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Training, What's It Worth?

an experimental case study at Johns-Manville Corp.

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Industrial training can theoretically be divided into two forms: *structured* and *unstructured.* Structured training can be thought of as the training of a new worker through a systematically developed educational program. On the other hand, unstructured training is on-the-job training of a new worker, without a specific program, by an experienced worker who simultaneously continues to perform his or her regular duties.

While the merits of structured industrial training are widely presented in the literature, little if any controlled research is reported.[1] This literature is obviously being written by advocates of structured training programs and when confronted with management opposition, the lack of empirical research leaves those interested in training with little more than the power of persuasion. Opposition to training is often a result of economics. As the profits of a company go, so goes training.[4] "Whenever top management cannot readily equate training and development activity with productivity, the training budget is bound to be curtailed or suspended completely."[3]

Opinions of either managers or trainers should not be the criteria on which industrial training investments are based. Whether or not structured training is a "frill" or a needed production tool can only be assessed if its relative cost effectiveness is known.

Purpose of the Study

The purpose of this study was to conduct an experimental comparison of the structured versus unstructured training of semiskilled production workers. The specific subproblems were as follows:

1. To select a production job representative of those semiskilled jobs in the Johns-Manville Corp. (J-M).
2. To characterize and develop an unstructured training program for the selected production job that is representative of the Johns-Manville unstructured training practice.
3. To characterize and develop a structured training program for the selected production job that is representative of the Johns-Manville structured training practice.
4. To select trainees that are representative of a Johns-Manville production-worker profile.
5. To develop methods for eval-

uating the product quality, worker competence, cost effectiveness and worker attitudes.

6. To execute the training experiment and collect the data.

7. To analyze the data by making comparisons to evaluate the effectiveness of the two training methods in terms of training time, worker competence, development and training costs, production losses, reactions to production problems and attitudes toward training.

This study is limited by the representative job, production-worker profile, structured training characteristics, and unstructured training characteristics that have been specified for this research.

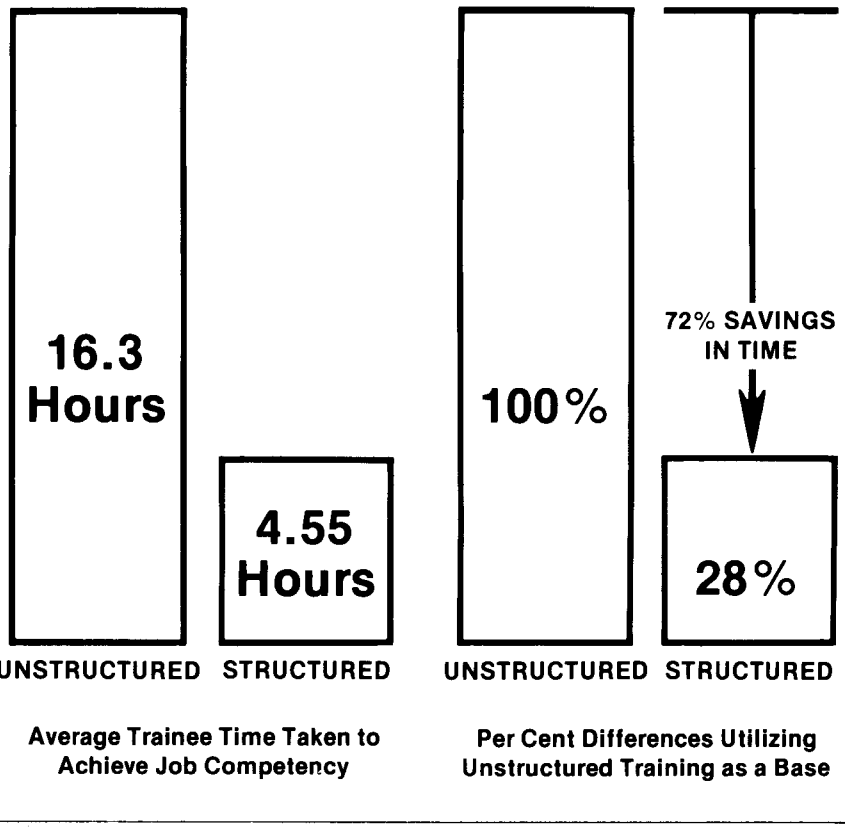
Structured training is defined as a thorough job analysis used as a basis for self-instructional and/or instructor-based training program that has been systematically developed to train a new worker in a logical progression from zero job competency to a specified mastery of the job. The trainee is the focal point of the training effort.

Unstructured training takes place when no purposeful instructional plan is used to train a new worker. The training is not systematic and the worker is usually trained by an existing employee (worker-trainer) while on the job. The worker-trainer has little or no interest in training, minimal skill to mastery of the job procedures, and little to no instructional skill. The ongoing production output is the focal point of the worker-trainer instead of the training experience of the trainee and mastery is not defined.

In theory, a structured training program has the advantage over unstructured training in that it can develop a better-trained worker with objective evaluation of trainee development and training costs. At surface evaluation, unstructured training is inexpensive, effective, and easy to implement. There is little evidence to prove or disprove these statements. Until training methods are submitted to systematic and carefully controlled research and evaluation, management will continue to use or discard a tool (structured or unstructured training) of unknown value.[2]

FIGURE 1.

TIMES TO REACH JOB COMPETENCY UNDER STRUCTURED AND UNSTRUCTURED TRAINING METHODS



Procedures

The organization of this "procedures" section is based on the subproblems of the study as presented earlier.

The selection of a representative production job of the Johns-Manville Corp. (J-M) required logical rather than statistical procedures. A series of tentative decisions, review sessions, adjustments and a final decision was the overall strategy. The final choice was to use the Rainville plastics extruder because of its face validity to J-M operations and general difficulty of operation. Basically, the job involved processing raw materials into quality plastic pipe from a plastic extrusion machine.

Inherent in the word "unstructured" is a looseness of definition or specificity. While unstructured training within J-M operations does allow for a wide range of training variables, there are many common conditions and variables that can characterize J-M unstructured-training programs. The attempts were to identify and simulate those conditions and variables during this research. Of equal concern was the identification of those conditions and variables that surrounded standard J-M structured-training practice. In both cases the reader may find them equally ap-

plicable to other training settings.

There were six major steps in the development of the extruder operator structured-training program. These steps were as follows:

1. Job and task analysis
2. General training-design decisions
3. Specific training-design decisions
4. Production of the training program
5. Pilot test
6. Training-program revision

The selection of experimental subjects (trainees) typical of a J-M semiskilled job trainee was based on logical rather than statistical procedures. The following dimensions were identified as being part of a trainee profile:

1. Age
2. Educational level
3. Local worker mobility
4. Worker motivations
5. Local and surrounding communities
6. Seasonal trends
7. Ramifications of local industry and BGSU

The subjects responded to recruitment methods either by telephoning about the position or applying in person. The subjects were asked to complete an application form and the Bennett Mechanical Comprehension Test. The pretest was used to obtain additional comparative data to insure the equality of the two experimental groups. A "t" test of means statistical comparison demonstrated that there was no significant difference ($p > .05$) between the pretest means of the two groups.

The fifth subproblem of this study was to develop methods for measuring the product, time, cost effectiveness and worker attitudes. Each of these evaluation tasks involved different criteria, methods and instrumentation, and are discussed separately.

Quantity and quality were considered in evaluating the product. Quantity was measured by count and weight. The quality of pipe production was based on visual and dimensional criteria. The visual criteria was handled in a judgmental format. Samples of defective pipe became comparative standards. The dimensional criteria of pipe roundness and concentricity required the development and validation of a mechanical test device.

Worker Competence

Worker competence was defined as being able to start up production, develop quality pipe and to recover from two production problems (remotely manipulated ma-

FIGURE 2.

HOURLY ATTAINMENT OF JOB COMPETENCY FOR STRUCTURED AND UNSTRUCTURED TRAINEES

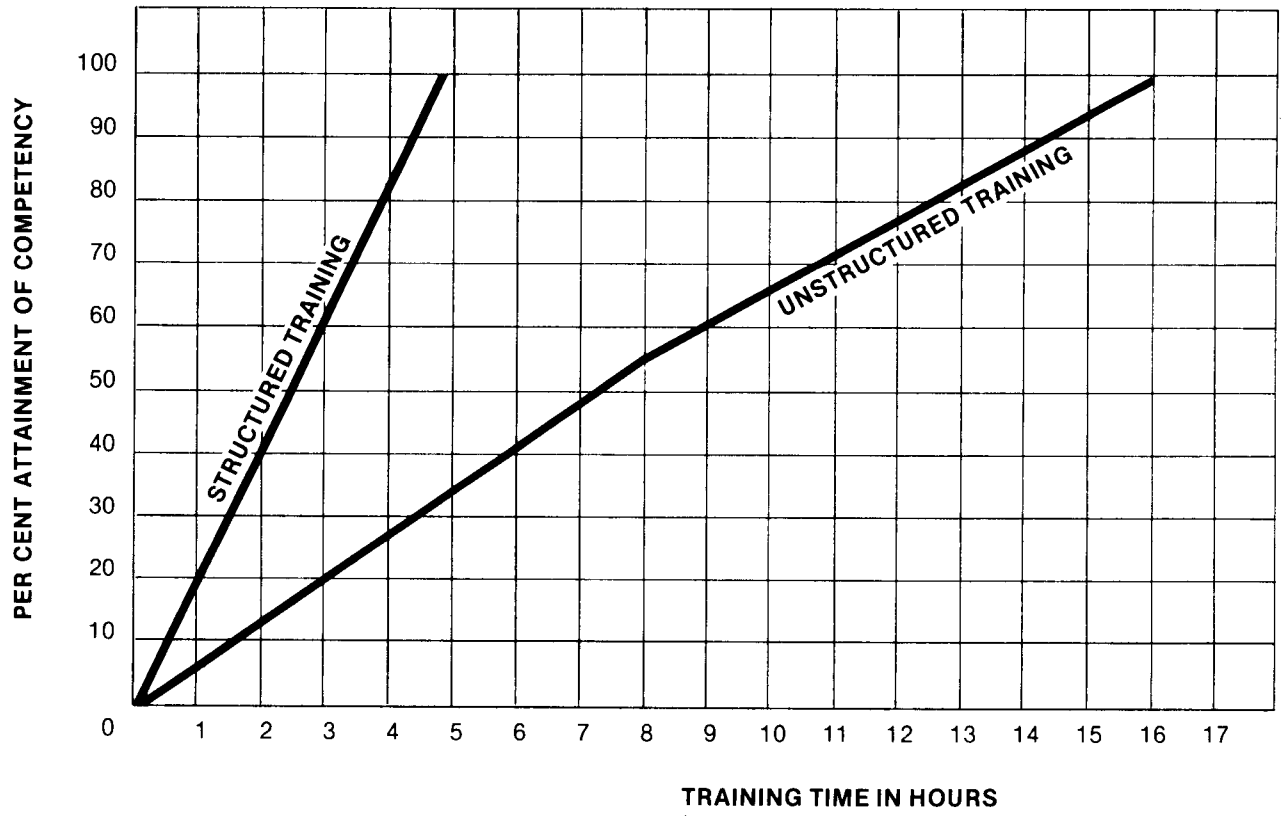
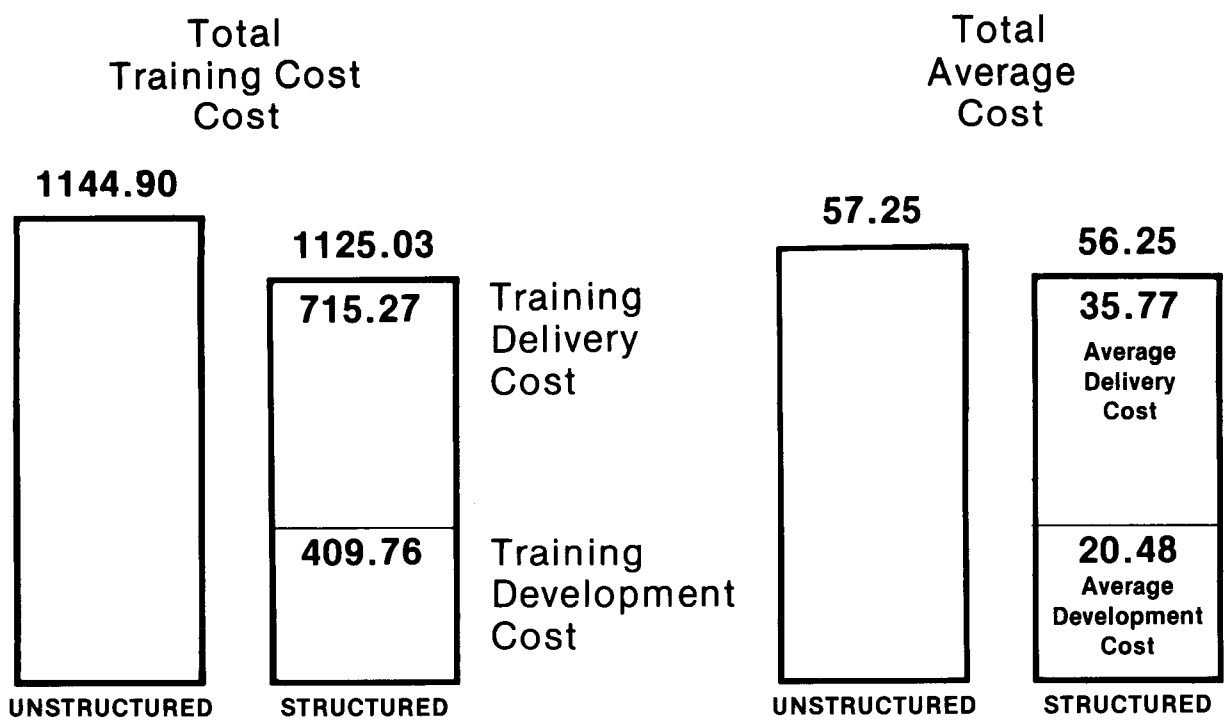


FIGURE 3.

COST COMPARISONS BETWEEN THE UNSTRUCTURED AND STRUCTURED TRAINING OF 20 INDIVIDUALLY TRAINED SEMISKILLED WORKERS



chine variables) without a loss of production rate. Remote observation of worker performance was believed to be of fundamental importance. A concealed closed-circuit television system was set up and used. The camera monitored the extruder operator work area and was broadcast to the project office some 100 feet away. In addition, all production rates and observation logs were systematically time-referenced.

Inputs to a cost-effectiveness model for the two industrial training methods were handled in a very practical manner. The actual expenditures from the ITRP budget were used. Simply stated, the hourly rate of the research assistant (who was performing as the industrial trainer) was used, as were all the project costs, even to the point of costing out the paper upon which the job analysis was written.

A *Worker Attitude Inventory* was developed to assess the attitudes of trainees toward their training and job. Content validity was established through the development of questions around the following points:

1. Attitudes toward the job
2. Attitudes toward training
3. Attitudes toward the trainer
4. Attitudes toward the equipment

When all provisions for the experiment were established and operable, the experiment was executed. The following research design provides an overview of the experiment:

EXPERIMENTAL GROUP 1
Unstructured Training Program:
M_1 T_1 M_2

EXPERIMENTAL GROUP 2
Structured Training Program:
M_1 T_2 M_2

M_1 = Bennett Mechanical Comprehension Test

T_1 = Plastic Extruder Operator Unstructured Training Program

T_2 = Plastic Extruder Operator Structured Training Program

M_2 = Plastic Extruder Operators' Performance Test and the Worker Attitude Inventory

The subjects in both groups were trained individually. The reason was that most new workers entering a J-M plant enter on a worker turnover basis.

The collection techniques and the data-recording methods depended on the type of data needed. The times a trainee reported for work and ended work, the hours a subject was a trainee, and the hours a subject was a worker trainer were recorded in a log.

To compare the material efficiency of one group to another, data was collected on production rates, production weight and material waste (scrap). Production rate was recorded as the number of quality pieces of pipe extruded per hour of work. At the end of each hour the researcher collected and counted the production. The production count and weight was recorded in the log.

The plastic determined as scrap was collected, weighed and recorded at the end of each hour by the researcher. Scrap was defined as plastic extruded not as pipe, and pipe not meeting the dimensional and visual standards. Comparisons were made between production weights and scrap weight per training group.

The attitudes of the subjects were recorded by a questionnaire completed by the subject at the end of the employment period.

Presentation and Discussion of the Data

The purpose of this section is to present and discuss data relative to the six research hypotheses.

• *Research Hypothesis I:* Trainees receiving training by the structured method will achieve competency in significantly less ($p < .05$) time than those being trained by the unstructured method.

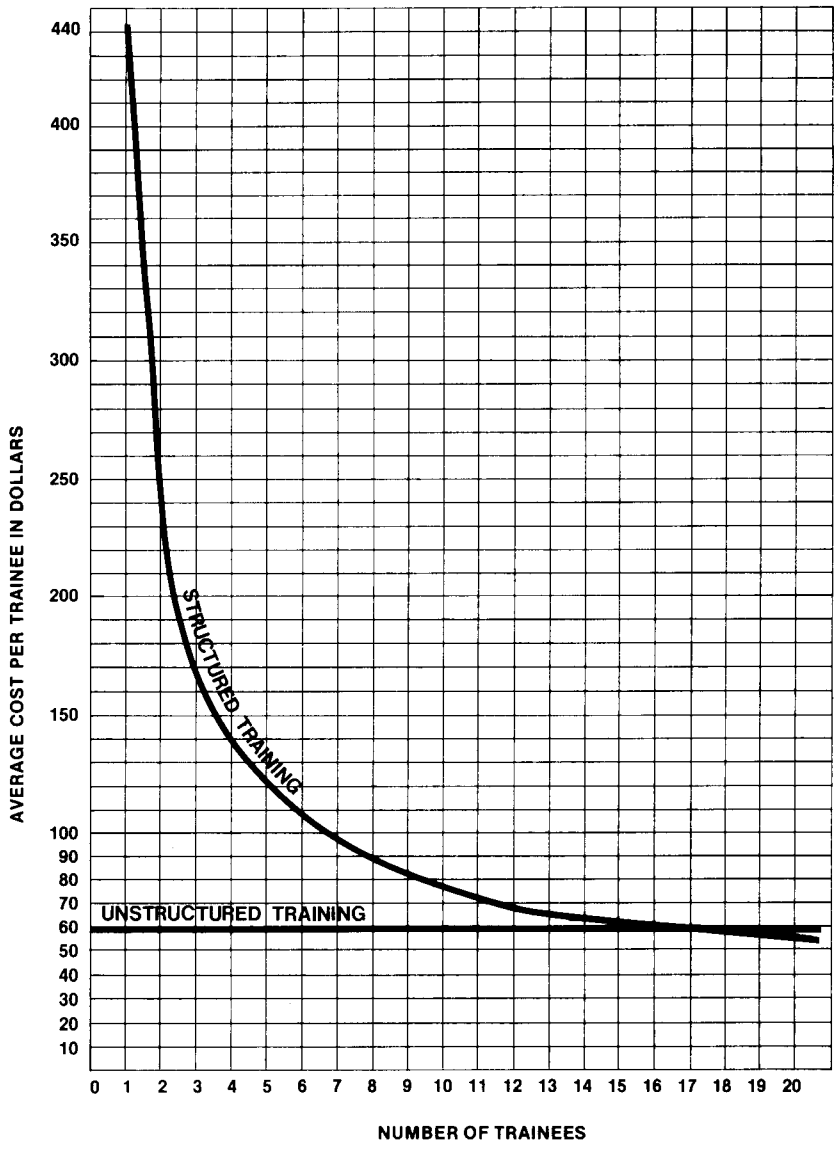
It was found that the structured training method 4.6 hour mean was significantly less ($p < .005$) than the 16.3 hour mean for the unstructured group. Therefore, Hypothesis I is accepted.

Figure 1 provides a graphic comparison of the relative times to achieve competency. The interpretation can be that structured training method will take 72.0 per cent less time than the unstructured method.

• *Research Hypothesis II:* Trainees receiving training by the unstructured method will achieve significantly higher ($p < .05$) in job competence at the four-hour, eight-hour, and 12-hour time intervals than those being trained by the unstructured method.

FIGURE 4.

COST COMPARISONS BETWEEN THE UNSTRUCTURED AND STRUCTURED TRAINING OF ONE THROUGH TWENTY SEMISKILLED WORKERS



At the four-hour interval, the 87.5 per cent competency of the structured group was significantly higher ($p < .01$) than the 28.8 per cent competence achieved by the unstructured group. At the eight-hour interval the 100 per cent competency was not significantly higher ($p > .05$) than the 55 per cent competence achieved by the unstructured group. At the 12-hour interval the 100 per cent competence of the structured group was not significantly higher ($p > .05$) than the 77.5 per cent competency achieved by the unstructured group.

With the strength of the four-hour comparison, the closeness to significance at the eighth hour, and continued positive trend in the twelfth hour, Hypothesis II was tentatively accepted.

Figure 2 provides a visual comparison of the relative time-interval competency levels between the

structured and unstructured training groups.

• *Research Hypothesis III:* There will be no significant difference in the average costs to train 20 extruder operators by the structured method as compared to training 20 by the unstructured method.

The $56.25 average cost to train a group of 20 extruder operators by the structured method was found to be not significantly different ($p > .05$) from the $57.25 average that it took to train an identical-size group by the unstructured method; therefore, Hypothesis III was accepted (Figure 3).

Two distorting factors influence the data on Hypothesis III, the group size and the relative values of various cost components. Hypothesis III deals with two groups of 20 people. Normally an industrial training program would be used to train considerably more than 20 workers. As the number of trainees increases under a structured-training program, the average cost per trainee is reduced because the cost to develop a structured program is fixed while the number of trainees increases. In an unstructured approach, however, the entire cost varies directly with the number of trainees. Figure 4 graphically illustrates this break-even concept. For the experiment, break-even was about 18 people.

Figure 5 illustrates that, of the total structured training cost, 36 per cent was devoted to development of the training program. In other words, it cost almost as much to develop as it did to implement the program. In the experiment, this was due to relatively low wages and a low output process. In real life, this is seldom the case. Since the conclusion of the experiment there have been strong indications that in J-M, development cost of structured programs runs 20-25 per cent of total cost. The value of wages, raw materials and machine output are proportionately greater than those exhibited during the experiment.

In the experiment, dollar amounts of various cost components are not nearly as important as the ratios. Likewise it is the ratio of the two experimental groups which is truly significant, when projected for a large group of trainees. Figure 5 combines the concept of cost ratios derived from the experiment with that of larger groups in order to simulate potential savings based on the research data. Most structured training in J-M should fall somewhere between the two lines. It should be noted that the 20 per cent line and the 36 per cent line cross at about 70 trainees due to absorption of fixed program development costs.

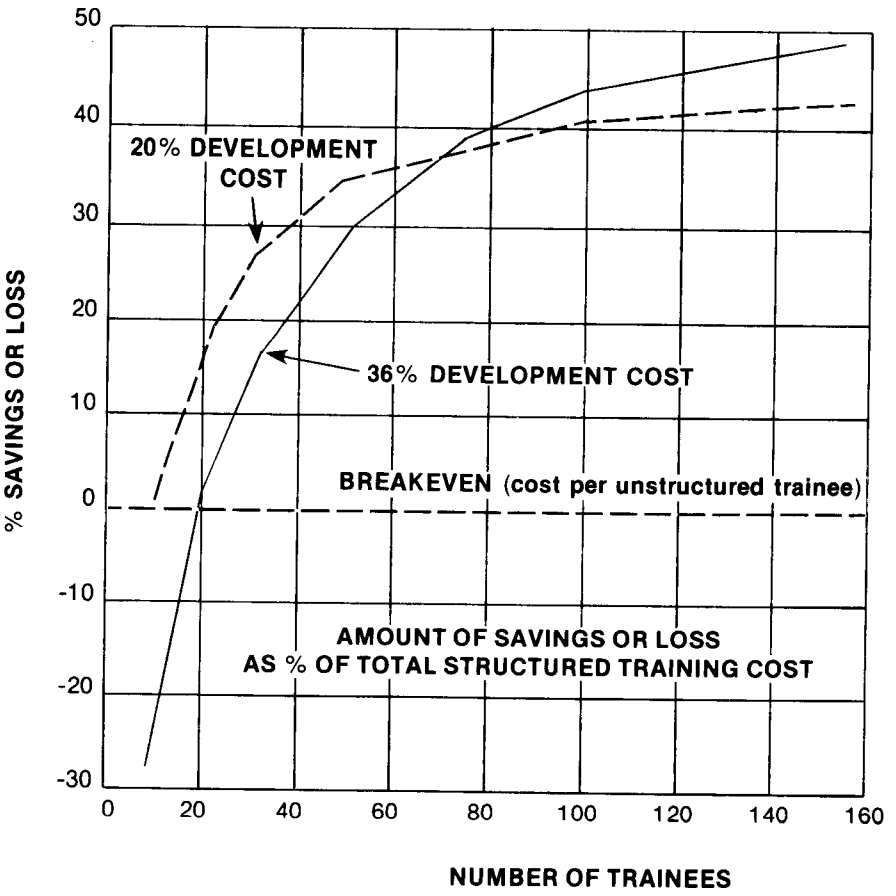
• *Research Hypothesis IV:* There will be no significant difference in the average production losses per trainee via the structured method as compared to those of the unstructured method.

As might be expected, training under both the structured and unstructured methods resulted in reductions from standard minimum-production rates. The average 2.91 pounds of production loss resulting from structured training was found to be significantly less ($p < .01$) than the 9.35 average pounds of production loss resulting from the unstructured training. Therefore, the Hypothesis IV was rejected in that significant differences did occur. Figures 6 and 7 visually illustrate the differences.

The approximate 70 per cent difference in production losses be-

FIGURE 5.

COST DEVOTED TO TRAINING PROGRAMS



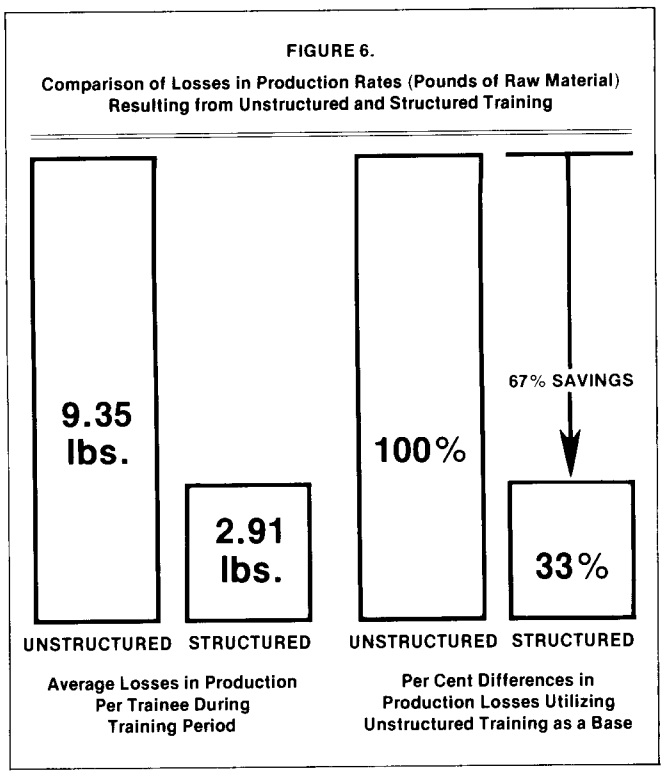


FIGURE 6.

Comparison of Losses in Production Rates (Pounds of Raw Material) Resulting from Unstructured and Structured Training

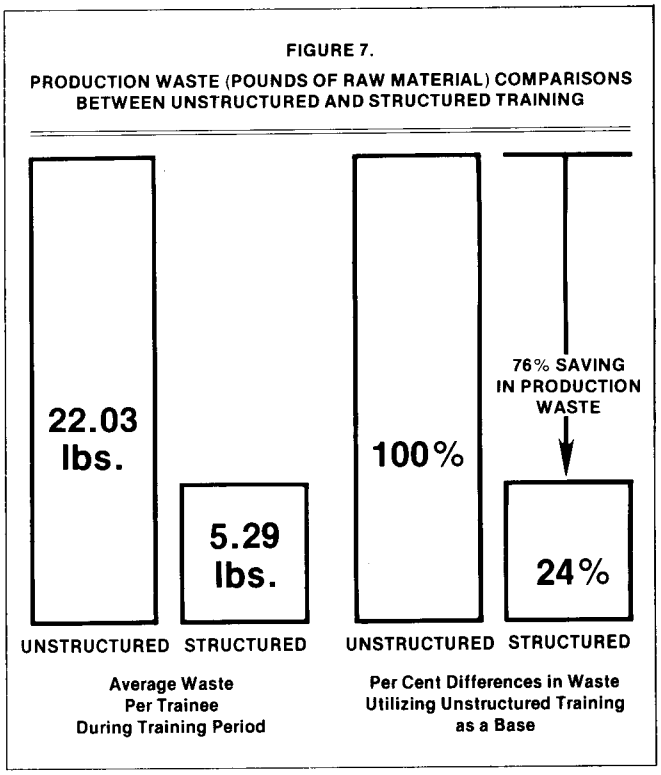


FIGURE 7.

PRODUCTION WASTE (POUNDS OF RAW MATERIAL) COMPARISONS BETWEEN UNSTRUCTURED AND STRUCTURED TRAINING

tween unstructured and structured training is dramatic. This percentage comparison can be useful in projecting the potential returns for very specific training-need situations.

• *Research Hypothesis V:* Trainees receiving structured training will resolve a significantly larger percentage of production problems than trainees receiving unstructured training.

The 80 per cent rate of success in production trouble-shooting by the structured program trainees was significantly higher ($p < .025$) than the 33 per cent rate of success by unstructured program trainees. Hypothesis V was accepted. The supporting statistical information is portrayed in Figure 7.

Obviously, expensive production downtime or difficult start-up procedures would make the reported differences of even greater concern.

• *Research Hypothesis VI:* There will be no significant difference in attitudes toward the job and training among structured-method trainees as compared to unstructured-method trainees.

While the attitudes toward the job by the structured training trainees were most positive, they were not significantly ($p > .8$) different from the trainees in the unstructured training group. Hypothesis VI, therefore, was accepted.

Conclusions

Research outcomes resulting from each of these pursuits have been discussed or presented in depth in this report. The formal conclusions from this research in terms of fixed hypotheses are as follows for the pipe-extruder operator's job:

1. Training time required under the unstructured method is significantly higher ($p < .005$) than the structured method.

2. At the four-hour training-time interval, trainees under the structured training had achieved a significantly higher ($p < .01$) level of job competence than the unstructured trainees. Though statistically significant differences were not found at the eight and 12-hour intervals, there is substantial difference in training times.

3. There was no significant difference ($p > .9$) in the costs to train 20 operators by the structured method or by the unstructured method. However, significant savings may be achieved by a structured training program when variable costs are relatively higher, or when larger numbers of people are trained.

4. Production losses were significantly greater ($p < .01$) under the unstructured method of training than under the structured method.

5. Trainees from the structured training program were able to resolve a significantly higher ($p < .025$) percentage of production problems than those trainees under the unstructured method.

6. There was no significant difference ($p > .8$) in attitudes toward the pipe-extrusion job among structured and unstructured trainees.

Observations

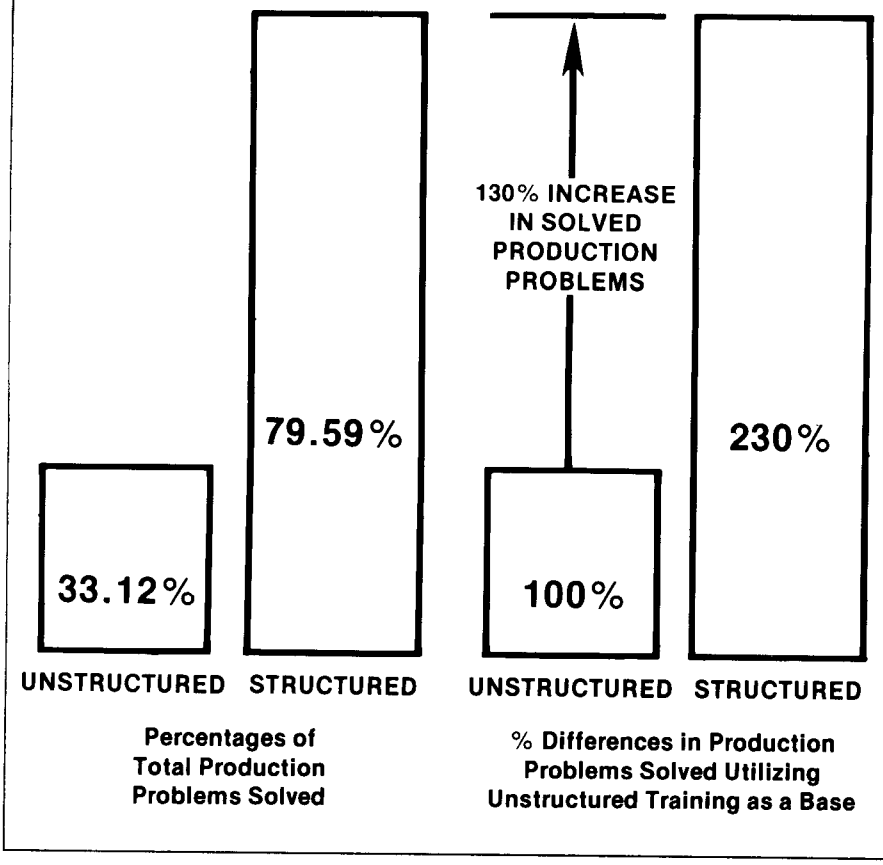
Several observations were made in the conduct of this Industrial

Training Research Project that are worth noting. They are:

- It is believed that controlled industrial training research, such as this study, may be impossible to conduct in ongoing plant operations. The variables are so complex that controlling them in a simulated situation is, in itself, very difficult.
- The simulated setting in a university industrial manufacturing laboratory was believed to be an ideal setting for conducting industrial training research. The face validity was high for both the researcher, visiting industrialists from Johns-Manville Corp., and for the trainees (as judged by the researchers). Nothing occurred during the 14 months of the research to discredit the simulation decisions that were implemented.
- The job-competency attainment under both training methods was in almost perfect steady linear progression over time.
- Training to job competency has been and remains a problem for the unstructured method. The looseness of the unstructured method often carries with it a looseness in evaluating attained levels of competency. Many believe that those trained via unstructured methods never reach competency, and we never know it. Research that compares unstructured and structured methods must be judged on identical competency criteria.
- Structured training program trainees responded more slowly and purposefully to their job tasks than did unstructured trainees and invariably relied on the job aids and manuals provided.

FIGURE 8.

Comparison of Percentages of Solved Production Problems Between Unstructured and Structured Trainees



NOTE: The Industrial Training Research Project (ITRP) was an experimental study under the direction of Dr. Swanson at Bowling Green State University (BGSU). Mr. Sawzin served as the principal investigator on the project. The origins of the project and its financial support came from Johns-Manville Corp. Both Mr. Cullen and Mr. Sisson had continued involvement in the conceptualization and conduct of the research.

REFERENCES

1. Antil, F.H., "Training Can Be Professional," *Training and Development Journal*, 1972, 26(11), 14-17.
2. Burke, R.J., "A Plea for a Systematic Evaluation of Training," *Training and Development Journal*, 1969, 23(8), 24-29.
3. Connors, J., "1976 — Looking Ahead," *Training and Development Journal*, 1976, 30(1), 28-31.
4. Douthat, J., "Accounting for Personnel Training and Development Costs," *Training and Development Journal*, 1970, 24(6), 2-6.

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