Data were presented just as those shown in Figure 1. This is an advantageous finding since group data are far easier and less time consuming to provide in applied settings, such as the present one, in which several hundred employees are involved and turnover rates are high.

A plethora of questions remain. One regards the long-term effects of a relatively benign consequence such as feedback. Will it be effective over an extended period of time? Are other back-up reinforcers necessary? Few studies have assessed the impact of programs over extended periods of time; and feedback programs in work settings are no exception to this general negligence. In the present study, the performance improvements remained steady in all departments. However, the duration of the feedback phase ranged from two to six months for the last and the first departments, respectively. It would be interesting to assess the impact of feedback over an extended period of time in all departments to see whether there would be decrements in performance which would necessitate other back-up reinforcers.

A related issue involves the frequency of feedback. It is widely accepted that feedback should be communicated frequently. At the same time, it has been demonstrated that less reinforcement is necessary once the behaviors have been established. In the two previous safety studies conducted by the senior author and her associates (Komaki et al., 1978; Komaki et al., 1980), as well as in the present study, feedback was provided three to four times a week. The substantial improvement in safety level indicates that, at least in these settings, the frequency was sufficient. However, there are questions

about the frequency necessary to maintain performance. Must one continue providing feedback as often? Can feedback be provided less often, while still maintaining the improvements? If the same level of performance could be maintained with less frequent feedback, considerable savings in implementation would result. However, little information exists regarding the frequency of reinforcement in applied settings. A systematic investigation of the frequency of feedback would surely benefit future programs utilizing feedback in work settings.

Still another issue involves supervisory and management personnel. Once the critical features of an effective program are demonstrated, implementation becomes critical. An in-house capacity must be established if programs are to be continued on a long-term basis. The problem of keeping supervisory personnel actively involved in program implementation, however, is commonly acknowledged. Unfortunately, a review of the literature reveals few well-controlled studies demonstrating the efficacy of programs designed to improve supervisory participation. Although the business literature is replete with recommendations and speculations, there is little direct evidence of sustained supervisory participation. The contingency management approach with its emphasis on behavioral specification and worker motivation may help to enhance supervisory participation in the area of safety as well as other areas of organizational functioning.

The present study demonstrates the importance of consequent control strategies and the potential of the behavioral approach in improving safety practices. A number of research questions await future study.

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Long-term Effects of Feedback in a Work Setting

Within the last decade, behavioral programs have been successfully introduced in a variety of business, industry, and government settings. While the improvements have often been dramatic, they have not necessarily been sustained. In a recent review of the organizational behavior management literature, Andrasik and his associates (in press) note the limited followup of most studies.

Among the reasons for the limited followup is that workers or management sometimes object to the type of consequence being provided or the manner in which it is presented. This, in turn, affects the longevity of the program and its subsequent evaluation. Pedalino and Gamboa (1974), in a study designed to decrease absenteeism at a manufacturing distribution facility, reported that management terminated the lottery incentive program after 16 weeks because of potential union demands. Yukl and Latham (1975), in one of the first studies of reinforcement schedules in a work setting, found that several workers and at least one supervisor disapproved of the procedure used in the variable reinforcement groups--guessing the outcome of a coin flip--because they believed it was a form of gambling.

Feedback, on the other hand, is readily accepted by both workers and management. Employees in a recent study (Komaki, Collins, & Hutcheson, Note 1), who were polled about their preference, voted overwhelmingly (72%) for the feedback, noting they liked it better than training and reminders because they could see how well they were doing. Although feedback has been reported effective in a variety of work settings (e.g., Cooper, Thomson, & Baer, 1970; Kim & Hamner, 1976; Nadler, Mirvis, & Cammann, 1976; Panyan, Boozer, & Morris, 1970; Quilitch, 1975; Sulzer-Azaroff, 1978; Sulzer-Azaroff & de Santa-

maria, 1980; "Performance Audit," 1972), questions often arise about its long-term effects: Will such a benign consequence be effective over an extended period of time? Are other back-up reinforcers necessary?

Like most organizational behavior management studies, however, the impact of feedback programs has not been assessed over an extended period of time. The senior author and her associates, for instance, have successfully used feedback to improve the safety practices of employees in a food manufacturing plant (Komaki, Barwick, & Scott, 1978), a vehicle maintenance facility (Komaki, Heinzmann, & Lawson, 1980), and a poultry processing plant (Komaki, et al., Note 1). In all three studies, information about safety performance was collected and posted on departmental graphs three to four times a week. Unfortunately, however, in the first two studies, the feedback phases lasted for only 3 to 11 weeks. Thus, one of the purposes of the present study was to capitalize on the relatively long duration of the third study and assess whether feedback would be effective in maintaining performance over an extended period of time.

The present study is a continuation of the third study, which compared the relative contributions of an antecedent and a consequent control component (Komaki, et al., Note 1). During the consequent control component, employees in a poultry processing plant were observed and given feedback on departmental graphs three times a week. By the end of the 46-week study, employees in four departments had obtained feedback about their safety level for 12 to 30 weeks, depending on their department. The present study continued for another 29 weeks, for a total duration of 75 weeks, enabling the assessment of feedback effectiveness over a six month period of time in all four departments.

A stringent test of the long-term effects of feedback was provided. Employees had opportunities to perform safely or unsafely thousands of times an hour; processing lines ran at the rate of 2,000 to 6,000 birds an hour. Other studies utilizing feedback with working adults have sometimes assessed its effect for as long as 13 months. However, the target behaviors occurred much less frequently--one to three training sessions per day (Panyan et al., 1970) and weekly/monthly corrections of hazardous laboratory conditions (Sulzer-Azaroff, 1978).

A related issue involves the frequency of feedback necessary to maintain performance in an applied setting. It is widely accepted that information about work performance should be communicated often (Anderson, Kulhavy, & Andre, 1971; Cook, 1968; Ilgen, Fisher, & Taylor, 1979; Ivancevich, Donnelly, & Lyon, 1970). Lawler and Rhode (1976) in their book on Information and Control in Organizations, for instance, point out that "the frequency and rapidness with which information is reported are important factors in determining the impact of the information" (p. 43). In the three previously discussed safety studies conducted by the senior author and her associates (Komaki, et al., 1978; 1980; Note 1), feedback was provided approximately three to four times a week. The fact that safe practices improved substantially indicates that, at least in these settings, the frequency was sufficient.

In most work settings, however, information is provided so infrequently as to be almost completely ineffective. The prevailing practice is to collect and communicate results to employees every quarter or every year. Performance appraisals, for instance, are typically conducted annually. Upon hearing the results of behavioral safety programs, management often

underestimates the importance of frequency of feedback. A frequent comment is: "We already do that. We post the number of accidents each month."

On the other hand, it has been shown that less frequent reinforcement is necessary to maintain behavior once performance is established. It is not clear though, whether it is necessary to continue providing feedback several times a week or whether the frequency can be reduced. If the same level of performance could be attained by providing feedback less frequently, personnel time for implementation could considerably decrease, thereby increasing the efficiency of the program.

Little information exists regarding the frequency of reinforcement in applied settings, however. Studies concerned with schedules of reinforcement in organizational settings have not directly addressed the problem of how to maintain performance over extended periods of time (Berger, Cummings & Heneman, 1975; Yukl & Latham, 1975; Yukl, Wexley & Seymore, 1972). As a result, the second purpose of the present study was to assess the relative effectiveness of different frequencies of feedback to determine how often feedback should be provided to maintain performance in a given setting.

Method

Subjects and Setting

Since the research was a continuation of the previous study, the subjects (approximately 200 employees working in the Chill and Pack, Cut-up and Bagging, and Evisceration I and II departments, who had an annual turnover rate of 200%) and site (a poultry processing plant in the state of Georgia) were the same. For further information, please refer to Comparison of Antecedent and Consequent Control Approaches to Occupational Safety.

Measure and Data Collection

The measure of safe performance and the data collection procedures were also identical to those used in the previous study. That is, observers went on-site and recorded whether employees performed specific incidents safely or unsafely. Data were collected approximately three times a week (2.9) for an additional 29 weeks, for 83 more observations. A total of 207 observations were conducted over 75 weeks, a period of almost a year and a half.

Interrater reliability continued to be assessed on both safe and unsafe items, using the percentage agreement method. A total of 12 reliability checks were made during this period, an average of one reliability check every 7 observations. Reliability for the safe and unsafe items averaged 98% (857/873) and 88% (156/178), respectively, for the four departments.

Conditions

Feedback: 3 x week. Feedback continued to be provided three times a week during this condition. Departmental data were posted on the graph each time an observation was made. This condition continued in the remaining departments, Evis. I and II and Cut-up and Bagging, until each had received feedweek thrice weekly for a six month period of time (28-30 weeks). Throughout all the conditions, supervisors continued to be encouraged to discuss how employees were performing at the weekly safety meetings. As before, the information was based on the three observations of the preceding week.

The purpose of this condition was to assess the effects of feedback with four different groups in a work setting over an extended period of time. Six months was selected because it was thought to be of sufficient duration to reveal most delayed decrements in performance. If decrements occurred, plans were to explore other alternatives such as increased supervisory involvement

or back-up reinforcers. If performance remained stable, plans were to assess the effects of reducing the frequency of feedback.

Feedback: 1 x week. The frequency of feedback was reduced from three times a week to once a week during this condition. Data were collected three times a week as before but only one data point reflecting that one day's observation was posted each week. The day that feedback was provided was selected randomly. The remaining two days' data were not posted. Refer to Figure 2 for an indication of the data points that were and were not posted during this condition. As in the preceding condition, supervisors were encouraged to hold weekly safety meetings and to discuss how employees were performing. The only difference was that information was based on the one posted observation rather than all three.

Supervisors were told that their departments had been doing so well that the researchers wanted to see what, if anything, would happen if data were posted once each week rather than three times each week. When employees asked the observers, workers were told that they would not receive information every time but that the information would probably be posted the next time.

The purpose of this condition was to determine whether it is necessary to continue providing feedback as often as thrice weekly or whether feedback could be provided once a week and still maintain the same results. The gradual reduction to once weekly rather than biweekly or monthly was chosen to ensure that information would be available for the weekly safety meetings which continued throughout. Another reason was that safety performance declined in a previous study (Komaki, et al., 1980) in which feedback was provided one or two rather than four or five times a week. If performance decrements occurred, plans were to return to providing feedback thrice weekly. If performance was maintained, plans were to continue the feedback once a week.

Feedback: 3 x week. Feedback was again provided three times a week during this condition. As before, supervisors were encouraged to discuss the feedback with their employees at the weekly safety meeting.

The purpose of this condition was to determine whether returning to thrice weekly feedback would reverse performance decrements which had occurred when feedback was provided only once a week.

Design

A multiple-baseline design across groups continued to be used to compare conditions. The thrice weekly and once weekly conditions were introduced in a staggered fashion to each of the four departments. For the sequence and duration of each condition, refer to Table 1.

Results

Figure 1 shows the percentage of items performed safely for the first 46-week period (observations 1-124) and Figure 2 shows the next 29-week period (observations 125-207). Table 2 lists the means and standard deviations for the total 75-week period for each of the five conditions, including the thrice weekly and the once weekly conditions.

Long-term effects. When feedback was provided thrice weekly, performance remained high and steady over the six months. The mean performance level was over 85% for all departments, with three out of the four averaging over 90%. Figures 1 and 2 show that employees were performing as well at the end of the sixth month as they were at the end of the first month. The one exception occurred in the Cut-up and Bagging department during a two-week period when the proper safety equipment was not available.

Because of the lack of any sustained performance decrements, no attempts

Table 1

Sequence and Duration of Experimental Conditions

Across Departments

	Department in poultry processing plant							
	Chill & Pack		Evis. I		Evis. II		Cut-up & Bag	
Condition	Sequence[a]	Duration	Sequence[a]	Duration	Sequence[a]	Duration	Sequence[a]	Duration
Baseline	1-13	5 wks	1-27	10 wks.	1-40	15 wks.	1-52	20 wks.
Antecedent	14-44	12 wks.	28-57	13 wks.	41-70	13 wks.	53-86	14 wks.
Consequent:								
3 x week	45-124	30 wks.	58-139	29 wks.	71-154	29 wks.	87-169	28 wks.
1 x week	125-175	17 wks.	140-196	19 wks	155-207	18 wks.	170-207	13 wks.
3 x week	176-207	11 wks.	197-207	4 wks.	-	-	-	-

[a]Starting and ending observation.

were made to introduce any alternative strategies. Instead, the effect of reducing the frequency of feedback was explored.

Frequency of feedback. The frequency of feedback was reduced from thrice to once weekly for approximately four months (17 to 19 weeks) in the first three departments and for approximately three months (13 weeks) in the last department, Cut-up and Bagging. The reduction in frequency produced mixed results. Performance remained high and stable in two departments but there were performance decrements and increased variability in the other two departments.

Performance in Evisceration II and Cut-up and Bagging continued at the same high and stable level as the previous phase, with means of 89% and 98% and relatively low standard deviations of 7% and 6%, respectively. Although Cut-up and Bagging experienced the once weekly condition for only three months, Figure 2 shows no indications that decrements would have occurred by the end of the fourth month.

In contrast, performance in Chill and Pack declined from a previously high mean performance level of 95% to 89% and in Evisceration I from 85% to 78%. As Figure 2 illustrates, performance also became more variable. Standard deviations increased from 8% during the thrice weekly condition to 12% during the once weekly condition in Chill and Pack and from 6% to 9% in Evisceration I.

As a result of the performance decrements and the increased variability in these two departments, feedback was again provided three times a week for 11 weeks in Chill and Pack and for 4 weeks in Evisceration I. Figure 2 shows that employees began performing at a higher level than they had when feedback was provided only once weekly. The one exception occurred in the

Figure 1

Safety Level for the First 46-Week Period

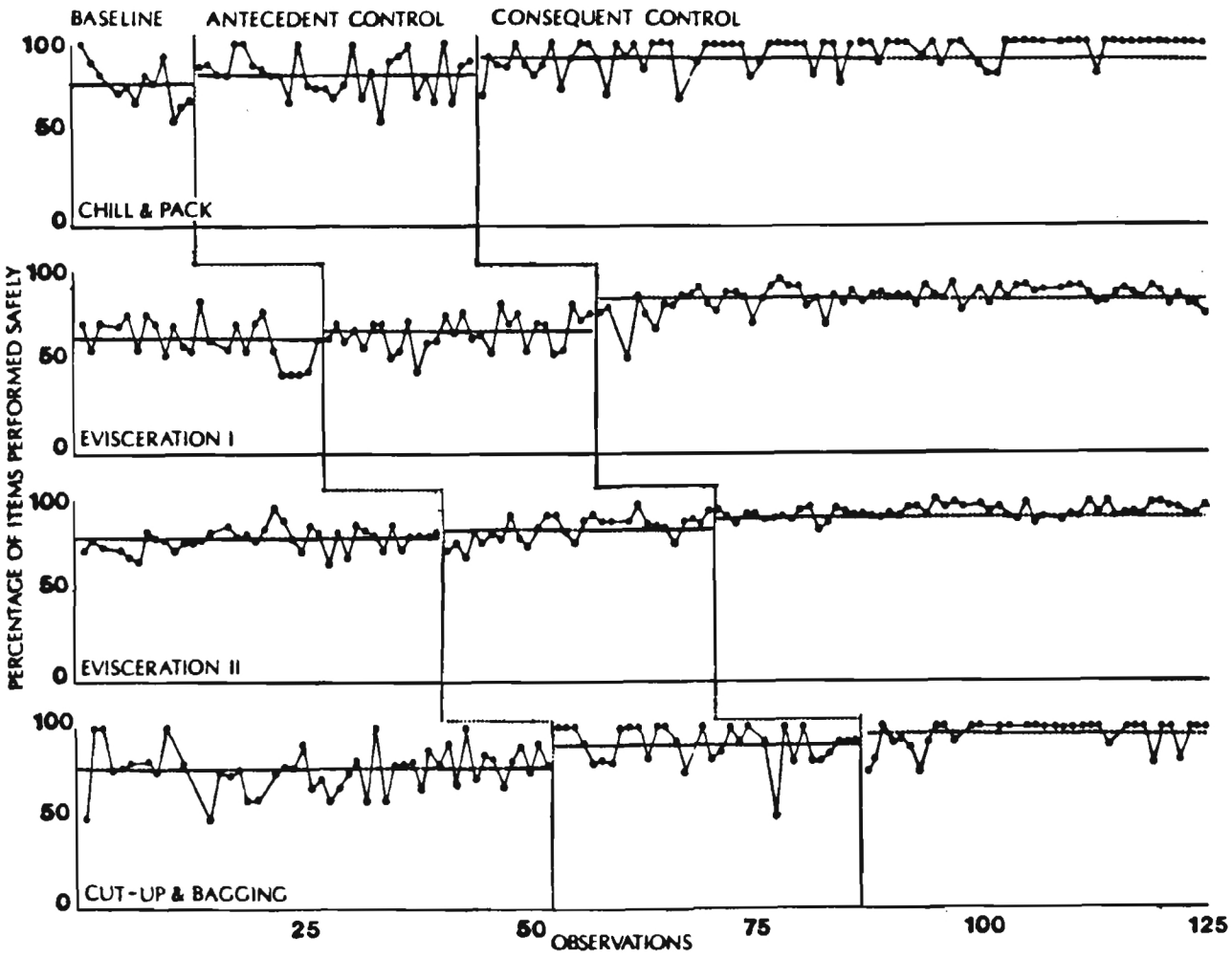

Figure 2

Safety Level for the Next 29-Week Period

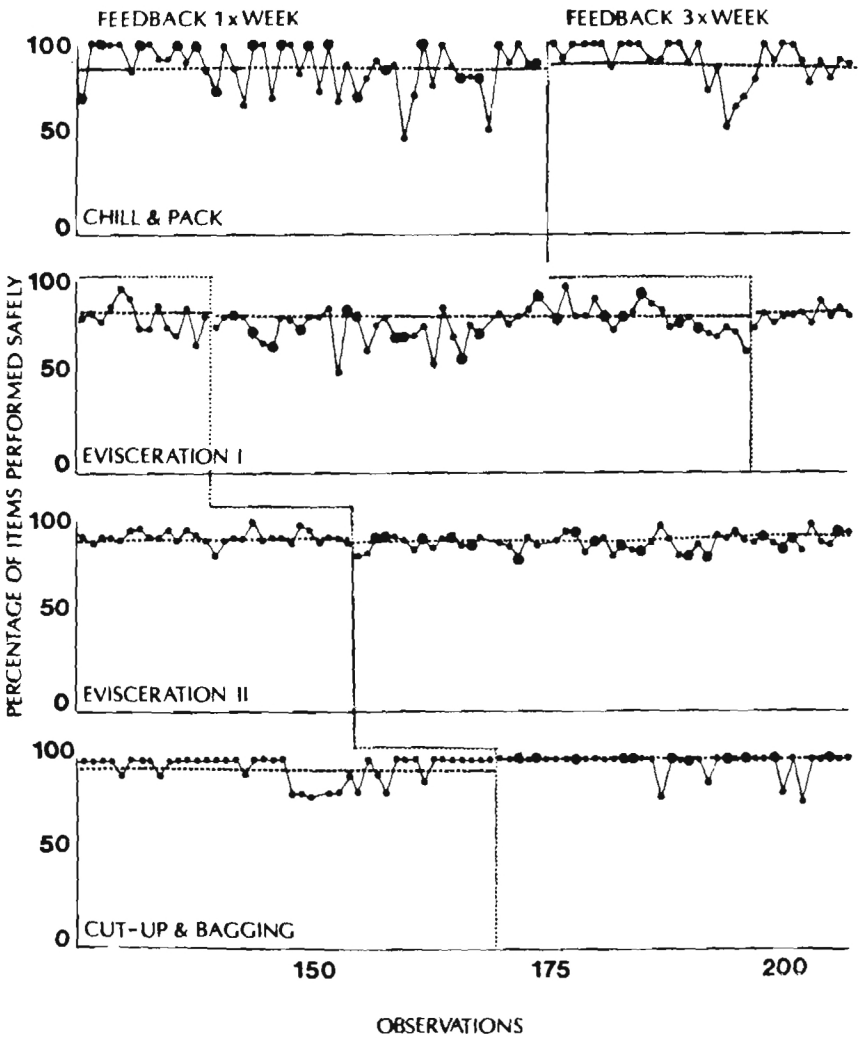

Table 2

Mean Safety Level (and Standard Deviations)

	Conditions Means				
Departments	Baseline	Antecedent	Consequent: 3 x week	Consequent: 1 x week	Consequent: 3 x week
Chill & Pack	78 (12)	83 (12)	95 (8)	89 (12)	91 (11)
Evisceration I	63 (11)	66 (9)	85 (6)	78 (9)	82 (4)
Evisceration II	79 (7)	84 (7)	92 (4)	89 (7)	
Cut up & Bagging	78 (13)	90 (11)	96 (7)	98 (6)	

Chill and Pack department when an influx of students began working in one of the key safety positions (box stacker) at the beginning of the summer.

Discussion

The results show that thrice weekly feedback, in combination with a weekly supervisor meeting and the posting of safety rules, is capable of maintaining safety performance for an extended period of time, in this case, six months. The sustaining of a consistently high level of performance is particularly noteworthy considering that occasions for safe or unsafe performance occurred thousands of times an hour; that performance was maintained in all four departments, which included approximately 200 employees and supervisors with different work styles; and that the turnover rate was over 200%.

The fact that a consequence such as feedback can maintain performance over an extended period has significant implications for the occupational safety field, in particular, and for work settings, in general. The results suggest that it is not necessary to introduce less indigenous systems such as safety contests to maintain performance and that a relatively benign consequence can sustain performance in work settings.

The results of the present study also highlight the importance of one dimension of feedback, the frequency with which it is provided. Performance declined and became more variable in two departments when feedback was provided only once a week. When the frequency was returned to thrice weekly, however, performance improved once again.

It is still not clear whether it is necessary to continue providing feedback several times a week or whether the frequency can be reduced, however. Performance declined in two departments and maintained in the other two, when feedback was reduced to once weekly. One factor which differentiated

the two sets of departments, however, was their previous level. In the two departments in which performance declined, performance was either lower than or more variable than those in which performance was maintained. This suggests that the frequency of feedback can be reduced without sacrificing improvements when previous performance is both high and stable.

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1. Komaki, J., Collins, R.L., & Hutcheson, P.P. Comparison of antecedent and consequent control approaches to occupational safety (Final report). Atlanta: Georgia Institute of Technology, December 1980.

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Effects of a Behavioral Safety Program on the Financial Cost of Accidents

Top management commitment to and active involvement in safety has been indicated as crucial to program effectiveness (Cohen, 1977; Simonds & Shafai-Sahrai, 1977 Smith, Cohen, & Cleveland, 1978). One way to obtain this commitment is to show how safety affects the bottom line. Although safety and health can be justified by other arguments, it is generally agreed that management is more likely to enthusiastically endorse, fund, and implement efforts which have an effect on company profits.

Despite this commonly accepted principle, a review of the literature reveals numerous articles lamenting the difficulties involved in obtaining management support, a few articles heralding cost savings, and almost no articles detailing how to determine the financial costs of accidents. Documented examples are rare. With few exceptions, data about the cost-effectiveness of safety programs in general, and behavioral programs in particular, are either completely omitted or are based on gross estimates.

On those occasions when dollar figures are given about cost savings, a wealth of questions arise: How was the figure obtained? Did it include both direct and indirect costs? Are the figures adjusted for inflation? Are just before and after comparisons made? Have other plausible alternative hypotheses been ruled out?

In one of the most extensive documentations of safety costs, Fox (Note 1) presents compensation and damage costs as they relate to the frequency and severity rate and the number of equipment and vehicle accidents. Indirect costs, which Fox himself estimates to be at least as high if not higher than the direct costs, however, are neglected.

Similarly, although there were reported reductions in the cost of workmen's compensation premiums in a previous safety study by the senior author (Komaki, Barwick, & Scott, 1978), no systematic estimates were made of the savings resulting from such indirect or uninsured costs as (a) the cost of wages paid for working time lost by workers viewing or discussing the accidents, (b) the net cost to repair, replace, or straighten up damaged materials or equipment, (c) the cost of wages paid for working time lost by injured workers other than workmen's compensation payments, (d) the extra costs due to overtime, (e) the cost of wages paid supervisors while their time is required for activities necessitated by the injury, (f) the wage cost due to decreased output of the injured worker after return to work, (g) the cost of the learning period of new workers, (h) the uninsured medical cost borne by the company, and (i) the cost of time spent by higher supervision and clerical workers on investigations or the processing of compensation application forms. As a result, this study assessed the financial impact of a behavioral safety program on work place accidents by taking into consideration both direct and indirect costs.

Although frequently proposed by safety specialists (Grimaldi & Simonds, 1975), assessing the financial impact of work place accidents is a relatively new field of endeavor for the accounting profession. Traditionally, the focus has been on the quantity and quality of goods and services and the implications of their production, such as profit and return on investment. Recently, however, increasing attention has been directed to practices viewed as having an effect on productivity, such as absenteeism, turnover, work disruptions, and accidents.

To express indicators of work performance fitting this broader conception of effectiveness in financial terms, several accounting methods have been

proposed (Alexander, 1971; Flamholz, 1974; Herrick, 1975; Macy & Mirvis, 1976). Distinctions are made between various human resource accounting asset and expense models. Asset models reflect the organizations' investment in employees and are directed toward assessing the value of employees as capitalized resources. The logic behind asset valuation is that investments in employees produce benefits beyond the current accounting period. As a result the costs of training the employee and, perhaps, the employee's experience within the company would be included in assessing the financial impact of an accident should the person not return or return with limited capability.

Expense models, on the other hand, measure the economic effects of employees' behavior. This approach, sometimes referred to as behavioral accounting, looks at what the individual does and attaches costs to these activities. Researchers at the Institute for Social Research at the University of Michigan (Macy & Mirvis, 1976; Mirvis & Macy, 1976; Mirvis & Lawler, 1977) have developed a standardized appoach for identifying, defining, and measuring indicators of work performance and the methods for expressing indicators such as accidents in financial terms. A series of steps assigns fixed, variable, and opportunity costs to a behavior. In the case of accidents, for example, one first asks whether (a) the worker is missing from his/her station, (b) there is a replacement from an extra work force, or (c) a replacement is transferred from another job. If it is determined that a replacement is transferred from another job, then one assesses whether the replacement is adequately trained for the job and determines production and quality changes, and training costs.

Although the expense model proposed above seems to be well conceived, few studies have been reported demonstrating the use of this model in assessing the financial impact of accidents. Furthermore, no assessments have been made

in an experimental setting. A unique contribution was made in the present study because it assessed the financial impact of work place accidents which occurred before and after the introduction of a behavioral safety program designed to improve safe practices and reduce work injuries.

Method

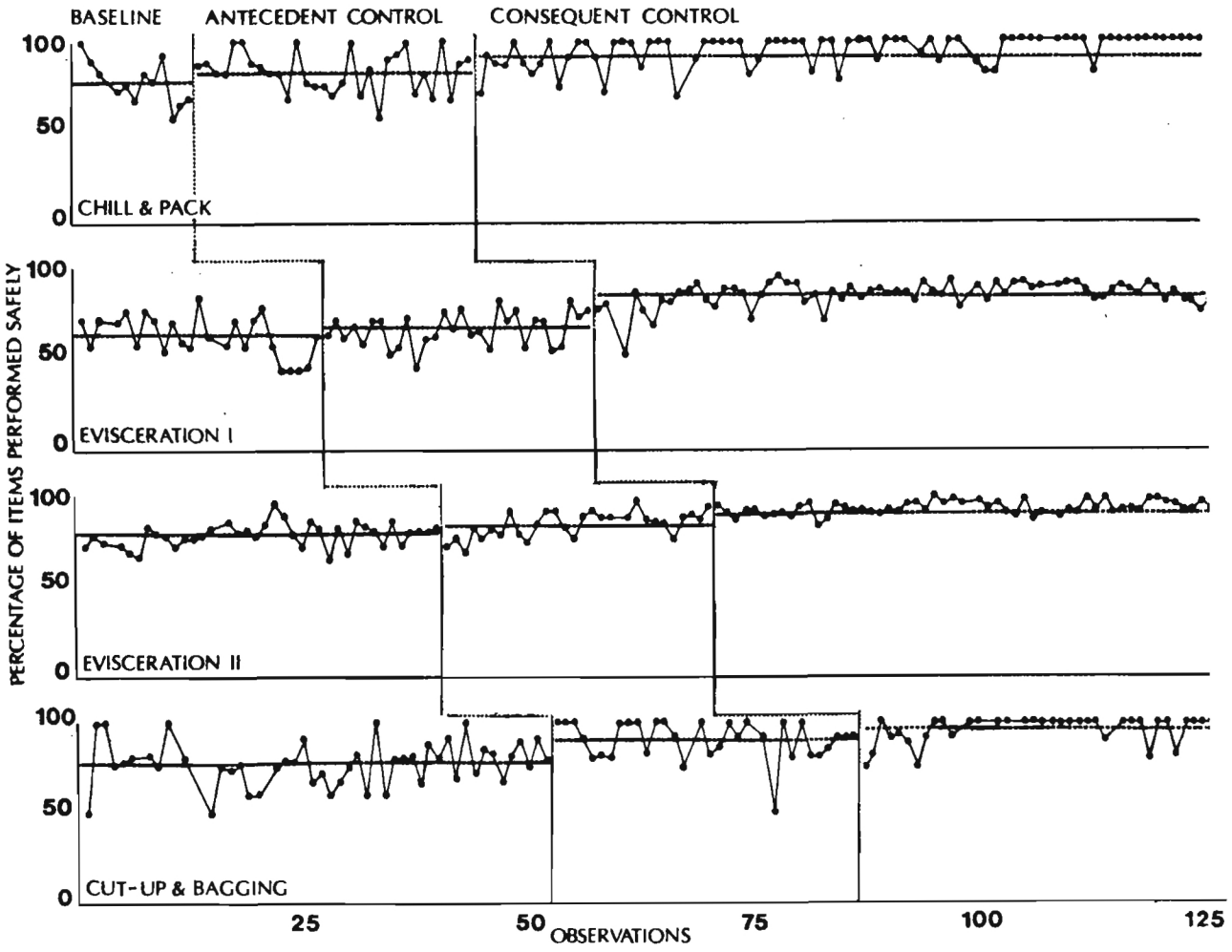
Setting

The subjects were approximately 200 employees in the Chill and Pack, Cut-up and Bagging, and Evisceration I and II departments of a poultry processing plant in the state of Georgia. Desired safety practices were identified. Information about the safety performance level was collected for 46 weeks. Following Baseline, two conditions were introduced: a) an Antecedent Condition consisting of the presentation of safety rules and reminders, and b) a Consequent Condition involving all aspects of a behavioral safety program, the presentation of safety rules and reminders and the provision of feedback about safety performance. To assess the relative contribution of the two conditions, a multiple-baseline design was used in which the conditions were introduced at staggered intervals. Refer to Figure 1. The staggering of the conditions and the replication of the effects in four departments effectively ruled out other extraneous factors such as history, maturation, and statistical regression which might otherwise be thought to be responsible for any of the changes. During the Consequent Condition, safety performance significantly improved over and above that of both the Baseline and the Antecedent Condition. Employees were performing on the average, at least 85% of the activities safely, and in three departments, over 90%. It was concluded that the behavioral safety program was responsible for the significant performance improvements.

Figure 1

Effects of Antecedent and Consequent

Conditions on Safety Level



Procedures

To determine the cost savings, if any, that occurred as a result of the behavioral safety program, the costs attributable to job-related injuries were assessed during the Baseline, Antecedent, and Consequent Conditions for the 46-week period of the study. Data were also obtained for comparable periods during the preceding four years, 1975, 1976, 1977, and 1978. These data were used to rule out seasonal and yearly fluctuations. If fewer accidents usually occurred during the winter when the Consequent Condition was in effect, then a comparison restricted to only the Baseline and Antecedent Condition during a single year would be misleading.

Define injury/accident. The first step in identifying costs associated with injuries was to define what is meant by an injury. For the purpose of this study, an injury was defined as an incident that resulted in the seeking of medical attention. This included lost workday, medical treatment, and first aid cases resulting in medical attention. The reason for the aggregation of OSHA-reportable accidents and non-OSHA incidents was the site's limited medical capabilities and the policy regarding the treatment of injuries which resulted in the seeking of outside medical assistance for almost all reported injuries.

Assess insured costs. Costs were viewed as either insured or uninsured. This distinction is similar to that made between direct and indirect costs but it has the additional advantage of highlighting those items not covered by the insurance premium. To assess the insured costs, the medical and indemnity payments made by the Workmen's Compensation carrier were obtained from the quarterly summaries provided by the carrier. To take into account the inflation rate, each year's figures were adjusted using the Consumer Price Index (CPI) figures with 1979 as the base year. For medical payments, the medical component of the CPI was used for adjustments.

Assess uninsured costs. To identify the uninsured costs, project staff held interviews modeled after procedures developed at the Institute for Social Research at the University of Michigan (Macy & Mirvis, 1976). In essence, this procedure tries to logically develop the sequence of events triggered by an accident and then determine the cost associated with each event. For example: Is an injured worker replaced or is the slack taken up by present workers? Does the replacement require training? Is overtime required to make up for the lost worker? Does the supervisor accompany the worker to the first aid station? Who is involved in processing paperwork? What are the salary continuation provisions?

The following categories were identified as being triggered by an accident/injury:

1. Time of injured employee till he or she either returns to work or is taken off the clock;
2. Time of supervisor while attending to accident, accompanying worker to first aid station, and/or arranging work to cover for employee;
3. Time of office personnel processing paperwork;
4. Time of first aid personnel attending to injuries or transporting employee to physician;
5. Disruptions caused by the departure of the injured employee (e.g., production waste, time of bystanders);
6. Occasional payments made to employees for "doubling up" after injured worker's departure;
7. Additional insurance premiums.

Costs were attached only to those categories which are variable (directly traceable to the accident and varying with the number of accidents) and fixed (incurred even if no accidents occurred) with clear opportunity costs (time could be more gainfully used in other ways).

With the exception of the time of the first aid personnel and the cost

of additional insurance premiums, the following categories were judged to include either variable costs or to be fixed with clear opportunity costs.

1.,2.,3. The wages of the injured employee, respective supervisor, and office personnel were fixed but were thought to have a clear opportunity cost associated with them. That is, wages would be paid regardless of whether an accident occurred; however, these individuals could be more gainfully employed in other activities had an accident not occurred.

4. The wages of the individual assigned to first aid were also fixed but were not judged to include opportunity costs since the person was primarily responsible for first aid.

5.,6. Disruptions caused by the departure of the injured employee and the occasional bonus payments were definitely affected by increases or decreases in injuries and were, therefore, a variable cost.

7. The cost of additional insurance premiums were, unfortunately, not included because it was impossible to determine a specific premium reduction given a specific reduction in the number of injuries/accidents. Exact formulae are not available to the public, including the insurance agent. Even if the exact formulae were known, the reductions for a given firm are considerably delayed. Premiums are based on two factors: a) a class rate which varies with industry experience and changes in federally mandated benefits, and b) an experience rate which is based, in part, on the payout of medical and indemnity payments for three consecutive years not counting the immediately preceding year. Thus, the effect of a reduction in accidents not only is delayed by one year but also is diluted by another two year's experience.

The costs for each category were determined as follows:

1.,2.,3. Based on interviews with plant personnel, the time losses per accident for injured employee, supervisor, and office personnel were estimated to be 2.25 hours, .33 hours, and .33 hours, respectively. The average hourly wages (determined by sampling hourly wages twice in each year) were then multiplied by each of the respective time estimates.

5.,6. The disruptions and occasional bonus payments were combined into a general disruption category. Again based on interviews with plant personnel, the time loss per accident was estimated to be 2.25 hours of an employee's time. The total cost for this category was calculated as the above time estimate multiplied by the average hourly wage.

To arrive at the total uninsured cost per accident, the costs of employee, supervisor, and office personnel and the disruption cost were added together. Table 1 presents the uninsured costs per accident for five years in both

actual and adjusted dollar figures. To take the rate of inflation into account, each year's total was adjusted using Consumer Price Index figures with 1979 as the base year.

Table 1

Uninsured Cost Per Accident

Year	Actual Cost	Adjusted Cost
1975	$ 13.64	$ 18.41
1976	14.46	18.42
1977	15.75	18.77
1978	17.49	19.61
1979	19.79	19.79

To arrive at the total cost per accident, the uninsured and insured costs were summed.

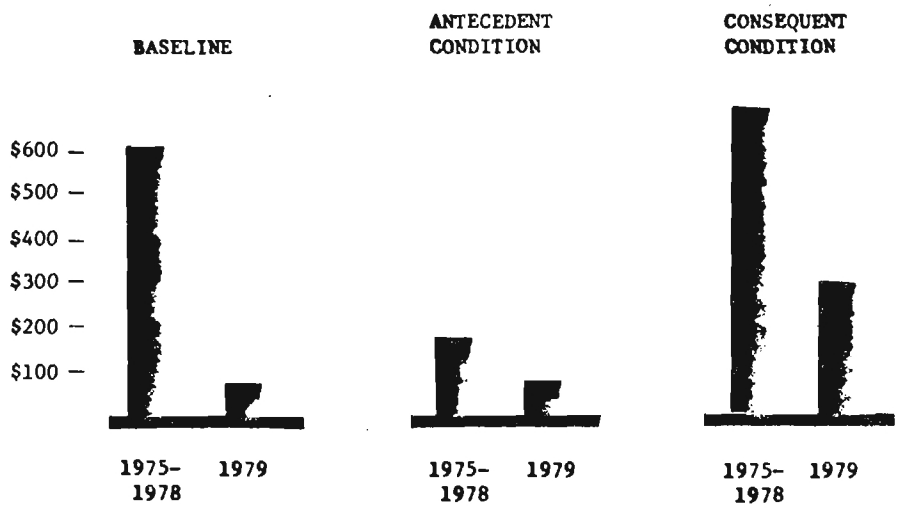
Results

Figure 2 depicts the total cost per accident for the departments combined during the three experimental conditions for 1979, the year of the research, and a four year average for 1975 thru 1978. Particularly noteworthy is the reduction in the cost per accident during 1979. The greatest reduction

Figure 2

Total Cost Per Injury

Between 1975-1978 and 1979



occurred during Baseline, from $612.64 to $59.63, a tenfold cost savings. The average cost per accident also declined substantially during the Consequent Condition, when the behavioral safety program was in effect, from $700.22 to $306.16 per accident, a cost savings of $394.06 per accident. A relatively slight decrease occurred during the Antecedent Condition, from $176.77 to $84.76 per accident.

Table 2 presents the average cost per accident by department during the three experimental conditions for 1979, the year of the research, and for comparable time periods during the preceding four years, 1975-1978. Of note is the range in the average cost. Costs ranged dramatically from a low of $19.79 in Cut-Up and Bagging during the Consequent Condition to a high of $6,839.56 two years before. Inspection of the data showed that high average costs were unduly influenced by accidents whose medical or indemnity payments or both were in the extreme tail of the distribution. Because of the disproportionate effect of these outliers, defined as payments exceeding $500, they were removed.

Figure 3 shows the average cost per accident with the outliers removed for the departments combined during the three experimental conditions for

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Figure 3

Total Cost Per Injury
With Outliers Removed
Between 1975-1978 and 1979

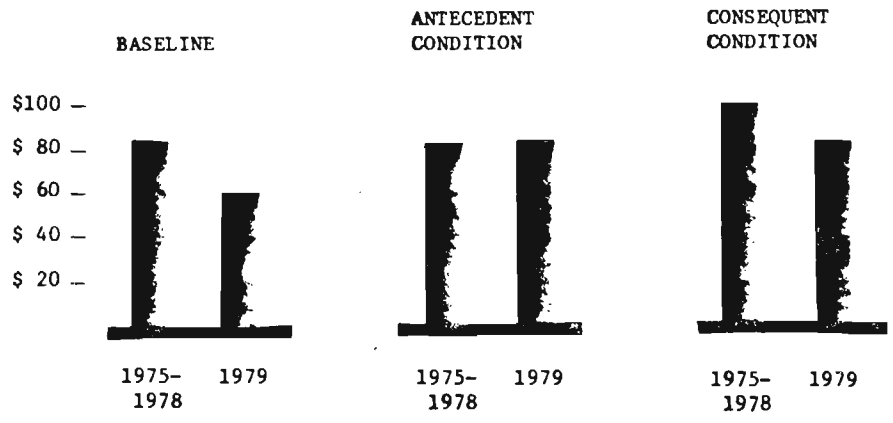

Table 2

Total Cost Per Injury by Department and Year

Year	Department and Condition											
	Chill & Pack			Evisceration I			Evisceration II			Cut-Up & Bagging		
	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent
1975	0	59.41	86.75	3089.09	359.65	310.03	61.78	126.13	86.29	1673.39	376.38	196.09
1976	0	95.38	133.88	114.71	49.86	129.87	1322.39	142.06	84.35	71.57	62.31	849.94
1977	0	61.67	110.81	87.21	0	139.13	62.58	110.81	82.49	894.33	90.55	6839.56
1978	69.11	453.01	1146.01	472.59	69.11	623.37	105.01	85.29	80.47	53.16	65.81	127.41
Average 1975-78	69.11	152.74	451.00	1263.28	244.94	341.55	435.73	118.28	83.88	682.44	191.11	1924.43
1979	0	95.79	98.19	85.99	84.65	425.98	72.04	82.61	680.68	80.50	75.99	19.79

1979 and a four year average for 1975 thru 1978. The average cost per accident during the Consequent Condition, when the behavioral safety program was in effect, declined from $98.57 to $82.56, a cost savings of $16.01 per accident. However, there were also substantial reductions during Baseline. During 1979, the cost was $59.63; prior to that, it was $82.45, a difference of $22.82 per accident. In contrast, during the Antecedent Condition when only the rules and reminders were in effect, there was essentially no change in the cost per accident. During 1979, the cost was $84.76; prior to that it was $82.53.

Table 3 presents the frequency of accidents by department for the three experimental conditions and the comparable period during the preceding four years, 1975-1978. Table 4 presents the frequency of medical treatment injuries for all departments combined which occurred during the three experimental conditions in 1979 and comparable time periods during 1975-1978.

Table 4

Difference in Frequency of Injuries

	Conditions		
	Baseline	Antecedent Condition	Consequent Condition
Average 1975-1978	18.5	16.75	32.25
1979	20.0	25.0	36.0
% Increase	108%	149%	112%

Although more injuries occurred during 1979, the year of the research, than during the same periods of the four preceding years, the increases were relatively slight during Baseline and the Consequent Condition, with increases of 108% and 112%, respectively. In contrast, a substantial increase occurred during the Antecedent Condition. One and a half times as many accidents took

Table 3

Frequency of Medical Treatment Accidents

Year	Department and Condition											
	Chill & Pack			Evisceration I			Evisceration II			Cut-Up & Bagging		
	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent	Baseline	Antecedent	Consequent
1975	0	3	14	6	8	15	6	9	15	6	6	4
1976	0	4	7	2	2	12	10	8	3	7	2	4
1977	0	1	3	4	0	6	8	4	5	4	6	3
1978	1	2	12	5	3	15	11	7	9	4	2	2
Average 1975-78	.25	2.5	9	4.25	3.25	12	8.75	7	8	5.25	4	3.25
1979	0	2	10	5	7	16	8	11	9	7	5	1

place during this condition than during the same periods of the preceding four years.

Discussion

The present study demonstrated the steps involved in assessing the financial impact of a behavioral safety program on work place accidents. Both direct and indirect costs attributable to job-related injuries were assessed. The direct costs included both medical and indemnity payments made by the insurance carrier. The indirect or uninsured costs were determined by identifying the events triggered by accidents and then determining the cost associated with each event. The events included the time of the injured employee, his or her supervisor, office and first aid personnel, as well as a general disruption category and the cost of additional insurance premiums. Costs were attached to those events which vary with the number of accidents (e.g., time of injured employee) or which have clear opportunity costs (e.g., supervisory time). Employee time, for instance, was calculated as the average amount of time spent per accident multiplied by the average hourly wage. To determine the cost per accident, both the direct and indirect costs were added together.

To determine the cost savings, if any, that would occur as a result of the behavioral safety program, the costs attributable to job-related injuries were assessed. The assumption was that the improvement in the level of safe performance which occurred during the behavioral safety program should result in a decrease in the number of accidents or a reduction in their costs or both.

No clear-cut conclusions were drawn about cost savings resulting from the behavioral safety program. There was no decrease in the number of accidents. Cost reductions did occur; however, they took place during both

Baseline and the Consequent Condition. Thus, cost savings could not be attributed to the behavioral safety program alone. One possibility is that the activities involved in the specification of desired performance and the establishment of an observation safety code resulted in all parties--management, supervisors, and employees--becoming more aware of the area of safety during Baseline. Another possibility is that there was a decrease in the frequency or severity of the accidents being reported. Whatever was responsible for the reduction in costs during Baseline, it was relatively short-lived, as evidenced by the results of the next phase, the Antecedent Condition.

The most provocative finding regards the Antecedent Condition, which consisted of several common improvement strategies--the posting of safety rules, the provision of training, and the weekly supervisory meetings reminding employees about safety. During the Antecedent Condition there were substantial increases in the frequency of accidents and the cost reductions were either slight or nonexistent (when the outliers were removed). At the very least, these findings suggest that a behavioral safety program is likely to be more effective than a traditional training program which only focuses on the improvement strategies listed above.

Although the present study was an initial step in the direction of understanding the financial impact of a behavioral safety program on work place accidents, two primary problems arose. One, a significant cost, that of the insurance premium, was not included because of the unknown and delayed nature of rate setting. Two, the site itself was not experiencing serious safety problems, thus diluting the potential effect of the behavioral safety program. Relatively few serious injuries involving time away from work had or were occurring at the site. Prior to the research year,

there were an average of 7 lost-time injuries for the entire plant; during the research year, only 5 occurred. As a result, the focus of the present study was on medical treatment injuries, which are less severe and notoriously unreliable. If a change in medical treatment injuries is reported, it is often not clear whether the actual frequency improved, the reporting changed, or persons' perceptions shifted. In the future, it is suggested that financial impact be assessed in a site with a more serious safety problem.

Despite these shortcomings, the present study illustrates a methodology for assessing the financial impact of work place accidents.

Reference Note

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II. PUBLICATIONS

To date, two publications have resulted from this research:

Komaki, J. Promoting job safety and accident prevention. In T. J. Coates (Ed.), Behavioral medicine: A practical handbook. Champaign, Ill.: Research Press, in press.

Komaki, J. A behavioral view of paradigm debates: Let the data speak. Journal of Applied Psychology, 1981, in press.

Plans are to submit the following for publication:

Komaki, J., Collins, R. L., & Hutcheson, P. P. Comparison of antecedent and consequent control approaches to occupational safety.

Komaki, J., Hutcheson, P. P., & Swanson-Williams, J. Long-term effects of feedback in a work setting.