1990

Development and validation of a model for training maintenance supervisors for productivity improvements in manufacturing operations

Robert Reed Johnson
University of Northern Iowa

INFORMATION TO USERS

The most advanced technology has been used to photograph and reproduce this manuscript from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

UMI

University Microfilms International
A Bell & Howell Information Company
300 North Zeeb Road. Ann Arbor. MI 48106-1346 USA
313 761-4700 800 521-0600

Order Number 9030646

Development and validation of a model for training maintenance supervisors for productivity improvements in manufacturing operations

Johnson, Robert Reed, D.I.T.

University of Northern Iowa, 1990

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

DEVELOPMENT AND VALIDATION OF A MODEL FOR TRAINING MAINTENANCE SUPERVISORS FOR PRODUCTIVITY IMPROVEMENTS IN MANUFACTURING OPERATIONS

A Dissertation

Submitted

In Partial Fulfillment

of the Requirements for the Degree of

Doctor of Industrial Technology

Approved:

Dr. Michael R. White, Advisor

Dr. Ronald D. Bro, Co-Advisor

Dr. Ervin A. Dennis, Member

Dr. Bruce G. Rogers, Member

Dr. David A. Whitsett, Member

Robert Reed Johnson

University of Northern Iowa

May 1990

ACKNOWLEDGEMENTS

It would not have been possible to complete this dissertation without the support of many individuals. However, special recognition needs to be made to my wife, Nina, who provided encouragement when the effort seemed impossible, and willingly allowed me the time required. In addition, I owe a major indebtedness to the professors at the University of Northern Iowa who served on my advisory committee. Their guidance, direction, and continued support over a period of several years made the completion of this work possible.

Finally, my Mother provided much loving support and encouragement and looked forward to the day I would complete my degree. The Lord chose to take her from this world just prior to completion of this work. This dissertation is dedicated, with love, to her.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

DEVELOPMENT AND VALIDATION OF A MODEL FOR TRAINING MAINTENANCE SUPERVISORS FOR PRODUCTIVITY IMPROVEMENTS IN MANUFACTURING OPERATIONS

An Abstract of a Dissertation

Submitted

In Partial Fulfillment

of the Requirements for the Degree of

Doctor of Industrial Technology

Approved:

Dr. Michael R. White, Advisor

Dean of the Graduate College

Robert Reed Johnson

University of Northern Iowa

May 1990

ABSTRACT

The problem of this study was to develop and validate a training model for training maintenance supervisors. This training model focused on those areas, defined by industrial managers, where additional supervisory training was most likely to improve the performance of the maintenance departments.

Research of industrial and maintenance publications identified the maintenance function as having one of the lowest productivity levels in manufacturing organizations. Supervisor training was identified as a means to improve productivity in maintenance departments. An industrial survey completed by maintenance managers in manufacturing organizations in Iowa, Illinois, Minnesota, and Wisconsin identified those activities that were the responsibility of maintenance supervisors. The managers rated the potential for each activity to improve productivity in maintenance if the supervisors received training.

Research in training and educational journals identified models in use, the structure and components of models, and means of model validation. Training journals and maintenance publications were used to identify training methodology for types of activities, training logistics design, and measures of productivity evaluation for maintenance departments. A jury of 15 experts with proficiency in maintenance operations, maintenance publications, and industrial training was used to validate the training model and its components.

A maintenance supervisor training model was constructed with five major components: needs assessment, content analysis, instructional

methodology, instructional design, and evaluation. A number of instruments were developed to provide industrial managers and trainers with a sequential and logical approach to work through the model.

Results of the validation by the jury of experts revealed that the model contained the required components and approach to achieve productivity improvements in maintenance departments. The logical and structured approach of the model was essential due to time and budget constraints, and the limited number of maintenance supervisors in manufacturing organizations. Additional measures of maintenance productivity were identified and other industrial applications of this type of model were discussed.

CHAPTER I

THE RESEARCH PROBLEM

Unsafe operations, production down time, environmental concerns, and the loss of utilities are a few of the major reasons that the maintenance function in industry has become so important. For many manufacturing concerns the maintenance department represents a major activity in the organization structure, and the costs of maintenance are now a major concern for managers (Bullock, 1979).

In the early 1960s it was recognized that maintenance was beginning to cost significantly more due to the increased size and complexity of the operations, and due to the skills required to install and maintain automated facilities (Miller & Blood, 1963). Regrettably, maintenance tends not to have the management attention it requires and is rather seen as a necessary evil by many industrial managers (Husband, 1976).

The effectiveness of plant maintenance has a major impact on the profit margin in most industries (Peele & Chapman, 1987). According to Murphy (1980), " . . . of all the major budget items that are found in American industry, none shows weaker return than maintenance" (p. 194). Recently, maintenance productivity is still a major concern as a 20% productivity improvement is still a conservative and realistic goal (Westerkamp, 1986). While training has come to the forefront in the Japanese "Total Productive Maintenance" program, the United States is still far behind in realizing the link between training and competitiveness (Horn, 1986).

Improvements in the maintenance function have been slow to develop because of the lack of management understanding about the

degree of cost control and management involvement that can be exercised, inadequate accounting information, and difficulties encountered in applying quantitative analysis to maintenance problems (Bullock, 1979). Modernization and automation of industrial plants also require more complex and costly equipment and tools for maintenance. In addition, maintenance personnel are required to have different and more complex skills that go beyond operation of facilities and equipment to repair, alignment, and modification.

In the past 15 years most research articles and books written about maintenance have been concerned with resolving maintenance accounting problems and applying quantitative analysis to solve maintenance management problems (Gradon, 1973; Husband, 1976; Kelly & Harris, 1978; Bullock, 1979; Murphy, 1980; Heintzelman, 1981). Through the assistance of maintenance publications and systems development, industries are attempting to resolve these problems in maintenance management, but they are faced with a critical shortage of skilled maintenance personnel (Murphy, 1980; Heintzelman, 1981; Katzel, 1982). In-house training programs have been proposed as the most cost effective and efficient means to supply the skills that are needed to correct operational inefficiencies (Piper, 1982) and the maintenance supervisor is most often the key individual to an effective training program (Murphy, 1980).

Statement of the Problem

The problem of this study was to develop and validate a training model for training maintenance supervisors. This model focused on those areas, defined by industrial managers, where additional

supervisory training was most likely to improve the performance of the maintenance departments.

Research Questions

Since the problem of this study was to develop a model, various means were used to collect data to answer several questions. The research questions were:

1. What key variables, as identified in the literature, impact training of maintenance supervisors?

2. What maintenance management activities, as identified by the literature and an industrial survey by plant maintenance managers, were perceived as contributing to enhanced productivity in the maintenance departments?

3. What supervisor applications of maintenance activities were defined by industrial managers as being the most appropriate to enhancing productivity in maintenance departments?

4. What training components were the most appropriate, as perceived by the jury of experts evaluating the model, for training maintenance supervisors in the above identified activities?

5. To what extent was the developed model supported by industrial managers and model evaluators for training maintenance supervisors?

Statement of Purpose

The purpose of this study was to: Systematically collect data to determine essential components of a model; create a training model for maintenance supervisors; and to validate the model using a panel of experts in maintenance management and training. This model could then

be used by industry to develop training programs that would enhance the productivity of maintenance departments to a level that could effectively and efficiently support automated and mechanized plant operations.

Significance of the Study

The maintenance departments of an industrial plant function to make production operations more efficient, and they constitute a significant amount of the factory overhead cost (Lynch & Williamson, 1976). Many plants tolerate efficiency levels of 50% to 70% on maintenance labor (Lane, 1979). When maintenance supervisors are trained to use and understand maintenance controls, dramatic results in cost reduction and efficiency improvements can be achieved (Hanna, 1976). This is further supported by other examples (Heintzelman, 1981) where in-plant supervisory training led to significant improvements in maintenance operations.

Due to expanded relationships and responsibilities, supervisors now require new skills that were traditionally higher management responsibilities (Zenger, 1988). An earlier survey (Husband, 1976) of maintenance managers in chemical industries revealed that maintenance supervisory training in industrial relations and management control/decision making was more important than training in technical aspects. A survey by personnel of H. B. Maynard and Company ("Survey Finds," 1982) showed few firms evaluate productivity of maintenance and that efficiencies were estimated between 40% and 60%. Managers of firms have not developed programs specifically for maintenance supervisors (Johnson, 1982) and only one maintenance management book

was found, Maintenance Management and Terotechnology, by T. M. Husband (1976) that provided a syllabus for a maintenance supervisor training course.

For firms to survive in the fiercely competitive 1990s, supervisors will need to be trained extensively to communicate with workers and understand human behavioral and interpersonal relations if productivity improvements were to be made (Cathey, 1983). The maintenance supervisory role has changed since the time many supervisors were craftsmen. Today supervisors must apply behavioral science techniques for coordination of employees, other plant groups, back-up services, and planning systems (Kelly & Harris, 1978). Top management must insure that maintenance supervisors receive training in modern management techniques pertinent to their operations if productivity is to improve in maintenance operations (Murphy, 1980).

In the early 1960s, maintenance researchers recognized that supervisors must have the management skills if the productivity problem in maintenance was to be resolved (Eschner, 1963). However, few plants initiated any specific training programs for maintenance supervisors (Husband, 1976; Johnson, 1982) although some research has shown that training programs for maintenance supervisors improve morale and have resulted in productivity improvements of up to 20% (Heintzelman, 1981). The potential exists in most plants for a 40% to 50% improvement (Hanna, 1976). Improving productivity to more acceptable levels continues to be a problem for maintenance departments in addition to training personnel. The training model developed in this study will provide the framework and guidance to

allow organizations to establish training programs to resolve these problems.

Assumptions

Two assumptions were made in pursuit of this study. These are:

1. A maintenance supervisor is a key individual capable of bringing together the management and technical requirements to make the maintenance operation function more effectively and efficiently.

2. Almost all new maintenance supervisors bring with them the technical skills required from their previous position or training as a skilled worker.

Delimitations

This study was conducted based on four delimitations, and the results of this study apply only to these types of plants. These are:

1. Managers who received the survey had to be in plants large enough to support a distinct maintenance management operation. Therefore, only firms who had 500 or more employees identified in their current state's directory of manufacturers were included.

2. Since maintenance operational concepts varied widely between process and product manufacturing, only firms identified as producing products in Major Group 35 (machinery, except electrical), as identified by the four state industrial classification manuals (Iowa Development Commission, 1983; Manufacturers' News, Inc., 1983; Nelson Marketing Services, Inc., 1982; Wisconsin Association of Manufacturers and Commerce, 1982), were included in the survey.

3. The concentration of firms in the upper Mississippi Valley, quad state area (Illinois, Iowa, Minnesota, and Wisconsin), where

Major Group 35 products were produced, was the geographical population for the sample.

4. To prevent bias toward organizations which had multiple plants in the population area, only one plant from a corporation was included in the study.

Terms

Several terms used in this study were used in a variety of ways in industrial management and maintenance. For consistent use in this research the following terms were defined:

1. Automated and mechanized facilities--Manufacturing and/or assembly operations in a plant that require some level of computerization to manufacture or assemble the products, and to provide the information systems necessary to continue the industrial activities.

2. Human resource development--The application of concepts, methods, techniques, and judgment in an organization that result in effective and efficient utilization of human resources for the benefit of both the organization and the individuals.

3. Maintenance--The repair, replacement, cleaning, and installation of machines, buildings, grounds, and plant equipment of an industrial manufacturing facility (Murphy, 1980).

4. Maintenance management tasks--Those components of maintenance, when combined and directed, support the overall objective of the manufacturing organization.

5. Maintenance supervisors--The first level of management who directly assign the activities of a specified work force and perform the management functions of an assigned maintenance area.

6. Plant--A physical facility at one location where personnel manufacture and/or assemble products.

7. Productivity--The net value of the increased output of an industrial operation due to the capital, labor, and material invested by the maintenance operation.

8. Program--The syllabus and details of a planned procedure or schedule of events for training.

9. Training Model--A device that incorporates needs assessment, content analysis, instructional design, instructional methodology, and serves as an instrument for evaluation of the trainee's progress based on their relationships to achieving training objectives.

10. Validation--The determination of how well a training model performs when measured against certain criteria or compared with other training models (Zais, 1976).

11. Model validation--A technique by which experts in the field appraise a model's potential to achieve the desired objectives.

12. Major Group 35 firms--A manufacturing classification of manufacturers of types of machinery excluding electrical machinery.

Research Budget

The completion of this research project required a number of expenditures. These expenditures are detailed in Appendix A.

CHAPTER 2

REVIEW OF THE LITERATURE

The review of literature was conducted of training models in existence that could have potential applications to maintenance supervisory training. Examined during the review of the literature were major process variables common to training models, variables that might be unique to the maintenance supervisor training model, and tasks that could be appropriate in the content of a maintenance supervisory training program.

Training Models

A training model includes inputs, processes, and outputs (Vaught, Hoy, & Buchanan, 1985). The inputs include the tasks selected for the model and the communications channels required to implement the training. The inputs are moderated by resource availability, legal requirements, unions, time constraints, and organizational climates. The process covers all the detailed training requirements including instructors, methods, strategy, media, and modes (Ribler, 1983). The outputs include organizational goals, individual goals, and process feedback (Vaught, Hoy, & Buchanan, 1985). Models are employed to define systems or problems, act as a vehicle to determine critical elements or components, and as predictors for planning future developments (Pritsker, 1986). A model depicts a system or process and the relationships among its elements (Pfeiffer & Ballew, 1988).

A number of models were examined to evaluate application and major process variables. One technical training model (Gay, 1980), perceives instructional planning in terms of systems, management, and

production that seeks to maximize proficiency and performance by application. This model is based on stimulus-response and operant conditioning theories with recent trends toward behaviorism, accountability, competency-based performance, and cost-effective analysis of educational programming. The technical model (Gay, 1980) consists of three steps: needs assessment, synthesis, and operations. Needs assessment includes task analysis, expressing tasks as behavioral objectives, and placing the objectives in order of instruction based on cognitive relationships. Synthesis involves identifying viable instructional design and determining evaluation procedures. Operations is the actual carrying out of the instruction and evaluation.

One model (Mirabile, 1985), integrates training with the overall organizational requirements. Major components of this model include analysis, assessment, and evaluation and planning. Analysis includes position profiles or tasks defined for the job, competencies defined for the tasks, and prioritization of these competencies. Assessment includes an evaluation of an individual's readiness for a particular job, a development plan for focusing on particular tasks, and an evaluation of the individual's opportunity to demonstrate competency. Evaluation and planning include comparison of individual competencies and a career action plan for training and developing each individual.

Another model (Carney & Kahn, 1984), defined a five stage process of trainee development. Although applied to counselors in a cross-cultural environment, this model treated training as a five stage process applicable to most training development programs.

Initially, a trainee's knowledge is based on job stereotype and a shared economic status where they need to accept that their limited knowledge may lead them to rely on faulty strategies and goals. The second state of training requires them to realize that an expanded knowledge exists until the third stage where they become uncertain about their past perceptions and begin an attitudinal shift incorporating new learning. In the fourth stage the trainee recognizes the importance of validating an expanded knowledge and they begin to emerge with a new and more professional identification. The fifth stage concludes with the trainee taking actions on the job to implement the learning, and a commitment on the part of the trainee to continue learning about oneself and the environment.

A simple model for instructional design (Rogoff, 1984) starts with needs assessment with a goal to define specific tasks as the first of four steps. The second step is to define realistic objectives of the training program. The third step involves the preparation of the curriculum including the design of the training and the methodology to be used. The fourth step involves making corrections and adjustments for improvement to continue the training process.

The goals of any management development process should be to support the strategic objectives of the company, provide for interdivisional consistency of management philosophy, and support integration of human resource functions like career development, employee appraisals, and management styles (Galosy, 1983). Several training design models, in addition to those previously described, start with needs assessment as the first major process variable

(Hunkins, 1980; Pratt, 1980; Leithwood, 1982). Problems in continuing the design process may be encountered at this stage due to too much data, confusing vocabulary, changing attitudes, and too futuristic an orientation (Pratt, 1980).

There has been a recent maintenance training model developed (Peele & Chapman, 1987). This model consists of five steps: establishing an organization responsible for the training, developing an assessment of maintenance skill requirements, conducting a skills inventory, comparing the maintenance requirements with the skills inventory to determine deficiencies, and developing a training concept to survey the resources available to accomplish program objectives. This model, however, does not consider means for determining whether or not the deficiency is related to training and it fails to provide a mechanism for continuing evaluation of training. This model addresses training in maintenance, but does not focus on maintenance supervisors.

The American Society for Training and Development produced a six step model (McLagan & Bedrick, 1983) to educate and train personnel in the field of training. The first step involved determining the roles of the personnel field being studied through literature reviews and studies of groups. The second step in the training model required a description of the environment and the implications the training could have. The third step required a listing of expected outputs from the training. The next two steps required an identification of competencies required in the field followed by a study of each competency and its relationship to other competencies. The final step

required the development and validation of behavioral anchors, a description of competencies in behavioral terms, as judged by a panel of experts.

Functions of models include explaining aspects of human behavior, integrating facts through research and observation, simplifying complex processes, teaching relationships, evaluating treatments of people, inventing ideas, or planning interventions (Pfeiffer & Ballew, 1988).

Training models focus on content or on behavior. The American Society for Training and Development (ASTD) model combines both content and behavioral applications (American Society for Training and Development [ASTD], 1983). The model defined 31 competencies applicable to the different training roles described within the model. Each training role had basic, intermediate, and advanced levels of expertise defined for each competency. Each level of expertise was defined in behavioral terms with two examples provided for each level. As a result, the level of expertise for an individual could be analyzed, or the skill level requirements for a particular position could be constructed for roles in the training and development field. The relationships of the different roles in the training and development field could be identified by the commonality of the competencies related to each role.

Disadvantages of training models include overgeneralization, enticing one into committing a logical fallacy, incorrectly identifying relationships between variables, incorrectly identifying constants, not validating the model, and diverting useful energy into

nonproductive model building activities (Zais, 1976). One must realize that the model is only an abstraction that represents a process or system (Pfeiffer & Ballew, 1988). Constraints in training development involve the ability and background of learners, motivation of learners, political constraints, policy constraints, external examinations, financial, material, staffing, time, physical environment, and resources available (Pratt, 1980).

Despite the disadvantages and constraints of the models, a well-defined model may provide a training outline that has identified learning outcomes that are consistent with program goals and that are precise, feasible, functional, significant, and appropriate to the situation (Pratt, 1980).

Models are constructed in two phases (Pfeiffer & Ballew, 1988). The first phase consists of observing phenomena involved in the model, identifying variables important to the model, and specifying only those variables pertinent to the model. The second phase includes defining the specific variables and the relationships that exist among them.

The training models examined (ASTD, 1983; Mirabile, 1985; Peele & Chapman, 1987) reflect, to varying degrees, five major process variables: needs assessment, content analysis, instructional design, instructional methodology, and evaluation and validity of the model. Each major variable was dependent on the others for successful application. Needs assessment in the ASTD model (McLagan & Bedrick, 1983) included role determination, environmental effects, and identification of outputs. Content analysis included identification and selection of tasks, task relationships, and competency

requirements. Instructional design and methodology incorporated methods of presentation as well as the curricula structure, presentation requirements, and training logistics. Finally, evaluation and validity of the models included measurements of performance against the outputs desired from the training, implementation improvements, and employee proficiency analysis.

Major Process Variables

Five major process variables, consistent with most models, have been defined in the models reviewed. These are needs assessment, content analysis, instructional design, instructional methodology, and evaluation of progress.

Needs Assessment

Needs assessment is determining if a requirement for training exists. A model for identifying and meeting needs (Kaufman & Sample, 1986) required the preparation of measurable objectives, a definition of performance specifications, and a results-oriented action plan that defined the actual tasks, knowledge, attitudes, and abilities required. This model strived at defining a reality-based set of goals and objectives derived from the difference between the impact an organization now has to what it should deliver. A nine step military training model (Ainsworth, 1981) failed because the needs assessment phase of the model emphasized teaching subjects rather than performance and defined as one major output the number of soldiers graduating on time rather than how well the tasks were learned.

Critical to the needs assessment variable is the recognition and support by the organization that a productivity problem exists in the

maintenance department. The effectiveness of plant maintenance has a major impact on the profit margin in most industries (Peele & Chapman, 1987). Maintenance, as a major support activity in manufacturing, has consistently shown the weakest return of all major manufacturing budget items (Murphy, 1980). Recently, it is still a major concern as a 20% productivity improvement is still a conservative and realistic goal (Westerkamp, 1986). While training has come to the forefront in the Japanese "Total Productive Maintenance" program, the United States is still far behind in realizing the link between training and competitiveness (Horn, 1986). Organizational recognition of needed improvements is a key element in the identification of a requirement for a training program.

In the manufacturing environment equipment downtime has been identified as one of the major impacts on the organization (Peele & Chapman, 1987). Likewise, there has been found to be a correlation between lack of training programs and excessive equipment downtime (Peele & Chapman, 1987). This excessive downtime has been translated into higher maintenance labor costs, wasted production labor costs, higher spare parts costs, and lost production revenue (Peele & Chapman, 1987). Additional environmental impacts that maintenance has on the manufacturing organization include machine life expectancy, reduced machine speeds causing revenue losses, defects in product caused by lack of maintenance on machines and systems, and losses caused by setup errors or adjustment problems (Technical Staff, 1986).

The second key element in needs assessment is the existing manufacturing environment that the maintenance department supports and

its perceived impact that maintenance has on its ability to function. Production departments should be able to provide tangible evidence where maintenance is not providing the support expected. Tangible evidence includes machines or systems which are down for long periods of time, machines or systems that seem to repeatably fail after maintenance personnel work on them, maintenance requests for outside technical services, and/or significant numbers of equipment down at the same time. Where the above conditions exist, there may be a need for training (Peele & Chapman, 1987).

Effective supervisors provide liaison to management, develop human resources, coordinate work efforts, and develop more innovative and efficient ways of doing things (Karp, 1981). Improved productivity is only one of the benefits of effective supervision. Effective maintenance supervisor training prepares a craftsman for promotion, increases productivity, overcomes problems, and develops new skills to handle higher technology responsibilities (Mann, 1983).

Experience is a poor teacher and should not be relied on to improve quality on its own (Byham, 1977). Despite this truth in a rapidly changing industrial environment, 17.8% of all first-line supervisors receive no training, and the average number of hours of training for all first-line supervisors is only 32.5 per year. Industrial supervisors, which include those in maintenance, are not high on the list of type of supervisors receiving training (Lee, 1984). The existing level of education and the level of training that maintenance supervisors possess will also become important determinants during needs assessment.

Up to this point in needs analysis, training requirements have been based on management perceptions, the manufacturing environment, and supervisor education and training levels. Planning productivity improvements requires establishing a target and determining where to start, removing obstacles, explaining to employees that productivity is important to self-respect and security based on product demand, keeping employees informed, and improving effectiveness through evaluation, selection, and training (Terry, 1978). It is best to begin slowly and use a low key approach in training to achieve successful productivity improvements (Smith, 1982).

In regards to maintenance operations, maximum productivity occurs at the point where the cost of production losses and the cost of maintenance added together are at the minimum level possible (Herbaty, 1983). Performance can be measured in numerous ways in maintenance departments and the more common of these are: costs per standard hour, the relationship of results to plans and estimates, maintenance costs as a percentage of sales, maintenance costs as a percentage of plant costs, maintenance costs as a percentage of investment, maintenance cost per direct labor hour, and plant to plant ratios (Bullock, 1979). Maintenance performance can also be evaluated by comparing work orders completed per manday over a period of time, and costs of maintenance labor per work orders completed over a period of time. Although measurement of productivity is extremely important in evaluating the training model, the measurement system can also be vital to identification of a specific training need for the personnel receiving the training.

If these measurements can be corrected by organizational changes (Karp, 1981), training should not be considered. Management would implement the required change and reevaluate the problem using the measurement system.

After evaluating the above needs assessment variables, management must decide if training is the potential answer to the productivity problem in maintenance. Improved productivity is the major expected outcome of the maintenance training model. Poor productivity may be the result of unclear goals, inadequate training, restrictive work rules, multiple shift assignments, lack of management support, and too great a span of control (Karp, 1981). It has also been stated that a decline in productivity in the United States is the result of the decline in the motivation of the American worker (Karp, 1981). One training professional (Lee, 1983) indicated that when you train for productivity in industry the training should contribute to the productivity, and if it doesn't, you shouldn't be doing the training.

Content Analysis

Content analysis defines the subjects or activities that will correct or improve the situations identified in the needs assessment. A number of maintenance management books have provided outlines of topics considered important to the field. A survey of maintenance supervisors in the chemical process industry (Husband, 1976) revealed that career supervisors needed training in administration, dispute procedures, disciplinary actions, safety procedures, industrial legislation, and payment schemes. Another plan (Smith, 1980) for training maintenance supervisors included the following topics as a

course outline: managerial functions, planning, motivation and behavior of employees, communications, maintenance performance standards, employee relations, morale, handling problems, disciplinary actions, and resolving complaints and grievances. A third source (Mann, 1983) revealed that the most important areas of a supervisory training plan were new employee orientation, supervisory management knowledge, and education in specifics like communications, training, discipline, grievances, employee evaluation, budgeting, planning, scheduling, analyzing technical problems, standard practices, and methods improvement.

The most common short courses (Husband, 1976) for maintenance supervisors were cost control, safety, industrial relations, employee management, job analysis, job descriptions, work study, and maintenance planning. A more recent maintenance management book (Herbaty, 1983) stated that the most important productivity factor in maintenance operations was crew size and the mix of labor types on the job. Other factors were tool and equipment availability, travel time, planning, employee working conditions, job methods, morale, scheduling, and employee skills.

A study of maintenance productivity factors (Westerkamp, 1986) identified the following skills and organizational concepts as important: organization, policy, all levels of training, motivation, negotiation if unions were present, management controls, budgets, work order planning and scheduling, material and tool control, preventive maintenance programs, engineering support, work measurement and incentives, and data processing support. Westerkamp's study was

designed to test the current productivity level of the organization based on the current status of each of these criteria.

Almost all recent articles on maintenance training (Peele & Chapman, 1987; Horn, 1986; Piper, 1987) are concerned with training maintenance craftsmen in high technology skills. There has not been one article in the past five years in the three professional maintenance publications (Plant Engineering, Plant Engineer, Maintenance Technology) that have attempted to outline a training program for maintenance supervisors incorporating the skills needed at the supervisory level. The need for managerial skills versus "doing" skills is supported by Peele and Chapman, (1987) when they report that maintenance supervisors see their own technical skills becoming obsolete to the point that they must rely on the technical skills of their subordinates in areas beyond their expertise. As managers, these maintenance supervisors may be relying too much on old (achieved) skills and not on developing new (managerial) skills.

To assure that the most tasks that could possibly be required by supervision in maintenance departments had been identified, recent writings on general supervision were also reviewed for additional supervisory tasks. It was found that new supervisors tended to require more data management and people management skills compared to knowledge of the corporate culture, motivation, performance appraisals, delegation, and communication skills (Hurley, 1983). An outline of successful supervision (Jackson & Keaveny, 1980) included basic management of human resources, motivation, organizational operations,

leadership styles, communication, the staffing process, and company policies.

A positive correlation was cited (George, 1982) as existing between employee morale and organizational productivity. Another study (Herbaty, 1983) supported the relationship between employee morale and productivity.

A number of studies from the journals Training and Training and Development have provided insights into the latest tasks about which supervisors most need training. Supervisor job competency tends to address three main areas: technical, human relations, and administrative (Ramsey & Bittel, 1983). A survey (Ramsey & Bittel, 1983) revealed that supervisors have more confidence in human relations skills and less confidence in administrative skills. This was probably a result of their previous job experience as a craftsman where minimal administrative skills were required. The need for stronger administrative skills was reinforced in an article on personnel subsystems for training (Byham, 1982) and new programs to be added to supervisor training in the area of planning, finance, and human relations (Germany & Von Bergen, 1980).

The training subjects that appeared 95% of the time in a comprehensive supervisory training program study in England conducted by the International Labour Organization (Prokopenko & Bittel, 1981) were planning, communication, directing or coordinating, controlling, motivation, staffing, performance evaluation, human relations, wage and salary administration, work methods, leadership, employee training, safety, and health. Another study (Prokopenko & Bittel,

1981) conducted by the Danish National Institute of Social Research reported that 87% of workers believe that the main role of supervision is to maximize production.

The newest trends in supervisory training are training in the orientation of new employees, development of supervisory behaviors, and motivation (Shea, 1982). Ineffective supervisors have new employees read policies and manuals for a few hours and have other employees orient the new employee (Shea, 1982). This type of supervisory action may not provide for a transfer of the appropriate information.

Survey Methodology

A review of the literature revealed that few attempts have been made to define maintenance supervisor activities or to develop training programs explicitly for maintenance supervisors. Other means of determining maintenance training needs could be determined by asking supervisors, asking their superiors, analyzing performance appraisals, conducting exit interviews, or using an advisory committee (Kirkpatrick, 1978b). Since support by management is one of the most important criteria of a successful supervisory training program (Phillips, 1978), it is highly important that maintenance managers have confidence in the training program. The survey method appeared to be the most viable means of obtaining maintenance manager input data.

The survey is an important prerequisite in educational planning (Worthen & Sanders, 1973). Advantages of surveys are that they are less costly than other techniques, they can be sent over a wide area,

and they are a better instrument than other techniques in that each respondent will see exactly the same questions (Roth, 1981). The major disadvantages are a low response rate and a potential sampling error that could be built in by those who do not respond (Roth, 1981; West, 1977). The use of a follow-up can help overcome the low response rate associated with using surveys to obtain data. Analysis of why some do not respond also helps to decide if the respondents represent the population.

Successful survey requirements (West, 1977) demand that the instrument have an accessible population, handle related population characteristics, sample at random, pretest the data collection instrument with a pilot survey, maximize response with follow-up, and attempt to make an evaluation of non-respondents. One procedure followed in developing a survey included determining what is to be found out, the development and refining of questions, making questions simple and clear, testing questions in a pilot survey, determining the population, setting the survey time frame, tabulating results, reporting results, and acting on the findings by developing a model (Stark, 1978).

Instructional Design

Instructional design is the process for the training of learners and requires a consistent relationship between general goals and specific objectives (Zais, 1976). The outcome of a training design process should be a structured series of intended learning outcomes (Johnson, 1977) or an organized set of formal training intentions (Pratt, 1980). Regardless of the definition, training design is an

important training model process that must be completed if an instructional system is to be effectively developed (Johnson, 1977).

It is particularly important to select experiences to go with the objectives and relate these to the training environment (Hunkins, 1980). Learning experiences are equated with instructional time, content, teaching strategy, and instructional materials in importance (Leithwood, 1982). Planning a training strategy requires knowledge of the level of training and the manner that the tasks are to be learned (Ribler, 1983). Task learning outcomes can be broken into five strategies. These strategies are tasks that require multiple responses and the means to discriminate between responses, concepts that must be learned for successful performance of a task, tasks that require a fixed sequence of learning, tasks that require the learning of principles as a prerequisite to learning concepts, and tasks that require the application of problem solving skills to arrive at a new way to solve a specified type of problem (Ribler, 1983).

Besides understanding training objectives and their relationship to task learning, it is also important to understand what has been classified as "effective training" to include some technique particulars that relate to methods. To be effective all training should allow the supervisor to learn something new, to integrate what is learned with the supervisor's experience realm, to develop a positive self-regard about the learning experience and find ways to build an atmosphere that promotes acceptance, and to find the learning experience as fun and satisfying (Gay, 1980).

During the training supervisors must be able to perform the task in the classroom if they are to be expected to do it on the job. They should never be allowed to leave the classroom feeling the skills are too difficult (Robinson & Robinson, 1979). Using reunions to bring supervisors together again after training, and support groups have helped improve the effectiveness of the training (Tauber, 1981).

Since most first-line supervisors come from the in-plant labor ranks, a false assumption is often made that a skilled, dedicated worker will be a good supervisor (Crumb, 1981). Supervisors often did not know what was expected from them or what was assumed they knew, and they often could not perform effectively in all the activities for which they had responsibility (Crumb, 1981). A pretest at the beginning of the training is useful in helping to determine what training is needed. If skills are being taught, a performance test is needed, but if knowledge or attitudes are being taught, a paper and pencil test is appropriate (Kirkpatrick, 1977).

Effective training also starts with non-controversial subjects (Anderson & Anderson, 1982). Other considerations would include following actual job task sequences, finding elements or principles that are common to several of the tasks, proceeding from the simple to the complex, and proceeding from general to specific material (Ribler, 1983). Common sense in effective training also dictates the practice must include error correction, new facts are best learned when related from a known idea, related facts are learned better, and without feedback little effective training will occur (Broadwell, 1978).

Industrial training today should be performance based, able to be put together quickly and inexpensively, be flexible enough to be oriented to a single job or the whole organization, and have key managerial support (McKenna, Svenson, Wallace, & Wallace, 1984). Successful training models teach the minimum theory required to perform the job, group concepts together which are similar, and demonstrate how different tasks depend on each other where the subject is theoretical (Gane, 1972).

Quality instructional design avoids common training errors like attempting to teach too much, lack of communication of the training plan, failure to provide the time to practice skills, failure to show the trainee what the overall goals of the training are for the company, failure to give reinforcement, and training only on expectations (Steimetz & Todd, 1979). Training fails (Salinger, 1975) when: The benefits of the training are not clear to top management, managers rarely are evaluated or receive rewards for training, top management does not plan and budget for systematic training, managers do not account for training in production planning, supervisors have problems meeting production requirements with employees in training, training is unsystematic and usually for short-term objectives, behavioral outcomes are often imprecise, external training programs sometimes teach techniques and methods contrary to practices, and trainers provide limited counseling and consulting to the rest of the organization. Overall, supervisory training fails when it is not based on needs analysis or when the training fails to properly utilize

behavioral change techniques for the effective transfer of skills (Martelli, 1981).

The beginning of each training period should be strongly endorsed by management. Management support should include endorsement before hand, a description of the changes desired in the organization, the need for these changes in the overall manufacturing operation, reinforcement of the behavior after the training, and follow-up on results (Phillips, 1978). Production gains from a combination of management and training initiatives are more effective than either one alone (White, 1987).

Each training objective should describe the activity, the conditions, and the standards to be achieved (Kirkpatrick, 1977). Each supervisor should also be advised that completion of the training includes demonstrated competence in the classroom that they are capable of performing the activity on the job. The goal of the training should be to improve productivity in the supervisor's maintenance department. The trainer should hold one or two follow-up sessions at the conclusion of the training on each grouping of activities or periodically (a week or two apart) for supervisors to demonstrate their knowledge of the activities. The trainer should let supervisors know the training has not been completed until they have demonstrated this knowledge in the follow-up sessions.

The trainer should have management personally acknowledge a supervisor's mastery of the activity and officially recognize a supervisor with a training completion notice (Phillips, 1978).

Mastery of the activities could be designed into the career development pattern for the supervisor.

Maintenance supervisor activities include management, technical, and behavioral activities. Behavioral activities imply the learning of concepts (Ribler, 1983). These activities should be selected for training maintenance supervisors ahead of management and technical activities according to sequencing based on commonalities (Zais, 1976). Activities that require the learning of concepts should be held in a formal classroom environment where the supervisors cannot be interrupted during the training.

Behavior modeling is translating motivational theory into action and is designed to maintain and enhance the self-esteem of employees, to focus on behavior and performance rather than personality and attitude, to use reinforcement techniques to shape desired behavior, to use active listening to show understanding without judgment, and to set goals, follow-up dates, and maintain communication (Rosenbaum, 1979). The failure to maintain or develop behavioral performance standards is one of the most neglected areas of training today (Michalak, 1981). To change or improve behavior supervisors must desire the change, have the knowledge and skill of what to do and how to do it, have the right job climate, receive help and encouragement, and receive appropriate rewards. The ASTD model described this as creating behavioral anchors (McLagan & Bedrick, 1983).

The maintenance training model (Peele & Chapman, 1987) included in the instructional design specific steps for maintenance training. These included a clear definition of the training organization and who

comprises it, combining the needs assessment of maintenance with the existing skills inventory to determine what deficiencies should be designed into the training program, and preparation of the training design. The training design should include who will be trained, where and when the training will be conducted, who will conduct the training, and how it will be conducted. Effective training design (Peele & Chapman, 1987) must be tailored to the particular plant needs and be directed towards transferring specific skills. From the training model specific lesson plans for each class section are developed.

Media requirements include the type of presentation materials appropriate to the task being trained. These may include overheads, flipcharts, slides, videotapes, films, computer-aided materials, and texts (Ribler, 1983). Specific media also related to maintenance training (Peele & Chapman, 1987) may also include technical manuals, policies, schematics, spare equipment subassemblies, and the plant equipment itself.

Due to the time and budget constraints on training in industry, it is important to consider minicourses, courses that concentrate on training a few related tasks in a shorter time frame as compared to a college course that may cover a large variety of tasks over several months. Minicourses have achieved desired results in attitude improvement, an increased desire to learn, and have also been valuable in terms of knowledge acquisition (Heintzelman, 1981). Another evaluation (Oliver, 1978) revealed that minicourses involve the

learner in program planning, capitalize on learner interests, and provide a more relevant training program.

Instructional Methodology

Instructional methodology is the process variable that describes how a particular activity or subject will be presented. Examples of this would be lectures or "hands-on" training. The training methodology used must prepare the learner by conveying important subject matter, developing a framework for learning, and triggering curiosity (Deming, 1982). In general, the method selected for each task should motivate, clearly illustrate, provide active participation, provide an opportunity to practice, give feedback on performance, reinforce the trainee while learning, be adaptable to specific problems, and allow the trainee to transfer what is learned to the job situation (Cascio, 1982). The method used should be straight forward, logical, and clearly organized (Gold, 1981).

The three types of training objectives (Kirkpatrick 1978a) are knowledge, skills, and attitudes. Lecture is the recommended method for knowledge training, case study is the recommended method for skills, and discussion and seminars are the recommended methods for attitude training (Husband, 1976).

Other presentation methods besides lecture are conference, correspondence course, motion picture, reading list, closed circuit television, programmed instruction, systematic observation, computer-aided instruction, and sensitivity training (Cascio, 1982). Other simulation techniques besides the case study are incident method, role playing, programmed group exercise, task model, in-basket techniques,

and business games (Cascio, 1982). Adults who must learn in the same environment where the application is to occur are most receptive to job specific training, simulation, role play, and demonstration and practice (Ward, 1983). On-the-job training methods were recommended for orientation training, apprenticeship, doing it, job rotation, committee assignments, coaching, and performance appraisal (Cascio, 1982).

It is best to use a presentation technique when the instructor has the subject knowledge and the participants don't (Kirkpatrick, 1978b). Lecture, as a method, has to be combined with other training methods to be effective during supervisory training (Sartain & Baker, 1978). Other supervisory training programs advocated that lectures should not be used when the only purpose of the training was to resolve a problem (Crumb, 1981).

Training techniques recommended for use with the lecture included dialogue, conference, case study, simulation, role playing, managerial grid, and sensitivity training. The managerial grid method was specifically related to leadership and management training (Sartain & Baker, 1978; Blake & Mouton, 1978).

Since all maintenance supervisors have practiced some method of planning, estimating, and scheduling maintenance work, an attitude change may need to take place if any of the past practices are not desirable. Discussion and seminars are the best methods on activities requiring attitude training (Cascio, 1982). Reinforcement of the activity training is best accomplished by demonstration and practice for management type activities (Cascio, 1982).

Technical activity training is required to increase expertise in a particular area. With a high technology revolution (Piper, 1987) taking place in American industry, plant maintenance personnel are faced with acquiring new and more complex skills. The method of training selected must clearly illustrate the technical area, provide an opportunity to practice, and transfer the learning to the job situation.

The method selected should provide a learning condition as close as possible to the actual conditions experienced by the supervisors in the job environment (Pratt, 1980). When it is not possible to train in the real environment where the job is actually performed, trainers need to be inventive and establish presentation methods that approximate the real job environment as closely as possible (Ribler, 1983).

Evaluation

Training must be evaluated to insure that it is effective and that the desired changes are occurring. The four stages used in evaluating the effectiveness of supervisory training (Kirkpatrick, 1978c) are: Measuring the satisfaction of the participants after the training, identifying what knowledge and skills were learned, observing to what extent behavior is changed, and measuring improvements expected.

There are also tangible measures of effective training depending on how the organization gathers data or how they perceive performance. Results of supervisory training programs may show decreases in absenteeism, accidents, rejects, unit costs, overtime, tardiness,

employee errors, turnover, machine downtime, break-in time for new hires, work backlog, complaints, and labor reporting corrections (Phillips, 1978). The trainer or training department can track these events both before and after training to obtain specific data on training effectiveness. Training results may also show increases in unit hours, total output, supervisory bonuses, productivity, meeting schedules, on-time shipments, dollar savings on equipment, and employee morale (Phillips, 1978). Effective training has resulted in standardized procedures, yielded improved methods, resulted in the development of trouble shooting guides, and prevented stupid mistakes (Hill, 1984). Common measures capable of evaluating the effectiveness of the training program are: Costs per standard hour, the relationships of completed work requests to plans and estimates, maintenance costs as a percentage of sales, maintenance costs as a percentage of total plant costs, maintenance costs as a percentage of investment, maintenance costs per direct labor hour, and plant to plant maintenance ratios (Bullock, 1979).

The costs of the training program must also be considered in the overall evaluation process. In-house training programs are less costly than sending supervisors to training locations and they may have the advantage of allowing immediate application of the training. The company, however, must have an individual capable of doing the training and the trainees must not be interrupted during the training sessions.

If information systems do not provide for measuring improvements in maintenance productivity, there are some simple internal

measurements that can be obtained from maintenance data. These include work orders completed per manday and cost of maintenance labor per work order completed. In any event, the company should be able to develop some type of measurement that will provide a basis for evaluating the effectiveness of the training program. Without measures of effectiveness it is difficult for management to determine future training requirements or the investment that should be made in training. As the final major step in the training model, this process includes the implementation, evaluation, and maintenance of the training (Hunkins, 1980; Pratt, 1980; Leithwood, 1982). Completion of the evaluation process frequently results in a new needs analysis.

Validation

The ASTD model (ASTD, 1983) required the validation of the description of the competencies by a panel of experts. Validation of a training model requires an unbiased viewpoint, establishment of the validity of the product, and a goal-free analysis where the evaluator is not influenced by the results (Noel & Hewlett, 1981).

Validation should first be completed internally and then through expert appraisal (Pratt, 1980). Complete training model validation requires attainment of concurrent validity, construct validity, and predictive validity (Roth, 1981). Concurrent validity is attained through research of the literature for specific tasks that had the potential through training to improve productivity and by verification of those tasks through expert, maintenance manager, input. Construct validity, interpretation of what the tasks selected really imply, can be decided in an unbiased environment by a jury of experts who have

had significant experience with maintenance and industrial training. Predictive validity evaluates the ability of the training model to predict the desired outcome, improved maintenance department productivity, based on the content and design of the training model.

Summary

The review of the literature has provided insight into existing training models today and the major components of these models. In addition, specific variables applicable to the major components of a maintenance supervisor training model were analyzed. Limited content analysis data were available for the maintenance supervisory field. The literature did identify the survey as one of the best means of developing specific content.

CHAPTER 3

METHODOLOGY

This study was conducted in two related phases. Phase One was the development and completion of a survey by industrial maintenance managers. The survey was a compilation of maintenance supervisor activities where training could be effective in improving the productivity of maintenance departments. Phase Two involved the development of a training model that combined current training processes from the literature review and the results of the industrial survey. Crucial to the success of this study was the survey of industry in which the training activities for maintenance supervisors were delineated in respect to the desired productivity outcomes.

Phase One: The Industrial Survey

A survey of 137 industrial plants was selected for inclusion in the study. These plants were defined as Major Group 35 (machinery except electrical) manufacturers. A stratified, by state and size of firm, random sample of the population in the quad state area (Iowa, Illinois, Wisconsin, and Minnesota) was surveyed. The population size was selected from Major Group 35 firms of 500 or more employees in the states of Iowa, Illinois, Wisconsin, and Minnesota as indicated by each state's current directory of manufacturers. The total population was 169 plants. Only one plant from any one corporation was included in the sample. This was done to prevent bias from corporations that had a number of plants within the population geographic area. The total sample size was 137 plants.

An initial review of the literature was completed to determine the potential scope of activities for maintenance supervisor training that should be included in the industrial survey of training needs, and the procedures to be followed for the survey. In addition, an initial review of the literature was completed to determine what training models for maintenance supervisors were in existence.

Development

Based on existing supervisor training programs, maintenance publications, and training journals, a listing (Appendix C) of 34 maintenance supervisor activities was compiled. Additional space was allowed for industrial survey respondents to add additional maintenance supervisory activities. The scope of 15 of the activities was large enough to require the survey respondents to more specifically identify what part of that activity was of the most importantance to them as it related to maintenance supervisors. Multiple selection questions were developed (Appendix C) to allow the respondents to define the activity in more detail after the listing of activities. The respondent was required to fill in technical areas of concern on one question.

Survey respondents were asked to indicate on the survey, regardless of how efficient or productive they considered their maintenance departments to be at the present time, whether a good training program for their maintenance supervisors in each particular activity would result in: (a) significant improvements in productivity, (b) some improvement in productivity, or (c) no improvement in productivity. For each activity marked as a

significant improvement a value of three was assigned for purposes of analysis. Likewise, a value of two was assigned for each question marked as some improvement, and a value of one for questions marked as no improvement.

Organizational data questions were developed (Appendix C) to determine demographic data about the survey respondents. In addition, questions were asked about the industrial plants where the respondents were managers.

Maintenance managers of plants large enough (500 or more employees) to have identified maintenance departments were selected as the survey respondents. Maintenance managers would have direct responsibility for productivity in maintenance departments, and would be in the most authoritative position to evaluate maintenance supervisor training.

The survey was pilot tested with the total population (11) of Major Group 35 (machinery except electrical) plants meeting the plant size criteria in the state of Nebraska to obtain content validation of the questions on the survey. A letter of introduction (Appendix B), the survey (Appendix C), and a self-addressed, postage paid envelope were mailed to the maintenance manager of the 11 plants.

The purpose of the pilot study was to verify that the answers provided would provide information that could prove valuable in the development of the training model, and to discern if any of the maintenance managers could provide any additional areas for training that were not covered in the survey. It was desired to have at least

three responses to the pilot study, however, four responses were achieved. There was no need for follow-up.

The participants did not recommend any changes be made to the survey nor were any additional activities defined. All of the questions in the pilot survey had a 100% response rate except for the question that required maintenance managers to define areas of technical knowledge where maintenance supervisors required additional training. The responses to this question indicated that a number of technical areas could be identified using the survey.

The results of the pilot survey were analyzed. Although no activity received unanimous support as contributing significant productivity through training in this small population from Nebraska ($\underline{N}$ = 11), 21 activities were identified as significant by a least two respondents. The dispersion of answers indicated that maintenance managers were able to assess the activities in relation to their maintenance department operations, and the managers could determine content analysis for a training model. The responses were considered appropriate and the survey was prepared for mailing to the population sample.

A 50% valid reply rate was established prior to the survey as required to verify training activities that should be included. To meet this requirement, firms in the sample population were sent a letter of introduction (Appendix D) and a self-addressed, postage paid envelope, to personally identify the manager who should receive the survey.

A letter of introduction and survey (Appendixes B and C) were mailed to 137 maintenance managers of the specific plants identified in the sample population as derived above. Nineteen plant managers did not respond to the request for the maintenance manager's name. For these plants, the survey and letter of introduction were mailed to the maintenance manager.

A follow-up survey was mailed to 90 non-respondents of the sample population since only a 34% response rate was received within 15 days from the mailing. A follow-up letter (Appendix E) was mailed with the same survey (Appendix C). A 20.7% valid reply rate was received from the follow-up survey for a total response rate of 54%.

Industrial Survey Data

Survey responses were analyzed. Only activities whose mean, median, and mode were greater than 2.0 were included as inputs to the training model because it was reasoned that only these activities could be considered as contributing significantly to the objective of increasing productivity in the maintenance departments. The distribution of industrial survey replies received is provided in Table 1. One reply on the follow-up survey was returned unanswered, and not included. The total of 74 replies represented 54% of the population sample and 43.8% of the total population. Based on the percentage and distribution of the replies, the responses were an adequate representation of the population.

To ascertain characteristics about the Major Group 35 firms included in the population sample for consideration in development of

the needs assessment component of the model, several questions were asked at the beginning of the survey. To qualify for the population sample, these firms had at least 500 employees working in the firm based on their state's current directory of manufacturers. Due to a downward economic turn in manufacturing since 1982, a number of these firms had decreased employment. The actual categorization of firm size by state is detailed in Table 2. This reflected a balanced distribution of plant sizes and helped insure that the firms were large enough to require a maintenance department.

Table 1

Response Rate From Industrial Survey Data

State	Total Firms	% of Pop.	Original Survey	Follow-Up Survey	Total Replies	Total Reply Percentage
Illinois	44	32%	16	8	24	54.5%
Iowa	15	11%	9	2	11	73.3%
Minnesota	41	30%	12	7	19	46.3%
Wisconsin	37	27%	9	11	20	54.1%
Totals	137	100%	46	28	74	54.0%

The model had to also be designed to meet the needs of any number of maintenance supervisors to be trained in each manufacturing plant. Maintenance manager responses on firm size by state are illustrated in Table 3. Over 80% of the firms indicated that they had one to five

maintenance supervisors to be trained. No firm had more than 20 maintenance supervisors.

As part of the needs assessment process, it was necessary to know the general level of education of the maintenance supervisors in the population sample and the current level of training they had received from their company. This information was considered to be useful for determining if the maintenance supervisors had previous training in some of the activities. The survey revealed that the highest level of education for 67% of the supervisors was a high school diploma. Another 29% had completed some type of technical course while only 4% had a baccalaureate degree.

Table 2

Results of Firm Size By State From The Population

State	Sample Population Responses	Employees Per Firm		
		Up To 499	500-999	1000 Or More
Illinois	24	15	4	5
Iowa	11	4	6	1
Minnesota	18	8	6	4
Wisconsin	20	3	9	8
Totals	73	30	25	18

Approximately 66% of the supervisors received no company training. Thirty percent of the supervisors had been given a general supervisory training course in their organization. Three maintenance managers responded that their plants had a specific course of instruction for maintenance supervisors.

Table 3

Maintenance Supervisors Per Manufacturing Plant

State	Supervisors Per Manufacturing Plant			
	1 to 5	6 to 10	11 to 20	21 or More
Illinois	20	2	2	0
Iowa	9	0	2	0
Minnesota	15	2	1	0
Wisconsin	16	3	1	0
Totals	60	7	6	0

Maintenance managers, who had conducted some type of supervisor training (34%), provided data on who administered the training. This data can be found in Table 4. The significant amount of on-the-job training indicated that even those managers who indicated that they had a training program, at most, had a very informal training program.

Organizational data on the survey supplemented the information found in the research of the literature for development of the research model. There is little training available for maintenance

supervisors, and what is available, is a general supervisory training program that focuses on supervisory principles applicable to all type of supervisors. The preliminary results also revealed that the majority of supervisors come into the position with only a high school diploma.

Table 4

Providers of Maintenance Training

Trainer	Number of Firms	Percentage
Other Supervisors	1	1.4
Outside Consultants	1	1.4
Seminars (Outside Trainers)	2	2.7
Maintenance Engineers	2	2.7
Training Department Members	4	5.5
Managers	6	8.2
No Instructor (On-The-Job)	9	12.3
Totals	25	34.2

These data also revealed that almost all training is done internally within each company. The primary trainers within the company can be expected to be either managers or members of the training department. The training model was designed so that it would fit this type of training pattern that seemed prevalent in the population sample. The low number of maintenance supervisors within

each plant may also make it very difficult for a plant to allow its maintenance supervisors the time required to complete a training program offsite. These findings were incorporated into the structure of the model in phase two.

Phase Two: Model Development and Validation

Different models were analyzed with their major process variables. The intent was to develop a training model that incorporated needs assessment, content analysis, instructional design, instructional methodology, and evaluation of progress as major process variables. This type of model was found to be well represented by the ASTD model (ASTD, 1983). A literature review was completed on each of the major process variables, maintenance supervisor training, and operations in maintenance departments as they pertained to the major process variables.

Development

Relationships were established among the five major process variables. Each major variable was found to be dependent on one or more of the other major variables for successful application. Without assessing the needs of the maintenance supervisors and the organization, it would be difficult to develop a relevant training program content applicable to that particular organization.

With the major process variables sequenced, an initial training model was developed (Appendix F). This training model was used to develop maintenance supervisor training requirements that could lead to productivity improvements in the maintenance departments.

Needs Assessment

Three subcomponents of needs assessment were identified: management's perception of maintenance, production indicators that a problem may exist, and maintenance performance indicators which provided a means to measure a supervisor's potential. The industrial survey was used to verify that maintenance managers perceived a need for training and to provide a profile of the current training status of maintenance supervisors.

An instrument (Appendix G) was developed for use by the plant manager, or other senior manager, to assess management's current perception of the effectiveness of the maintenance department. Statements about maintenance operations were developed to allow the manager to assess if training of maintenance supervisors could be a viable option for improving maintenance operations.

Another instrument (Appendix H) was developed for use by the production or manufacturing manager to assess the present ability of the maintenance department to support manufacturing and/or assembly operations. Statements about maintenance operations were developed to allow the manufacturing manager to assess the extent to which improvements in maintenance could be a viable option for improving manufacturing operations.

A third instrument (Appendix I) was developed for use by the maintenance manager to assess the present performance of each maintenance supervisor. Statements about the performance of a maintenance supervisor were developed to allow the maintenance manager to determine if training could result in improvements in performance.

A fourth instrument (Appendix J) was developed for use by the maintenance manager to determine if the supervisor had the education, prior training, or experience required to perform in the position. Based on the industrial survey data, many maintenance supervisors are promoted into their positions from the craft areas and they may have never been exposed to many of the skills required of them as maintenance supervisors.

Content Analysis

A training content selection instrument (Appendix K) was developed from the maintenance supervisor activities defined in prior supervisor training programs and the industrial survey (Appendix C). Using the needs assessment instruments as a guide, the maintenance manager or trainer would rate each activity based on its training potential for improving productivity in the maintenance department. Those activities, where supervisor training indicated a high potential for productivity improvement, would be further developed in the model.

The activities selected for training were placed into one of three groupings for organizational purposes and to make training design easier. These were: employee and organizational behavior content, technical content, and maintenance management content.

After training content has been developed, the measurement system used to evaluate the training (Appendix N), must be used to establish current measurements if the trainer is to measure and assess productivity gain after the training is completed.

Instructional Methodology

Based on training research, an instructional methodology instrument (Appendix L) was developed for use by the trainer. The instrument provided recommended types of training methods, and was designed to allow the trainer to select the training methodology desired for each activity to be trained on.

Instructional Design

Based on training research, an instructional design logistics instrument (Appendix M) was developed for use by the trainer. The instrument provided a check list to insure that all logistic requirements for each training activity had been completed prior to initiating the training.

Evaluation

A training evaluation instrument (Appendix N) was developed to allow selection of productivity measurements, both before, and after the maintenance supervisor training had taken place. The results of these measurements were designed to indicate productivity improvements that had resulted in the maintenance departments due to the maintenance supervisor training, and allow the maintenance manager to conduct a new needs assessment.

Conclusion

Relationships among major process variables and those pertinent to the maintenance supervisor model were developed. For example, content analysis should not be determined until needs assessment had been completed. Instruments were designed to allow the appropriate manager or trainer to work through each major process variable in the

model. Each instrument detailed those variables pertinent to that process.

A completed training model (Chapter 4) was constructed using the five major process variables and their instruments. The model included inputs, expected outputs, and provided potential measures to evaluate the results of the training.

Validation

The completed model (Chapter 4) and its supporting instruments (Appendixes G thru N) were validated by a jury of experts as described below. A validation instrument mailed to the jury was used to obtain the data required to evaluate the training model.

Development. A jury of three groups totalling 15 experts was selected to validate the model. Five of the experts were corporate executives responsible for training and management development of personnel in their industrial organization. Five of the experts were identified from academia in the area of industrial training including subjects related to maintenance. Five of the experts were noted for their knowledge in maintenance operations and had recent involvement in maintenance training or publications.

A letter of introduction (Appendix O) was prepared for mailing to the jury of experts. The letter of introduction described the purpose of the model, the need for the model, and asked their expert opinion in evaluating the model.

A validation instrument (Appendix P) was developed for the jury of experts to evaluate each of the major process variables in the

model, the overall model, and the potential use of the model by industry to improve productivity in the maintenance departments. In addition, the validation instrument included a place for each jury member to provide demographic data since the confidentiality of jury members was assured in the letter of introduction.

The degree to which the developed model, in part or in total, was adequate was determined by the validation instrument (Appendix P) completed by the jury of experts. When a majority, eight or more, of the jury of experts believed that an input to the model was not adequate, as described in the validation instrument, that part of the model was eliminated. When five to seven members of the jury of experts agreed that a part of the model was not adequate, or did not produce desirable productivity results, appropriate comments were made in that section of the model concerning the potential problem, but the model was not changed. When comments or changes were to be made to the model, the basis of the comment or change had to come from the majority of the jury of experts who completed the validation instrument.

The listing of the jury, the completed model (Chapter 4), the supporting instruments (Appendixes G thru N), and the validation instrument (Appendix P) were approved by the doctoral advisory committee. The maintenance supervisor training model (Chapter 4), the supporting instruments (Appendixes G thru N), a letter of introduction (Appendix O), the validation instrument (Appendix P), and a self-addressed, postage paid envelope were mailed to the jury of experts.

To provide follow-up, jury members were provided with a collect phone number to call in the letter of introduction (Appendix O). Four members of the jury did telephone to discuss different aspects of the model. In addition, a follow-up phone call was made with an additional eight members of the jury who could be reached.

Validation results. A total of 13 responses were received from the 15 member jury of experts. The other two jury members, each from a different group, could not be contacted.

The responses on the validation instruments were analyzed. Demographic data provided by the 13 members of the jury of experts is detailed in Appendix Q. Responses to the validation instrument are detailed in the following chapters.

CHAPTER 4

THE TRAINING MODEL

One means of improving productivity in maintenance departments is to train maintenance supervisors. Where training is an option, the model is intended to provide the maintenance manager and trainer with a structured approach to analyze the potential for productivity improvements.

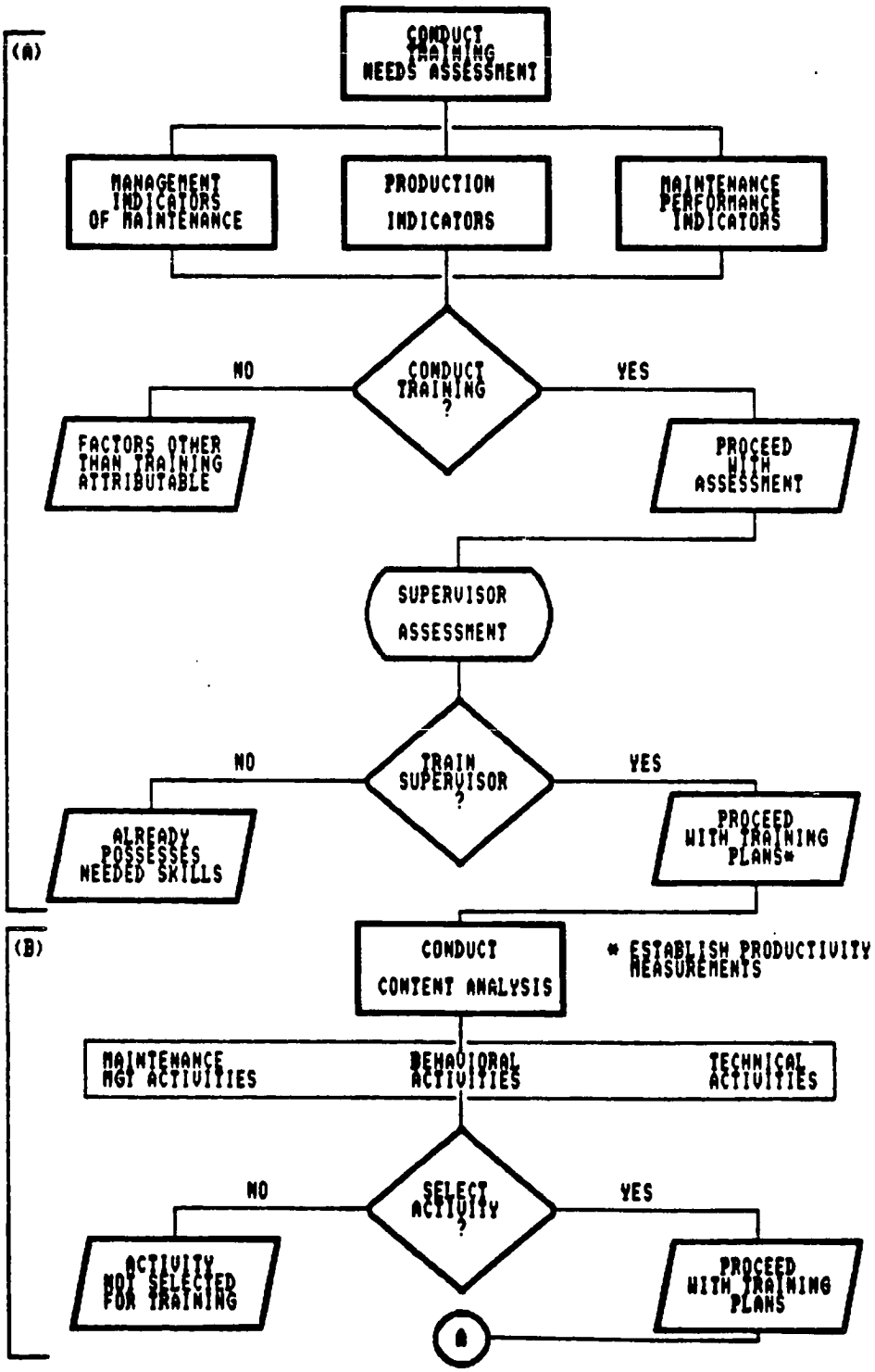
The maintenance supervisor training model is portrayed graphically to illustrate the relationship among the five major model components: (a) needs assessment, (b) content analysis, (c) instructional methodology, (d) instructional design, and (e) evaluation. The letters are used to refer to each major component of the model in the graphic illustration.

Included with the model are the supporting instruments (Appendixes G thru N) to allow the user of the model to assess the training model's potential for improving productivity in the maintenance department through maintenance supervisor training. These instruments are used to facilitate delimitation of needs, content, methodology, logistics, and evaluation.

Needs Assessment

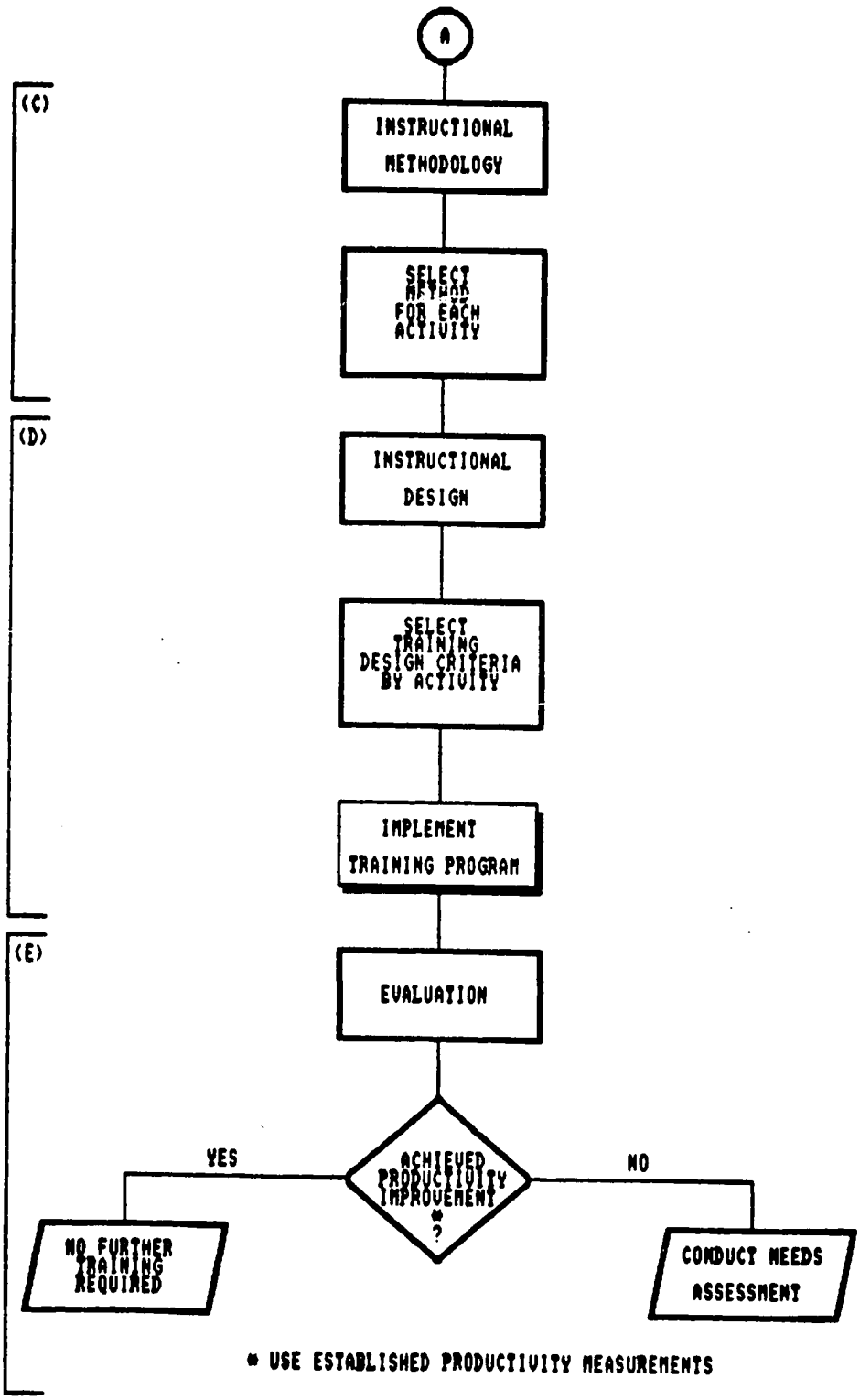
The purpose of needs assessment (Part "A" of the model) was to determine if training maintenance supervisors is a viable solution to improving productivity in the maintenance department. Three instruments are used to conduct a needs assessment for training maintenance supervisors: management perceptions of maintenance (Appendix G), production indicators (Appendix H), and maintenance

Maintenance Supervisor Training Model



(Continued on Next Page)

Maintenance Supervisor Training Model



performance indicators (Appendix I). If productivity problems exist in the maintenance departments, but utilization of the instruments do not indicate that training is a solution, the manager should look at other organizational solutions. These other organizational solutions were beyond the scope of the maintenance supervisor training model.

Management Perceptions of Maintenance

This instrument (Appendix G) was designed for use by the plant manager, or other senior manager, to assess the manager's perception of maintenance department operations. Twelve statements identified different aspects of maintenance operations. The manager could respond to each statement on a scale of one (strongly agree) to seven (strongly disagree). Six statements were designed to support a need for training. Agreement with the other six statements would indicate that training was not required from the manager's perspective. A method of numerical analysis was provided to facilitate making a decision regarding the provision of training.

Production Indicators

This instrument (Appendix H) was designed for use by the production or manufacturing manager to assess the present ability of the maintenance department to support manufacturing and/or assembly operations. Eight statements identified different aspects of maintenance support. The manufacturing manager could respond to each statement on a scale of one (strongly agree) to seven (strongly disagree). Four statements were designed to indicate that maintenance personnel were presently not supporting manufacturing as effectively as expected. Agreement with the other four statements would indicate

that maintenance personnel provided excellent support, and was not the cause of production problems in the plant. A method of numerical analysis was provided to determine if manufacturing management perceived a need for improvement in maintenance operations, including training of maintenance supervisors.

Maintenance Performance Indicators

This instrument (Appendix I) was developed for use by the maintenance manager to assess if the present performance of each maintenance supervisor was adequate. Ten statements identified different aspects of the maintenance supervisor's performance. The maintenance manager could respond to each statement on a scale of one (strongly agree) to seven (strongly disagree). Five statements were designed to indicate that the performance of the maintenance supervisor is adequate. Agreement with the other five statements would indicate that the maintenance supervisor was presently not performing adequately in the position, and may require new or additional training. A method of numerical analysis was provided to determine if the maintenance manager perceived a need for training the maintenance supervisor.

Needs Assessment Analysis

The composite scores on the needs assessment instruments (Appendixes G thru I) were designed to be evaluated by the maintenance manager or the trainer. Where the composite scores of two of the three assessment instruments indicated a need for improvement in maintenance operations, and the maintenance manager or trainer did not perceive that the cause of the need was due to some other

organizational factor, the maintenance manager or trainer would continue to work through the training model.

Supervisor Assessment

This instrument (Appendix J) was developed for use by the maintenance manager or trainer to assess if the supervisor had the education, prior training, or experience required to perform in the position. Eleven statements identified different aspects of prior training or experience. The maintenance manager or trainer could respond to each statement on a scale of one (strongly agree) to seven (strongly disagree). If the composite score of the results was less than 30, the supervisor, most likely, had the knowledge required of the position. If the composite score was 30 or greater, the maintenance supervisor may have never had prior training or experience in the skills required of the position. If the needs assessment instruments indicated a potential need for training, and supervisor assessment instrument indicated the supervisor had not had prior training or experience in supervisory skills, the trainer would proceed through the training model.

Content Analysis

Once the decision was made in needs assessment to develop a maintenance supervisor training program, the content analysis selection (Part "B" of the model) is the next step to be completed in the training model. Using the training content selection instrument (Appendix K), the maintenance manager or trainer, would select those maintenance supervisor activities that have the highest potential for improving productivity in the maintenance department.

The instrument provides a listing of 34 maintenance supervisor activities, and a place to add additional activities should the manager determine a particular need based on the plant's maintenance organization. Each activity was rated between one (high potential for improving productivity) and seven (low potential for improving productivity). The rating for each activity was based on the manager's knowledge of the supervisor and the responses received on the needs assessment instruments (Appendixes G thru J).

Only those activities with the highest potential for productivity improvements were included in the training program. Other factors that the manager must consider were budget and time available to train.

The activities selected were grouped into three categories: technical, employee and organizational behavior, and maintenance management. Grouping like activities together simplified planning and developing the training program.

The manager must also determine what measurements were to be used to evaluate the effectiveness of the training for each activity. These were the same measurements (Appendix N) that were to be used after completion of the training to determine if the training program produced any productivity improvements. Concerns noted on the needs assessment instruments were to be considered in selecting the measurements.

Instructional Methodology

The next process in the training model was to determine the instructional methodology (Part "C" of the training model) for each

activity included in the training program. The trainer would use the instructional methodology selection instrument (Appendix L) to select the method or methods to be used for each activity. The instrument also included recommended methods of training for the three categories of activities based on training research.

Instructional Design

The next process in the training model was to determine the instructional design (Part "D" of the training model) requirements for each of the activities included in the training program. These included: personnel considerations, time considerations, location considerations, and training considerations.

The trainer would use the instructional design logistics instrument (Appendix M) as a check list to insure all logistics requirements had been considered before conducting the training program. Once completed, the training program was conducted.

Evaluation

The last process in the training model was evaluation (Part "E" of the model). The manager or trainer would use the training evaluation instrument (Appendix N) to evaluate the effectiveness of the training. Once the manager had determined that sufficient time has passed after completion of the training to allow the maintenance supervisors to implement the activities learned, the same measurements taken during content analysis would be taken again. The manager evaluated the "before" and "after" measurements to see if the desired improvements had occurred. Where desired productivity improvements had not been attained, the manager should conduct a new needs analysis.

CHAPTER 5

RESULTS

The results include answers to the research questions asked at the beginning of this study. In addition, the results of the validation of the maintenance supervisor training model are provided.

Research Questions

Five research questions were asked at the beginning of the study. The results are based on the review of the literature, the industrial survey, and model validation by the jury of experts.

Question One

What key variables, as identified in the literature, impact the training of maintenance supervisors? There were several key variables that had an impact on the training of maintenance supervisors as identified by the industrial survey and the literature.

First, was industrial managers' perception that a need for training existed. Selection of training was highly dependent on the managers' perception of training overall and the amount invested by the company in training in general. Responses by maintenance managers substantiated that maintenance supervisor training had not been given a high priority based on the current training and education level of maintenance supervisors in the population sample.

Closely associated with the managers' perception of training was the impact that training had on production or assembly operations. From the literature a number of related observations could be made. Production managers could see the effectiveness of maintenance in machine downtime, additional production costs like overtime that were

related to maintenance problems, performance of preventive maintenance, the need for outside maintenance support, and the ability to meet production schedules. This was a key variable to assessing the productivity level of the maintenance department as well as providing evidence of the potential need for training maintenance supervisors.

A third key variable that indicated a potential need for training of maintenance supervisors was the maintenance manager's perception and expertise at recognizing potential problems. This included analysis of the motivation of the maintenance work force, the ability to complete projects within budget and on schedule, the ability to accurately estimate maintenance requirements, an effective and timely preventive maintenance program, the ability to apply the latest technology to predict maintenance problems before they became critical, and the ability to achieve a level of maintenance that could support production within the prescribed budget.

Another key variable related to training maintenance supervisors was the lack of a measurement system to evaluate the effectiveness of training conducted. If the manager paying for the training could not see tangible results, investment in future training was less likely to occur.

The final variable pertained to the low number of maintenance supervisors in an industrial plant, as substantiated by responses to the survey. Where the maintenance manager only had one supervisor over each maintenance department, it was difficult to find the time required to allow that supervisor to train.

Question Two

What maintenance management activities, as identified by the literature and an industrial survey by plant managers, were perceived as contributing to enhanced productivity in the maintenance departments? There were 34 major activities identified (Appendix C).

The responses of maintenance managers in the industrial survey to these 34 activities are provided in Table 5 and Table 6. The scope of 15 of the activities was large enough to require the respondents to more specifically identify what part of the activity was of the most importance to them as it related to maintenance supervisors. The results of these responses are described in Appendix R.

Question Three

What supervisor applications of maintenance activities were defined by industrial managers as being the most appropriate to enhancing productivity in maintenance departments? The responses of maintenance managers to the industrial survey revealed eight maintenance supervisor areas that contributed to enhanced productivity in the maintenance departments based on the criteria established for analyzing the survey results earlier in this study. These were understanding maintenance employee motivation, establishing preventive maintenance programs, technical knowledge of the maintenance crafts, scheduling maintenance activities, planning and estimating maintenance workload, understanding craftsmen job satisfaction, understanding job enrichment, and understanding job enlargement.

Table 5

Contributors To Enhanced Productivity

Item	Activities	Survey Values			
		Mean	Median	Mode	SD
12	Understanding Employee Motivation	2.603	3.0	3	.520
21	Establishing Preventive Maintenance Programs	2.573	3.0	3	.599
16	Technical Knowledge of Crafts	2.548	3.0	3	.554
20	Scheduling Maintenance Activities	2.493	3.0	3	.604
19	Planning and Estimating Maintenance Workload	2.479	3.0	3	.603
13	Understanding Craftsmen Job Satisfaction	2.472	3.0	3	.604
14	Understanding Job Enrichment	2.466	3.0	3	.603
15	Understanding Job Enlargement	2.431	2.5	3	.624

The eight activities with the most potential for improving productivity are listed in Table 5. The item number refers to the industrial survey (Appendix C). Four of the five top activities required training maintenance supervisors using maintenance specific material. This indicated that general supervisory training courses do not target the specific examples most capable of improving the productivity of maintenance organizations. In contrast, the remaining activities to be included in the training model focused on organizational and employee behavioral principles that could be

directed toward the many technical supervisors found in the plant, but did not necessarily require maintenance specific examples.

Standard deviations for the responses received on these activities were between .520 and .624. This indicated consistency in the responses by maintenance managers across the quad state area.

The remainder of the survey activities that did not meet the criteria for inclusion in this training model are listed in Table 6. Individual companies, given specific training requirements, may have a particular need to train on one or more of these activities.

Table 6

Areas Excluded From The Training Model

Item	Activities	Survey Values		
		Mean	Median	Mode
1	Oral Communications With Craftsmen	2.356	2.0	2
17	Guidelines For Training Craftsmen	2.333	2.0	2
2	Oral Communications With Staff and Management	2.329	2.0	2
9	Maintenance Operation Policies	2.324	2.0	2
25	Understanding Organizational and Employee Needs	2.260	2.0	2
18	Maintenance Work Measurement	2.257	2.0	2
26	Understanding Group Behavior At Work	2.233	2.0	2
31	Delegating Responsibility To Craftsmen	2.233	2.0	2

(Table Continues)

Item	Activities	Survey Values		
		Mean	Median	Mode
11	Supervisor Work Ethics	2.222	2.0	2
22	Maintenance Budgeting	2.219	2.0	2
32	Understanding Supervisory Styles	2.192	2.0	2
8	Utilizing Existing Plant Information Systems	2.164	2.0	2
23	Maintenance Material Procurement	2.151	2.0	2
24	Improving Safety Practices	2.151	2.0	2
29	Using Management By Objectives	2.139	2.0	2
6	Plant Discipline Procedures	2.125	2.0	2
5	Plant Industrial Relations Procedures	2.111	2.0	2
34	Utilizing Plant Staff Personnel	2.111	2.0	2
30	Basic Principles Of Management	2.096	2.0	2
10	Understanding Future Organizational Plans	2.055	2.0	2
3	Written Communications With Craftsmen	1.986	2.0	2
7	Understanding The Plant's Organization	1.877	2.0	2
33	Principles Of Time And Motion Study	1.833	2.0	2
28	Understanding Employee Life Work Patterns	1.726	2.0	2
27	Evaluating Labor Turnover	1.616	1.0	1

Instructional design required that the activities be grouped into a logical sequence for training presentation in the industrial

setting. Three such groupings existed in the activities selected by the maintenance managers: employee and organizational behavior activities, maintenance management activities, and maintenance technical activities.

Employee and organizational behavior activities. Four of the eight activities in Table 5, selected by the maintenance managers, were: understanding employee motivation, understanding craftsman job satisfaction, understanding job enrichment, and understanding job enlargement. These activities are related to the area of understanding employee and organizational behavior. Since the majority of the supervisors had only a high school education, it could be expected that the understanding of these behavior theories would be new knowledge.

Maintenance management activities. Three of the eight activities in Table 5, selected for their specific relationship to maintenance department management, were: establishing preventive maintenance programs, scheduling maintenance activities, and planning and estimating maintenance workload. These activities related directly to a supervisor's ability to manage his/her department and complete the administrative requirements of supervising the department. Since supervisors already have an understanding of the activities, and already have developed means of completing them, any change in their manner of activity accomplishment may require a change in attitude. The training approach to activities that have become a normal part of a maintenance supervisor's responsibility required an on-the-job demonstration that an attitude change may have occurred. These

changes could also require a change to organizational policies and practices toward supervision.

Technical activity. One activity selected, technical knowledge of the crafts, required specific types of technical training depending on the manager's needs and the current level of supervisor technical expertise. The technical question on the survey asked maintenance managers to identify those technical areas where they felt their maintenance supervisors lacked technical expertise. The managers were given enough space on the survey to write in up to four technical requirements. There were a total of 80 technical needs identified on 73 survey responses. Two responses were given as multi-craft and one response as a maintenance program. The exact technical nature of these three responses could not be identified. The results of the responses made to this activity on the survey (See Appendix C, Item 41) are shown in Table 7.

Since technical training required the ability of the maintenance supervisor to apply specific knowledge to a technical problem on the job, the method of training selected must clearly illustrate the technical area, provide an opportunity to practice, and transfer the learning to the job situation.

In many cases an industrial plant may not have individuals with the technical expertise for the training required. As a result, manufacturers of the equipment requiring the technical training or outside consultants may be required to provide the training at either the plant location or offsite.

Table 7

Maintenance Supervisor Technical Training Requirements

Technical Area	Responses	Percentage of Total
Electrical Training	28	36
Hydraulics Training	15	19
Mechanical Training	10	13
Heating, Ventilation, and Air Conditioning Training	7	9
Machine Repair Training	3	4
Numerical Control Training	3	4
Construction Training	2	3
Pneumatics Training	2	3
Welding Training	2	3
Other	5	6
Total	77	100

Question Four

What training components were the most appropriate, as perceived by the jury of experts evaluating the model, for training maintenance supervisors in the above identified activities? The five major components of the training model were needs assessment, content analysis, instructional methodology, instructional design, and evaluation. The components were evaluated by the jury of experts, on the validation instrument (Appendix P), as being appropriate for

inclusion in the maintenance supervisor training model. Each component was rated from one (very adequate) to five (very inadequate) with a value of three being adequate. The jury of 13 experts rated all components of the model between adequate and very adequate, and made recommendations or comments on each component. The results of model component evaluation are listed in Table 8.

Table 8

Evaluation Of Model Components By The Jury Of Experts (N = 13)

		Survey Values[a]		
Model Part	Model Component Evaluation	Mean	Median	SD
A	Needs Assessment For Training	2.23	2	.7
A	Supervisor Assessment	1.85	2	.6
B	Content Analysis	2.23	2	.7
C	Instructional Methodology	1.77	1	1.2
D	Instructional Design	1.46	2	.4
E	Evaluation	2.23	2	.4

[a] 1 = Very Adequate; 5 = Very Inadequate

Needs assessment for training. The jury of experts was asked if the needs assessment instruments (Appendixes G thru I) provided an adequate evaluation of training as a potential solution to productivity problems. Several members of the jury of experts made

the comment that the needs assessment instruments had to be used together. One expert noted that the needs assessment instruments needed to address the extent to which maintenance could be a profit center. Another expert stated that the maintenance impact on product quality needed to be considered.

Two jury members noted that plants with the most need for assessing training as a potential solution to productivity problems may not have the maintenance expertise in management to complete the instruments. Two jurors indicated that the needs assessment instruments should be expanded to evaluate factors other than training that could affect productivity. Recommendations for other factors to be included were the attitude of management toward maintenance, and organizational policies and procedures that inhibit further productivity improvements in maintenance.

Supervisor assessment. The jury of experts was asked if the supervisor assessment instrument (Appendix J) provided an adequate evaluation of the current training, experience, and education status of the supervisor. Individual jurors made several comments pertinent to this instrument. A consultant noted that the needs assessment instruments in general attempted to fulfill management's responsibility to know the strengths and weaknesses of each supervisor. Three additional areas that could be included in the supervisor assessment instrument were knowledge of the company policies and procedures, support of maintenance goals, and the supervisor's knowledge of productivity assessment. These are areas, however, that may require training and could be included in the

content analysis component. Finally, one juror noted that there was too much emphasis on education in the instrument for maintenance supervisors. Four jurors specifically stated that the instrument was very pertinent and necessary for needs assessment.

Content analysis. The jury of experts was asked if the major activities in the training content selection instrument (Appendix K) covered a maintenance supervisor's responsibilities. One juror stated that understanding future organizational plans, maintenance budgeting, evaluating labor turnover, and basic principles of time and motion study belonged at the management level and should be excluded. Individual jurors stated that two activities that should be included were an understanding of plant financial systems and union contracts. Five of the jurors noted that the activities provided a comprehensive listing.

Instructional methodology. The jury of experts was asked if the training methodologies (Appendix L) support the training activities. Individual comments made were that seminars and conferences were not exactly the same thing, and the use of videos should be enhanced. One juror was not sure why the recommended codes were used. Not included in the model, however, was the training research that recommended the different methodologies to use depending on the type of subject being trained.

Instructional design. The jury of experts was asked if the course design instrument (Appendix M) covered the major factors that must be considered in training. Areas that could be improved that were noted by individual jury members were: A need to cover

participant involvement and commitment, reasons why maintenance supervisors would want to attend the training, and the need to consider the logistics of the training location where union involvement was required.

Evaluation. The jury of experts was asked if the measurements described in the evaluation instrument (Appendix N) were adequate to evaluate productivity. Additional measurements suggested by individual jurors were: The labor cost trend to install one dollar of material, percentage overtime used, preventive maintenance weekly compliance, percentage of man-hours used on preventive maintenance versus emergency repair and scheduled maintenance, monthly maintenance costs (labor and material) divided by one-twelfth the gross book value of material and equipment plus the monthly plant direct labor cost, and maintenance as a percentage of total burden cost. This wide variety of additional measurements indicated there were no generally established measurements for evaluating productivity in maintenance departments. One juror stated that it has been difficult to equate skills of personnel like maintenance supervisors to overall department performance.

Question Five

To what extent was the developed model supported by industrial managers and model evaluators for training maintenance supervisors? The overall model was evaluated by the jury of experts on the validation instrument (Appendix P). The overall model was rated on whether it contained all the essential elements for a training model, if it provided the users of the model with a logical development of a

training program, and if the model and its instruments would make planning and evaluating a training program easier for the jury of experts. Each of the three parts was rated from one (very adequate) to five (very inadequate) with a value of three being adequate. The jury of 13 experts rated the overall model between adequate and very adequate, and made recommendations or comments. The results of overall model evaluation are listed in Table 9.

Table 9

Evaluation Of Overall Model By The Jury Of Experts (N = 13)

	Survey Values[a]		
Elements Of Overall Model Evaluation	Mean	Median	SD
Contains All Essential Elements	2.23	2	1.0
Provides Logical Development Of Training	1.92	2	1.1
Makes Planning And Evaluating Easier	2.08	2	1.2

[a] 1 = Very Adequate; 5 = Very Indadequate

The jury of experts did not identify any additional components required for the model to be used by industry. Individual comments included that the design was on track to support the objectives, and the user must be knowledgeable of maintenance operations or the model would require more detail. One juror believed the model should emphasize company objectives and customer service more.

Six jurors rated the model as very accurate in providing a logical development of a training program. Only one juror rated the model below adequate. This juror emphasized that the manager using the model must be very knowledgeable about maintenance operations, and the model development process assumed this would be the case.

Eight jurors rated the model above adequate in making planning and evaluating a training program easier. The one juror who rated the model as inadequate stated that the model would only be useful for managers knowledgeable of maintenance operations.

Validation Results

In addition to the results provided under the research questions, the jury of experts was asked four questions on the validation instrument (Appendix P) for the purpose of improving the model and/or the supporting instruments. When asked if they had seen other models that provide this type of training analysis for maintenance supervisors, 10 experts answered "no" and three answered "yes." Those who answered "yes" stated that they had seen similar models, but they were in a modified and less structured format.

Twelve of the 13 experts stated that they would use this model in industry. One maintenance manager on the jury applied the model to a maintenance department and concluded that training could help one of his maintenance supervisors. The expert who disagreed was a consultant who stated that he preferred to know the strengths and weaknesses of the supervisors, and not use a model to evaluate training. Two other comments indicated that application of the model

depended on the managers' ability to motivate supervisors to train, and their willingness to track the results of the training.

The jury was unanimous in agreeing that this type of model had other applications in industry. Applications suggested were for: manufacturing supervisors, material handling supervisors, safety, problem solving training, new plant start-up, and integration of new technologies in manufacturing. One consultant suggested that this type of model would be appropriate in comparing companies.

The last question asked the jurors if implementation of this model could result in productivity improvements. Twelve jurors responded "yes" and one "no." The expert who responded "no" did not provide any comment, but had previously stated that it was more important to know the supervisors well.

The jury of experts was also asked to make recommendations for model improvement. For the training content component, two jurors recommended including maintenance quality control. A recommendation was also made to seek input from supervisors on training content when that part of the model was being developed. Supervisors should have a better understanding of the principles of change according to one expert.

Prior to training, one expert believed that the logistics design instrument should include a plan for selling the training. In addition, the training plan itself must include a section on "what is" and "what is not" productive maintenance.

As mentioned previously, one juror believed that the model should be expanded to include a component on factors other than training that

would affect productivity. This component should explore areas like inadequate information systems and poor management above the supervisor level.

One juror believed the model could be enhanced by defining more closely how individual supervisor training impacts the maintenance department as a whole. This expert wanted the model personalized more to an individual supervisor.

At the beginning of the model, one expert believed that maintenance should be explained as a multi-functional discipline. Before applying the model, the user should have a thorough understanding of the relationship of maintenance to the other plant disciplines.

There were no recommendations made by the majority of the jury of experts to delete or add any components to the model. Likewise, there were no recommendations made by the majority to change any of the instruments. The individual recommendations provided were mainly enhancements to the various instruments used in the model and how managers should approach use of the model.

CHAPTER 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to develop a maintenance supervisor training model for use in industry to improve productivity in maintenance departments. A maintenance supervisor training model was developed and validated using a jury of experts in maintenance and training.

Summary

A maintenance supervisor training model was developed that incorporated five major components: needs assessment, content analysis, instructional methodology, instructional design, and evaluation. A number of instruments (Appendixes G thru N) were developed to allow the managers and trainers using the model to work through each of the major components. The design of the training model was based on other successful models in use. Surveys were used to obtain industrial input to model development by maintenance managers, and to validate the completed model.

Conclusions

Six major conclusions can be made as the result of this study. These are:

1. Ample evidence was found to indicate a need for improving productivity in maintenance departments. As a major function in manufacturing plants, maintenance was found to be lagging behind other functions in achieving productivity improvements. At the same time, the skills required to supervise a maintenance department are increasing due to automation of manufacturing operations, automation

of information processing systems, and new technologies available to the maintenance function to support manufacturing.

2. Most maintenance supervisors are promoted into their positions from the craft areas, and often do not have the skills required to function effectively as supervisors. Maintenance manager responses to the industrial survey (Appendix C) provided a number of supervisor activities where training had the potential to improve productivity in the maintenance departments. In addition, over the past three years, there were no articles or studies documented in the maintenance publications concerning supervisor training.

The majority of maintenance supervisors in the population sample received no training after being assigned to their positions. Where supervisory training courses were conducted, they did not provide training specific to maintenance operations. Although the responsibilities for other supervisors in industry are almost the same as those identified in the maintenance supervisor training model, the application of the activities are unique due to the technology applied and the support role of the maintenance function to the manufacturing organization. For these reasons, maintenance managers most often promote supervisors from within the maintenance organization to allow some skill transfer, and seldom use general supervisory courses to train maintenance supervisors.

3. There are no generally recognized measures to analyze productivity in maintenance departments. The evaluation instrument (Appendix N) provided 11 measures of productivity for maintenance departments. An additional six measurements for measuring

productivity were provided by the jury of experts on the validation instrument (Appendix P).

4. The design of the training model for maintenance supervisors was not unique. The same major components used in this training model have been applicable to a number of other models developed. When asked if this model had other applications in industry (Appendix P), the jury of experts provided several additional recommended uses outside of the maintenance function.

5. Application of this training model to maintenance supervisors was unique. Ten of the 13 experts on the validation instrument (Appendix P) stated that they had not seen a model like this developed previously and 12 of the experts endorsed the use of this model in industry. The three experts who indicated that they had seen a previous model, stated that the other models were in modified and less structured formats. Due to the limited availability of existing training programs in industry for maintenance supervisors, the structured format and logical sequence of development would be essential for managers and trainers designing a maintenance supervisor training program for the first time.

6. The jury of experts, on the validation instrument (Appendix P), validated the training model and its major components. The instructional design logistics instrument (Appendix M) was rated by the jury as very adequate. The other instruments were rated between very adequate and adequate.

Only one of the 13 experts stated that use of the model would not provide a potential for improving productivity in the maintenance

departments. Since changes to the model would only be made if a majority of the jury of experts recommended a change to the model or its supporting instruments, no changes were made based on model validation (Appendix P).

There were three basic criticisms of the model by three members of the jury of experts. These jurors thought that too much effort was required to work through the model to arrive at a training program capable of producing a productivity improvement. In addition, these jurors believed that needs assessment needed to be expanded to include an assessment of factors other than training that might be responsible for not achieving a higher level of productivity in maintenance. Third, two consultants believed that understanding the strengths and weaknesses of the maintenance supervisors would eliminate the need to work through a model. The other 11 experts, however, supported the model.

The majority of the jury of experts noted one major strength (Appendix P) of the training model. The model provided a structured approach to evaluate a need for training as well as a means to evaluate the success of the training program. The structured approach could prevent many of the failures of past training efforts to achieve tangible results.

Recommendations

As the result of data presented in this study and the experience of developing and validating the model, several recommendations can be made. These are:

1. The jury of experts validated the model and its components. The model, however, needs to be applied in industry. By evaluating a number of applications of the model, components can be tested, training programs developed, and the evaluation capability of the model improved. Additional applications of this model could be developed for different areas as recommended by the jury of experts. The results of this additional research would be a structured approach to training that provides industrial managers with tangible results and more competence to continue investing in training.

2. A number of executives in manufacturing organizations have been searching for productivity specialists as evidenced by advertisements to fill these types of positions. A number of experts during validation of this model were concerned that the user of the model have a solid maintenance background. At the same time, experts in industry were concerned about the time required to work through the model. One expert specifically stated that the users of the model needed training on how to use models. It is recommended that this model be applied by a team of managerial, maintenance, and training personnel.

As a specialization field in productivity begins to develop, these personnel will need structures like this model to evaluate the ability of training as well as other factors for achieving improved productivity goals. The use of structured training models to improve productivity could become an integral function of the productivity discipline. More research, however, is needed to further define the relationships between training of specialty groups like maintenance

supervisors and improved productivity in the departments that they represent. This includes improved methodologies for defining the most effective means to improve productivity.

3. Finally, a number of measurements were provided to determine if productivity had improved after a training program had been completed. Those defined in the evaluation instrument as well as the additional measurements provided by the jury of experts indicated that there is no consistent, agreed upon, measurement for evaluating productivity in maintenance departments. Additional research is needed to begin developing a recognized norm for measuring maintenance productivity. This norm would provide maintenance managers and consultants with a basis for determining productivity improvement potential and what is required to achieve this potential.

References

Ainsworth, J. (1981, October). Criterion referenced instruction, United Stated Army--1967-1981--an update. Performance and Instruction, 20, 15-16.

American Society for Training and Development (ASTD). (1983). Models for excellence. Washington, D.C.: Author.

Anderson, R., & Anderson, K. (1982, March). HRD in "Z" type companies. Training and Development Journal, 36, 14-23.

Blake, R., & Mouton, J. S. (1978, April). Should you teach there's only one best way to manage? Training, 15, 24-25, 28-29.

Broadwell, M. M. (1978). The supervisor as an instructor. Reading, MA: Addison-Wesley Publishing Company.

Bullock, J. H. (1979). Maintenance planning and control. New York: National Association of Accountants.

Byham, W. C. (1977, April). Changing supervisory and managerial behavior: Part 1, problems with conventional training. Training and Development Journal, 31, 3-6.

Byham, W. C. (1982, January). Applying a systems approach to personnel activities. Training and Development Journal, 36, 70-71, 73-75.

Carney, C. G., & Kahn, K. B. (1984). Building competencies for effective cross-cultural counseling: A developmental view. Counseling Psychologist, 12, 111-119.

Cascio, W. F. (1982). Applied psychology in personnel management (2nd ed.). Reston, VA: Reston Publishing Company, Inc.

Cathey, P. (1983, January 21). Industry's man in the middle. Iron Age, pp. 36-39.

Crumb, C. V. (1981, September). Performance-based line supervisor training. Training and Development Journal, 35, 44-47.

Deming, B. S. (1982). Evaluating job related training. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Eschner, L. F. (1963). Developing maintenance managers. In E. J. Miller & J. W. Blood (Ed.), Modern maintenance management (pp. 41-66). New York: American Management Association.

Galosy, J. R. (1983, January). Curriculum design for management training. Training and Development Journal, 37, 48-51.

Gane, C. (1972). Managing the training function. Beverly Hills, CA: Davlin Publications, Inc.

Gay G. (1980). Conceptual models of the curriculum-planning process. In A. W. Foshay (Ed.), Considered action for curriculum development (pp. 120-143). Alexandria, VA: Association for Supervision and Curriculum Development.

George C. S., Jr. (1982). Supervision in action (3rd. ed.). Reston, VA: Reston Publishing Company

Germany, P. J., & Von Bergen, C. W., Jr. (1980, November). How to determine the training needs of your supervisors when they're spread across the map. Training, 17, 55-57.

Gold, L. (1981, September). Job instruction: Four steps to success. Training and Development Journal, 35, 28-32.

Gradon, F. (1973). Maintenance engineering. New York: John Wiley & Sons.

Hanna, G. T. (1976). Reducing the cost of maintenance. Pittsburgh, PA: Technical Publishing Company.

Heintzelman, J. E. (1981). The complete handbook of maintenance management. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Herbaty, F. (1983). Cost-effective maintenance management. Park Ridge, NJ: Noyes Publications.

Hill, T. C. (1984, December). Technical training: Finding money on the factory floor. Training, 21, 81-90.

Horn, P. (1986, November 26. Why train? Plant Engineering, 40, 62-64.

Hunkins, F. P. (1980). Curriculum development: Program improvement. Columbus, OH: Charles E. Merrill Publishing Company.

Hurley, P. G. (Ed.). (1983, March). Supervisory development: Where the rubber meets the road. Training and Development Journal, 37, 11.

Husband, T. M. (1976). Maintenance management and terotechnology. Westmead, Farnborough, Hants., England: Saxon House.

Iowa Development Commission. (1983). Directory of Iowa manufacturers. Des Moines, IA: Author.

Jackson, J. H., & Keaveny, T. J. (1980). Successful supervision. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Johnson, M., Jr. (1977). Definitions and models in curriculum theory. In A. A. Bellack & H. M. Kliebard (Ed.), Curriculum and evaluation (pp. 3-19). Berkley, CA: McCutchan Publishing Corp.

Johnson, R. R. (1982). The maintenance supervisor selection process. Unpublished survey, Cedar Falls, IA: University of Northern Iowa.

Karp, H. B. (1981, August). Executive development for first-line supervisors. Training, 18, 95, 98.

Katzel, J. (Ed.) (1982, February 4). Accept responsibility for the future now or face the consequences. Plant Engineering, pp. 42-48.

Kaufman, R., & Sample, J. (1986, March). Defining functional competencies for training and performance development. Educational Technology, 26(3), 16-21.

Kelly, A., & Harris, M. J. (1978). Management of industrial maintenance. Boston: Newnes-Butterworths.

Kirkpatrick, D. L. (1977, February). Determining training needs: Four simple and effective approaches. Training and Development Journal, 31, 22-25.

Kirkpatrick, D. L. (1978a, May). Determining supervisory training needs and setting objectives. Training and Development Journal, 32, 16-19.

Kirkpatrick, D. L. (1978b, June). Developing an in-house program. Training and Development Journal, 32, 40-43.

Kirkpatrick, D. L. (1978c, September). Evaluating in-house training programs. Training and Development Journal, 32, 6-9.

Lane, R. E. (1979). Administering and controlling plant operations. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Lee, C. (Ed.). (1983, August). Congoleum Corp: Training for productivity. Training, 20, 49-52.

Lee, C. (Ed.). (1984, October). Who, what, and where. Training, 21, 39-47.

Leithwood, K. A. (1982). Implementing curriculum innovations. In K. A. Leithwood (Ed.), Studies in curriculum decision making (p. 252). Toronto, Ontario: Ontario Institute for Studies in Education.

Lynch, R. M., & Williamson, R. W. (1976). Accounting for management (2nd ed.). New York: McGraw-Hill Book Co.

Mann, L. W. (1983). Maintenance management (Rev. ed.). Lexington, MA: Lexington Books.

Manufacturers' News, Inc. (1983). Illinois manufacturers directory. Chicago, IL: Author.

Martelli, J. T. (1981, November). The relationship between management training and other predictor variables and managerial performance among selected industrial first-line supervisors. Cedar Falls, IA: University of Northern Iowa Doctoral Dissertation.

McKenna, D. D., Svenson, R. A., Wallace, K. M., & Wallace, G. (1984, September). How to build a training structure that won't keep burning down. Training, 21, 77-83.

McLagan, P. A., & Bedrick, D. (1983, June). Models for excellence: The results of the ASTD training and development competency study. Training and Development Journal, 37(6), 10-20.

Michalak, D. F. (1981, May). The neglected half of training. Training and Development Journal, 35, 22-28.

Miller, E. J., & Blood, J. W. (Ed.). (1963). Modern maintenance management. New York: American Management Association.

Mirabile, R. J. (1985, April). A model for competency-based career development. Personnel, 62(4), 30-38.

Murphy, J. A. (Ed.). (1980). Plant engineering management (2nd ed.). Dearborn, MI: Society of Manufacturing Engineers.

Nelson Marketing Services, Inc. (1982). Minnesota directory of manufacturers. Minneapolis, MN: Author.

Noel, K. L., & Hewlett, B. (1981, September). Plying your craft: Instructional development and the use of heuristics. Performance and Instruction, 20(7), 15-18.

Oliver, A. I. (1978). Maximizing minicourses. New York: Teachers College Press.

Steele, T. T., & Chapman, R. L. (1987, August 13). Designing a maintenance training program. Plant Engineering, 41, 52-55.

Pfeiffer, J. D., & Ballew, A. C. (1988). Using lecturettes, theory, and models in human resource development. San Diego, CA: University Associates, Inc.

Phillips, J. J. (1978, August). How to improve management support for supervisory training programs. Training and Development Journal, 32, 23-30.

Piper, J. (1982, April 15). Selecting a maintenance training medium. Plant Engineering, 81-84.

Piper, J. (1987, June 18). Training for advanced technology. Plant Engineering, 41, 114-118.

Pratt, D. (1980). Curriculum design and development. New York: Harcourt Brace Jovanovich, Inc.

Pritsker, A. A. B. (1986). Introduction to stimulation and SLAM II. West Lafayette, IN: Systems Publishing Corporation.

Prokopenko, J., & Bittel, L. R. (1981, February). A modular course format for supervisory development. Training and Development Journal, 35, 14-22.

Ramsey, J. F., & Bittel, L. R. (1983, March). New dimensions for supervisory training and development. Training and Development Journal, 37, 12-20.

Ribler, R. I. (1983). Training development guide. Reston, VA: Reston Publishing Company.

Robinson, J. C., & Robinson, L. E. (1979, September). How to make sure your supervisors do on-the-job what you taught them in the classroom. Training, 16, 21-26.

Rogoff, R. C. (1984, April). The training wheel: A simple model for instructional design. Training, 21, 63-64.

Rosenbaum, B. L. (1979, August). Common misconceptions about behavior modeling and supervisory skill development (SST). Training and Development Journal, 33, 40-44.

Roth, R. A. (1981). How to conduct surveys, follow-up studies, and basic data collection in evaluation studies. Washington, D.C.: University Press of America, Inc.

Salinger, R. D. (1975, February). Why training fails. Training, 12, 26-33.

Sartain, A. Q., & Baker, A. W. (1978). The supervisor and the job (3rd ed.). New York: McGraw-Hill Book Company.

Shea, G. F. (1982, January). Supervising new employees. Training and Development Journal, 36, 50-56.

Smith, J. (1982, March). A trainer's guide to successful productivity improvement planning. Training, 19, 41-44.

Smith, L. J. (1980, June 26). Training maintenance supervisors. Plant Engineering, 101.

Stark, S. L. (1978). Conducting community surveys (3rd. ed.). Midland, MI: Pendell Publishing Company.

Steimetz, L. L., & Todd, H. R., Jr. (1979). First-line management. Dallas, TX: Business Publications, Inc.

Survey finds few firms evaluate productivity of maintenance work. (1982, January). Industrial Engineering, 7.

Tauber, M. S. (1981, September). Supervisory skill development. Training and Development Journal, 35, 49-54.

Technical Staff. (1986, March 13). Total productive maintenance. Plant Engineering, 40, 119-123.

Terry, G. R. (1978). Supervision (Rev. ed.). Homewood, IL: Richard D. Irwin, Inc.

Vaught, B. C., Hoy, F., & Buchanan, W. W. (1985). Employee development programs. Westport, CT: Quorum books.

Ward, L. D. (1983, November). Warm fuzzies vs. hard facts: Four styles of adult learning. Training, 20, 31-33.

West, L. J. (1977). Design and conduct of educational surveys and experiments. Delta Pi Epsilon Service Bulletin No. 2, New York: The City University of New York.

Westerkamp, T. A. (1986, December 24). How to test maintenance productivity. Plant Engineering, 40, 68-71.

White, M. R. (1987, Summer/Fall). Team building: A management technology improving productivity. The Journal of Epsilon Pi Tau, 13(2), 4-10.

Wisconsin Association of Manufacturers and Commerce. (1982). Classified directory of Wisconsin manufacturers. Milwaukee, WI: Author.

Worthen, B. R., & Sanders, J. R. (1973). Educational evaluation: Theory and practice. Belmont, CA: Wadsworth Publishing Company.

Zais, R. S. (1976). Curriculum principles and foundations. New York: Harper & Row Publishers, Inc.

Zenger, J. (1988, April). Supervisors today: Strategic to success. Automation, 23-26.

APPENDIXES

APPENDIX A

Research Budget

Administrative Supplies (Paper, Envelopes, Etc.)	$200
Postage For Surveys	90
Postage For Mailing Dissertation to Committee Members	140
Dissertation Typing And Preparation	530
Travel Expenses	2,450
Telephone Expense	80
Total Dissertation Cost . .	$3,490

Appendix B

Survey Letter of Introduction

University of Northern Iowa
Cedar Falls, Iowa 50614
Date

Dear Sir:

I am a doctoral student in the Department of Industrial Technology at the University of Northern Iowa. I have also worked for a number of years as a maintenance supervisor in private industry and the military. I plan to use my industrial experience and education to develop and manage a futuristic-oriented productivity system in an industrial maintenance area.

Recent publications on industrial maintenance organizations in American industry have revealed that maintenance provides one of the poorest returns on each dollar invested, and some maintenance experts believe that the potential exists in most plants for a 40 to 50 percent productivity improvement. Few plants have initiated any specific training program for maintenance supervisors despite the evidence that programs implemented have resulted in improved morale and productivity improvements of up to twenty percent in maintenance operations.

I am designing a model training program for first level maintenance supervisors and foremen that will allow industrial organizations to develop their own in-house training program to achieve a twenty percent or more productivity improvement in maintenance. Based on a review of recent maintenance publications most of the tasks considered to be important can be found on the enclosed survey. To assure that these are the appropriate tasks to be trained, a number of knowledgeable managers are being asked to complete the survey. An executive in your organization has identified you as the most capable manager to complete the survey. All data will be kept strictly confidential. The self-addressed envelope is provided for your convenience in returning the survey.

I hope you are interested in this important area, and I will look forward to receiving the complete survey in the near future.

Sincerely,

Robert R. Johnson

Appendix C

Maintenance Supervisor Training Survey

The purpose of this survey is to collect data from maintenance managers on particular tasks that they would include in a maintenance supervisor training course. The major goal in training maintenance supervisors on these particular tasks is to improve productivity in the maintenance departments.

Organizational Data

Please check the response that best describes your organization.

1. The total number of personnel in your entire organization is:

   A. Up to 499 _____
   B. 500-999 _____
   C. 1000 or more _____

2. How many maintenance supervisors or foremen are in your organization?

   A. 1 to 5 _____
   B. 6 to 10 _____
   C. 11 to 20 _____
   D. 21 or more _____

3. The general level of education of the majority of your maintenance supervisors is:

   A. High School Diploma _____
   B. Technical Diploma _____
   C. College Degree _____

4. Your company's maintenance supervisor training program now consists of:

   A. On-the-job training only _____
   B. General supervisor training course _____
   C. Specific course for maintenance _____

5. Who now conducts maintenance supervisor training at your company?

   A. Personnel from the training department _____
   B. Maintenance Engineering _____
   C. The General Supervisor or Manager _____
   D. Other: _____ _____
   E. No training is conducted _____

Directions

Regardless of how efficient or productive you consider your maintenance departments to be at the present time, rate how you think a good training program for maintenance supervisors in the following tasks would impact on your plant's maintenance operation. Please check your response.

Significant improvement in productivity could result.

Some improvement in productivity could result.

No improvement in productivity.

Effective training in the following activities	Significant	Some	No
1. Oral communications with craftsmen.	__	__	__
2. Oral communications with staff & management.	__	__	__
3. Written communications with craftsmen.	__	__	__
4. Written communications with staff & management.	__	__	__
5. Plant industrial relations procedures.	__	__	__
6. Plant discipline procedures.	__	__	__
7. Understanding the plant's organizational structure.	__	__	__
8. Utilizing existing plant information systems.	__	__	__
9. Maintenance operation policies.	__	__	__
10. Understanding future organizational plans.	__	__	__
11. Supervisor work ethics.	__	__	__
12. Understanding employee motivation.	__	__	__
13. Understanding craftsmen job satisfaction.	__	__	__
14. Understanding job enrichment (make work more meaningful).	__	__	__
15. Understanding job enlargement (allow more tasks to be done by craftsmen).	__	__	__
16. Technical knowledge of crafts (i.e. welding, plumbing, electrical, etc.)	__	__	__
17. Guidelines for training craftsmen on the job.	__	__	__

Effective training in the following activities	Significance	Some	No
18. Maintenance work measurement.	—	—	—
19. Planning and estimating maintenance workload.	—	—	—
20. Scheduling maintenance activities.	—	—	—
21. Establishing preventive maintenance programs.	—	—	—
22. Maintenance budgeting.	—	—	—
23. Maintenance material procurement.	—	—	—
24. Improving safety practices.	—	—	—
25. Understanding organizational and employee needs.	—	—	—
26. Understanding group behavior at work.	—	—	—
27. Evaluating labor turnover.	—	—	—
28. Understanding lifework patterns of employees.	—	—	—
29. Using management by objectives.	—	—	—
30. Basic principles of management.	—	—	—
31. Delegating responsibility to craftsmen.	—	—	—
32. Understanding supervisory styles.	—	—	—
33. Basic principles of time and motion study.	—	—	—
34. Utilizing plant staff personnel.	—	—	—
35. Other: _____	—	—	—
Other: _____	—	—	—

If you were able to offer only one class in each of the following tasks under each question, check the one task that you consider most appropriate for your maintenance supervisors in helping them improve productivity.

36. Oral communications.

A. Use of the telephone _____
B. Making presentations _____
C. Clear and concise speech _____
D. Giving directions _____

37. Written communications.

A. Spelling and grammar _____
B. Company forms _____
C. Writing reports _____
D. Writing work orders _____

38. Industrial relations.

A. Knowing the rules _____
B. Communicating problems _____
C. Handling situations _____
D. Other: _____ _____

39. Discipline.

A. Knowing the rules _____
B. Knowing when to act _____
C. Handling employees _____
D. Other: _____ _____

40. Supervisor work ethics.

A. Standards of conduct _____
B. Compliance to rules _____
C. Setting an example _____
D. Other: _____ _____

41. Technical knowledge (Areas).

A. _____
B. _____
C. _____
D. _____

42. Maintenance work measurement.

A. Establish standards _____
B. Time and motion study _____
C. Using standards _____
D. Other: _____ _____

43. Controlling activities.

A. Scheduling work _____
B. Preventive maintenance _____
C. Planning & estimating _____
D. Other: _____ _____

44. Work improvement.

A. Make tasks meaningful _____
B. Understand motivation _____
C. More job satisfaction _____
D. Increase scope of work _____

45. Related maintenance activities.

A. Budgeting _____
B. Safety procedures _____
C. Material procurement _____
D. Other: _____ _____

46. Plant operations knowledge.

A. Information systems _____
B. Organization structure _____
C. Maintenance policies _____
D. Future plant plans _____

47. Training craftsmen.

A. Define needs _____
B. Existing programs _____
C. Creating a program _____
D. Other: _____ _____

48. Human behavior.

A. Employee/company needs _____
B. Career patterns _____
C. Group work behavior _____
D. Labor turnover _____

49. Supervisory functions.

A. Styles of supervisors _____
B. Setting goals _____
C. Delegating _____
D. Other: _____ _____

50. Basic management.

A. Principles of management _____
B. Corporate policies _____
C. Utilize staff more _____
D. Other: _____ _____

Thank you for completing the survey. Please return in the enclosed envelope to: Department of Industrial Technology
ATTN: Robert R. Johnson
University of Northern Iowa
Cedar Falls, IA 50614

Appendix D

Letter of Introduction

University of Northern Iowa
Cedar Falls, Iowa 50614
Date

Dear Sir:

I am a doctoral student in the Department of Industrial Technology at the University of Northern Iowa. I have also worked for a number of years as a maintenance supervisor in private industry and the military. I plan to use my industrial experience and education to develop and manage a futuristic-oriented productivity system for an industrial firm.

Recent publications on industrial maintenance organizations in American industry have revealed that maintenance provides one of the poorest returns on each dollar invested, and some maintenance experts believe that the potential exists in most plants for a 40 to 50 percent productivity improvement. Few plants have initiated any specific training program for maintenance supervisors despite the evidence that programs implemented have resulted in improved morale and productivity improvements of up to twenty percent in maintenance operations.

I am designing a model training program for first level maintenance supervisors and foremen that will allow industrial organizations to develop their own in-house training program to achieve significant productivity improvements in maintenance. To assure that the training model includes the most appropriate tasks, a number of maintenance managers will be asked to complete a survey that will take about ten minutes. All data will be kept strictly confidential. In the space below will you please provide the name and address of the maintenance manager to whom the survey is to be sent. A self-addressed envelope is provided for your convenience. I hope you are interested in this important area, and I will look forward to receiving the completed information by 16 July 1984.

Sincerely,

Robert R. Johnson

Name: _____

Address: _____

_____

Appendix E

Follow-Up Letter

University of Northern Iowa
Cedar Falls, IA 50614
Date

Dear Sir:

Approximately three weeks ago I sent a survey to you to define the most important work tasks performed by maintenance supervisors that will contribute to improved productivity in the maintenance departments. Your valued input will be used to develop a training model for maintenance supervisors. From this model, industries will be able to develop maintenance supervisor training programs based on the organization's needs and current level of training.

To date, I have not received the completed survey from you. The survey only takes a few minutes to complete and I am providing a self-addressed envelope for your convenience. Again, I assure you that any specific data you provide will be kept strictly confidential.

Data received from other maintenance managers is providing valuable insight into the training needs of maintenance supervisors. Since maintenance experts today are indicating that significant productivity improvements can be made in maintenance and past research has demonstrated that proper training does translate to improved productivity, the results of this survey should be of considerable interest to managers like yourself.

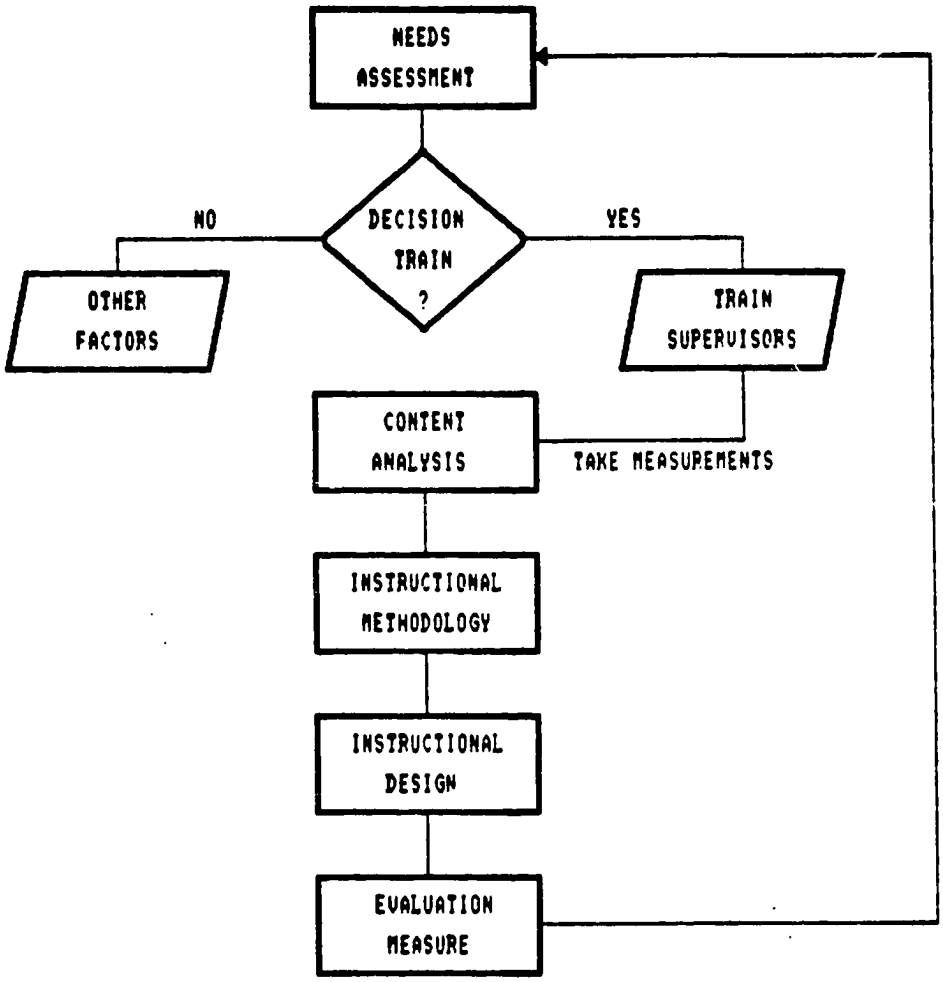
As a professional in maintenance management, I appreciate your concern for improving maintenance operations and thank you for your participation in this survey. I look forward to receiving the completed survey from you in the near future.

Sincerely,

Robert R. Johnson

Appendix F

Maintenance Supervisor Training Model



Appendix G

Needs Assessment Instrument
Management Perceptions of Maintenance

Directions: Have the plant manager assess the maintenance department on the following activities. Circle the number most applicable.

	Strongly Agree						Strongly Disagree
1. Company management believes that an effective maintenance program contributes to the bottom line profit of the company.	1	2	3	4	5	6	7
2. Management invests in training for various activities (need not be maintenance) in the plant.	1	2	3	4	5	6	7
3. Management believes that there is an adequate number of maintenance personnel for the plant.	1	2	3	4	5	6	7
4. Management believes that the maintenance organizational structure is designed properly.	1	2	3	4	5	6	7
5. Management respects the skills of the personnel in the maintenance department.	1	2	3	4	5	6	7
6. Maintenance personnel are respected as contributing, helpful members of the company.	1	2	3	4	5	6	7
7. Production problems do not appear to be due to a lack of maintenance skills.	1	2	3	4	5	6	7
8. It appears that only the number of technicians required are assigned to a job.	1	2	3	4	5	6	7
9. Maintenance supervisors appear to be well organized and have work well planned.	1	2	3	4	5	6	7
10. There always seems to be some crisis in maintenance with a machine or system down.	1	2	3	4	5	6	7

	Strongly Agree			Agree			Strongly Disagree
11. Production supervisors are very supportive of the maintenance supervisors and respect them.	1	2	3	4	5	6	7
12. The maintenance department is able to operate effectively within its budget.	1	2	3	4	5	6	7

Total for questions 1, 2, 3, 4, 10, and 11 _____ (A)

Total for questions 5, 6, 7, 8, 9, and 12 _____ (B) If the (A) score is equal to or greater than the (B) score, training should be considered.

Appendix H

Needs Assessment Instrument
Production Indicators

Directions: Have the manufacturing or production manager assess your maintenance department and maintenance activities on the following items. Circle the number most applicable.

	Strongly Agree			Agree			Strongly Disagree
1. More machines and systems always seem to be down than the maintenance department can repair.	1	2	3	4	5	6	7
2. Maintenance personnel often leave machines down for several days or more waiting for repair parts.	1	2	3	4	5	6	7
3. Maintenance personnel perform regular preventive maintenance on machines and equipment.	1	2	3	4	5	6	7
4. The maintenance supervisor usually is able to meet the repair schedules he/she plans.	1	2	3	4	5	6	7
5. Maintenance personnel appear to be able to rapidly diagnose problems on machines and equipment.	1	2	3	4	5	6	7
6. The same machines and equipment seem to continually break down.	1	2	3	4	5	6	7
7. Production very seldom must work over time or make schedule changes due to maintenance problems.	1	2	3	4	5	6	7
8. Maintenance depends to a large extent on outside professional personnel to repair machines and equipment.	1	2	3	4	5	6	7

Total of questions 1, 2, 6, and 8 = _____ (A) points.

Total questions 3, 4, 5, and 7 = _____ (B) points.

If the (A) point total is equal to or greater than the (B) point total, problems can most likely be solved with training.

Appendix I

Needs Assessment Instrument
Maintenance Performance Indicators

Directions: Have the maintenance manager assess the maintenance department on the following. Circle the number most applicable.

	Strongly Agree						Strongly Disagree
1. Maintenance supervisors prepare daily schedules of work to be completed.	1	2	3	4	5	6	7
2. Maintenance supervisors have preventive maintenance and lubrication schedules that are followed on machinery and equipment.	1	2	3	4	5	6	7
3. Maintenance personnel use infrared detection, vibration analysis, laser alignment, or other techniques for early detection of potential problems.	1	2	3	4	5	6	7
4. Supervisors communicate maintenance requirements and problems to management in a timely and effective manner.	1	2	3	4	5	6	7
5. Maintenance personnel do not have necessary repair parts in stock or readily available most of the time.	1	2	3	4	5	6	7
6. Maintenance supervisors are seldom able to support plant requirements within their budgets.	1	2	3	4	5	6	7
7. Turnover of maintenance employees is high.	1	2	3	4	5	6	7
8. Maintenance employees do not appear motivated and complain regularly about their jobs or supervisors.	1	2	3	4	5	6	7
9. Maintenance supervisors are not able to make realistic time or cost estimates on most projects or major repair requirements.	1	2	3	4	5	6	7
10. Maintenance supervisors have problems maintaining technically qualified personnel to support the plant.	1	2	3	4	5	6	7

Total of questions 1, 2, 3, 4, and 5 = _____ (A) points.

Total of questions 6, 7, 8, 9, and 10 = _____ (B) points.

If the total (B) point total is equal to or greater than the (A) point total, training may be a solution to problems.

Appendix J

Supervisor Assessment Instrument

Directions: Have the maintenance manager evaluate the current training, experience, and education of the supervisor. Circle the number most applicable.

Name of Supervisor: _____

	Strongly Agree						Strongly Disagree
1. Supervisor has no prior work experience in the area over which he/she supervises.	1	2	3	4	5	6	7
2. Supervisor has been given specific training in maintenance supervisory activities.	1	2	3	4	5	6	7
3. Supervisor has in-house technical training in the areas of his/her responsibility.	1	2	3	4	5	6	7
4. Supervisor has a college/university degree.	1	2	3	4	5	6	7
5. Supervisor has completed a general supervision program of instruction.	1	2	3	4	5	6	7
6. Supervisor has a high school education or less.	1	2	3	4	5	6	7
7. Supervisor has attended seminars specific to his/her maintenance responsibilities.	1	2	3	4	5	6	7
8. Supervisor has a strong educational background but limited work experience.	1	2	3	4	5	6	7
9. Supervisor has a technical diploma from a trade or technical school related to his/her responsibilities.	1	2	3	4	5	6	7
10. Supervisor has adequate work experience in maintenance but limited education.	1	2	3	4	5	6	7
11. Supervisor has an excellent educational and an excellent work experience background.	1	2	3	4	5	6	7

Sum of numbers circled = _____

If the sum is less than 30, training may not be required. If the sum is equal to or greater than 30, training may be beneficial.

Appendix K

Assessment Of
Training Content Selection Instrument

Directions: Evaluate the content associated with maintenance supervision based on how training could improve productivity in the maintenance departments. Circle the most appropriate response.

		Productivity High						Low
1.	Oral communications with craftsmen.	1	2	3	4	5	6	7
2.	Oral communications with staff and management.	1	2	3	4	5	6	7
3.	Written communications with craftsmen.	1	2	3	4	5	6	7
4.	Written communications with staff and management.	1	2	3	4	5	6	7
5.	Plant industrial relations procedures.	1	2	3	4	5	6	7
6.	Plant discipline procedures.	1	2	3	4	5	6	7
7.	Understanding the plant organizational structure.	1	2	3	4	5	6	7
8.	Utilizing existing plant information systems.	1	2	3	4	5	6	7
9.	Maintenance operation policies.	1	2	3	4	5	6	7
10.	Understanding future organizational plans.	1	2	3	4	5	6	7
11.	Supervisor work ethics.	1	2	3	4	5	6	7
12.	Understanding employee motivation.	1	2	3	4	5	6	7
13.	Understanding craftsman job satisfaction.	1	2	3	4	5	6	7
14.	Understanding job enrichment (make work more meaningful).	1	2	3	4	5	6	7
15.	Understanding job enlargement (allow more activities to be done by craftsmen).	1	2	3	4	5	6	7
16.	Technical knowledge of crafts (i.e. welding, plumbing, electrical, etc.)	1	2	3	4	5	6	7
17.	Guidelines for training craftsmen on the job.	1	2	3	4	5	6	7

		Productivity High						Low
18.	Maintenance work measurement.	1	2	3	4	5	6	7
19.	Planning and scheduling maintenance workload.	1	2	3	4	5	6	7
20.	Scheduling maintenance activities.	1	2	3	4	5	6	7
21.	Establishing preventive maintenance programs.	1	2	3	4	5	6	7
22.	Maintenance budgeting.	1	2	3	4	5	6	7
23.	Maintenance material procurement.	1	2	3	4	5	6	7
24.	Improving safety practices.	1	2	3	4	5	6	7
25.	Understanding organizational and employee needs.	1	2	3	4	5	6	7
26.	Understanding group behavior at work.	1	2	3	4	5	6	7
27.	Evaluating labor turnover.	1	2	3	4	5	6	7
28.	Understanding lifework patterns of employees.	1	2	3	4	5	6	7
29.	Using management by objectives.	1	2	3	4	5	6	7
30.	Basic principles of management.	1	2	3	4	5	6	7
31.	Delegating responsibility to craftsmen.	1	2	3	4	5	6	7
32.	Understanding supervisory skills.	1	2	3	4	5	6	7
33.	Basic principles of time and motion study.	1	2	3	4	5	6	7
34.	Utilizing plant staff personnel.	1	2	3	4	5	6	7
35.	_____	1	2	3	4	5	6	7
36.	_____	1	2	3	4	5	6	7
37.	_____	1	2	3	4	5	6	7

Select the content for training that has the greatest potential for improving productivity in the maintenance department. Select those items with the most potential for improving productivity based on your knowledge of the maintenance supervisors and the results of the needs assessment instruments.

Appendix L

Instructional Methodology Selection Instrument (Part C of the Model)

Directions: For each content item selected for training maintenance supervisors, select the method(s) of presenting the training. Based on experts in training, certain methodologies are more effective than others depending on the content of the training. Recommended methods for technical content, employee and organizational behavior content, and maintenance management content are listed below. The trainer should select the method, or combination of methods, considered most appropriate for presenting each training content item.

1--Recommended For Technical Content

2--Recommended For Employee and Organizational Behavior Content

3--Recommended For Maintenance Management Content

4--No Recommendation

Methods Available	Recommended For	Check those that apply to the training content
Lecture	1, 2	_____
Hands-On Training	1	_____
Role Play	2	_____
Job Specific Examples	2	_____
Simulation	2	_____
Seminar/Conference	3	_____
Discussion	3	_____
Demonstration and Practice	3	_____
Case Study	4	_____
Programmed Instruction	4	_____
Auto-Tutorial (Interactive Educational Technology)	4	_____
Observation	4	_____
Job Specific Methods (On-The-Job Training, Mentor, Correspondence Course)	4	_____

Appendix M

Instructional Design Logistics Instrument
(Part D of the Model)

Directions: After the methods of training are selected for each content area, detailed planning is required to insure that the training will be successful. The elements that must be considered for each content area are presented below. The plan must insure that all of these elements are considered for each item of content. This instrument is to be used as a basic checklist to insure that the training is well-planned and all requirements for successful training have been considered. Complete the training design check list for each content item.

Check when each has been completed

Personnel Considerations:

Who will attend? (names, positions, plants, number of personnel) _____

Who will conduct the training? (names, positions, departments, outside sources) _____

Who will provide the funding? (names, amount, procedures) _____

Who must authorize the training? (names, positions) _____

Who will setup the training location? _____

Who will introduce training and recognize completion? _____

Time Considerations

When will the training be scheduled? (dates, times) _____

How much time will be allocated? (per class, content) _____

Is time available to practice and answer questions? _____

Check when each has been completed

Location Considerations

Where will the training be conducted? (on-site, off-site, specific location, address, building, room) _____

Training Considerations:

What media is required (overheads, flipcharts, slides, videotapes, films, texts, technical manuals, computer aided materials, policies, schematics, equipment, components, chalkboard, scale models) _____

Define training objectives and standards to be met for each content. _____

What safety requirements are there? _____

What are the benefits of training? _____

Is a pretest needed to ascertain the existing level of training? (content, presentation, method) _____

Are elements of the training sequenced? (simple to complex, general to specific) _____

Are feedback mechanisms developed? _____

Has a training outline been made? _____

Will credits be given or a certificate be issued? _____

Will training be recorded in a supervisor's personnel file? _____

Appendix N

Training Evaluation Instrument
(Part E of the Model)

Directions: As indicated on the model during content analysis selection, it is necessary to select the measurements by which the success of the training will be evaluated. Select the measurements to be used in the "Before" column and obtain actual measurement(s) using maintenance records or plant information systems just prior to the training. After completion of the training and when sufficient time has passed for supervisors to implement the content learned, take the same measurements in the same manner to see if the training achieved a productivity improvement. Although it is recognized that there are other benefits to training, this instrument pertains only to productivity. Differences observed between the two measurements can be used to evaluate if a productivity improvement occurred. Appropriate measures of maintenance productivity improvements include the following measurements used in industry.

Measurement	Plan to Use	Before	After
Maintenance cost per standard hour	_____	_____	_____
Ratio of completed work requests to plans and estimates	_____	_____	_____
Maintenance costs as a percentage of sales	_____	_____	_____
Maintenance costs as a percentage of total plant costs	_____	_____	_____
Maintenance costs as a percentage of investment	_____	_____	_____
Maintenance costs per direct labor hour	_____	_____	_____
Plant to plant maintenance ratios	_____	_____	_____
Maintenance department employee turnover	_____	_____	_____
Work requests completed per month or year	_____	_____	_____
Average time required per work request	_____	_____	_____
Machine downtime per month or year	_____	_____	_____
Other: _____	_____	_____	_____

Appendix O

Validation Letter

University of Northern Iowa
Cedar Falls, Iowa 50614
Date

Dear Sir:

Maintenance, as a major support activity in manufacturing, has consistently shown the weakest return of all major manufacturing budget items according to a number of experts in the field. On an average, a 20% productivity improvement is a conservative and realistic goal.

I am a doctoral student at the University of Northern Iowa and am in the process of completing the dissertation requirement. I have developed a training model to assist maintenance supervisors in achieving productivity improvements. The model was developed after thoroughly researching the existing work in maintenance supervisor training. Also, selected maintenance managers completed a survey regarding maintenance training requirements and the existing skill levels required of their maintenance supervisors.

The attached model is designed for use by manufacturing firms to determine if training of maintenance supervisors could improve productivity. In addition, the model provides a methodology for developing a successful training program.

To complete my research, I am required to validate the model using experts in maintenance and education. In my opinion, you have the expertise needed to analyze the potential for this model to assist in improving productivity in the maintenance field.

If you would read through the model and answer the short evaluation questionnaire at the back, your analysis will provide the professional insight into the model's potential. I know that your time is valuable, and your professional judgment and input will be most helpful as I work toward completing the Doctor of Technology degree program. I have enclosed a self-addressed, stamped envelope for your convenience. If you have any questions regarding what I'm asking you to do, please feel free to call me collect after 4:00 P.M.

Sincerely,

Robert R. Johnson

Appendix P

Maintenance Supervisor Training Model
Validation Instrument

Directions: Please indicate the potential for using the model to improve productivity in the maintenance department of a manufacturing company by circling the most appropriate answer to each question. Please use the back side to continue any comments. Letters in parentheses refer to a specific part of the model.

Model Components Evaluation

	Very Adequate		Adequate		Very Inadequate
(A) Do the needs assessment instruments provide for an adequate evaluation of training as a potential solution to productivity problems? Comments:	1	2	3	4	5
(A) Does the supervisor assessment instrument provide an adequate evaluation of the current training, experience, and education status of the supervisor? Comments:	1	2	3	4	5
(B) Do the major activities in the training content selection instrument cover a maintenance supervisor's responsibilities? Comments:	1	2	3	4	5
(C) Do the training methodologies proposed support the training activities? Recommendations?	1	2	3	4	5
(D) Does the course design instrument cover the major factors that must be considered? List others that should be included:	1	2	3	4	5
(E) Are the measurements described in the evaluation instrument adequate to evaluate productivity? Others Recommended:	1	2	3	4	5

Overall Evaluation

	Very Adequate		Adequate		Very Inadequate
Does the model contain all the essential elements? Describe:	1	2	3	4	5
Does the model provide users with a logical development of a training program? Comments:	1	2	3	4	5
Would the model and its instruments make planning and evaluating a training program easier for you? Comments:	1	2	3	4	5

	Yes	No
Have you seen other models that provide this type of training analysis for maintenance supervisors? If yes, describe:	___	___
Would you use this model in industry? Comments:	___	___
Does this type of model have other applications in industry? If yes, describe:	___	___
Implementation of this model will result in productivity improvements? Comments:	___	___

List recommendations for improving the model and/or supporting instruments:

1.

2.

3.

Demographic Data

Answering any of the following questions is optional. However, the data will provide a general understanding of the background of the individuals evaluating the model and its instruments. Completing this form would be greatly appreciated.

Name: _____

Title: _____

Length of time in your position: _____

Highest Attained Education Level:
( ) High School ( ) Bachelor
( ) V.T. Certificate ( ) Master
( ) Associate ( ) Doctor

Company or University: _____

Involvement in maintenance or education: _____

_____

_____

Would you like a summary of the results of this survey?

Yes No

Appendix Q

Jury of Experts Demographic Data

The jury of experts provided demographic data about themselves in the validation instrument (Appendix P) to substantiate their expertise in for validating the training model. The position titles for the jury and years of experience in the position are contained in Table Q-1.

Table Q-1

Jury of Experts Titles and Years Experience (N = 13)

Title	Years	Groups of Jury Members: Industrial Managers	Maintenance Experts	Academia (Training)
Facilities Manager	19	X		
Personnel Manager	11	X		
Personnel Manager	16	X		
Training Manager	7	X		
Assistant Journal Editor	9		X	
Consultant	22		X	
President, Consulting Firm	5		X	
President, Consulting Firm	7		X	
Program Manager	33		X	
Associate Professor	12			X
College Dean	18			X
Professor	6			X
Professor	14			X
Average Experience	14			

The jury of experts in Table Q-1 was from one of three groups. They had expertise as corporate managers responsible for training and management development, as maintenance experts, or as academia in the area of industrial training. Two experts stated that they had over 40 years involvement with maintenance even though they had not been in their present positions that long. In addition, three experts stated that they had experience in directing maintenance operations as well as teaching at the college level or consulting.

The jury of experts was also asked what educational background they had completed. The level of education of the jurors is provided in Table Q-2. One juror had two masters degrees and one juror had two baccalaureate degrees.

Table Q-2

Jury Of Experts Educational Level (N = 13)

Educational Level	Number of Jurors
High School	2
Vocational Certificate	0
Baccalaureate Degree	5
Masters Degree	3
Doctorate Degree	3
Total Jurors	13

Appendix R

Industrial Survey Activity Detail

On the industrial survey (Appendix C), 15 activities were identified that had a scope large enough to require the maintenance managers to more specifically identify what part of the activity was of the most importance to them as it related to maintenance supervisors. Responses to each of these activities are provided below in the blanks.

If you were able to offer only one class in each of the following tasks under each question, check the one task that you consider most appropriate for your maintenance supervisors in helping them improve productivity.

Item	Activity	Response
36.	Oral communications.	
	A. Use of the telephone	0
	B. Making presentations	8
	C. Clear and concise speech	2
	D. Giving directions	63
37.	Written communications.	
	A. Spelling and grammar	6
	B. Company forms	3
	C. Writing reports	42
	D. Writing work orders	22
38.	Industrial relations.	
	A. Knowing the rules	6
	B. Communicating problems	24
	C. Handling situations	43
	D. Other: _____	0
39.	Discipline.	
	A. Knowing the rules	7
	B. Knowing when to act	24
	C. Handling employees	42
	D. Other: _____	0
40.	Supervisor work ethics.	
	A. Standards of conduct	16
	B. Compliance to rules	8
	C. Setting an example	46
	D. Other: _____	0

Item	Activity	Response
41.	Technical knowledge (Areas).	(See Table 7)
	A. _____	
	B. _____	
	C. _____	
	D. _____	
42.	Maintenance work measurement.	
	A. Establish standards	38
	B. Time and motion study	3
	C. Using standards	26
	D. Other: _____	0
43.	Controlling activities.	
	A. Scheduling work	34
	B. Preventive maintenance	25
	C. Planning and estimating	13
	D. Other: _____	0
44.	Work improvement.	
	A. Make tasks meaningful	22
	B. Understand motivation	28
	C. More job satisfaction	13
	D. Increase scope of work	7
45.	Related maintenance activities.	
	A. Budgeting	22
	B. Safety procedures	28
	C. Material procurement	17
	D. Other: _____	2 Engineering and Emergency
46.	Plant operations knowledge.	
	A. Information systems	22
	B. Organization structure	12
	C. Maintenance policies	27
	D. Future plant plans	9
47.	Training craftsmen.	
	A. Define needs	29
	B. Existing programs	5
	C. Creating a program	36
	D. Other: Apprenticeship	1

Item	Activity	Response
48.	Human behavior.	
	A. Employee/company needs	36
	B. Career patterns	1
	C. Group work behavior	34
	D. Labor turnover	0
49.	Supervisory functions.	
	A. Styles of supervisors	14
	B. Setting goals	34
	C. Delegating	24
	D. Other: _____	0
50.	Basic management.	
	A. Principles of management	50
	B. Corporate policies	3
	C. Utilize staff more	17
	D. Other: _____	0