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AUTHOR	Chen, Kan; And Others
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ABSTRACT

This report centers around a plant-level study of the development and utilization of human resources in the context of technological change and industrial restructuring in the crankshaft production area of Ford Motor Company's Dearborn Engine Plant (DEP). The introductory chapter describes how the study was conducted, provides an introduction to DEP, reports on the selection of personnel for follow-up discussions, and documents the research strategy. Chapters 2, 3, and 4 present findings with each chapter corresponding to a segment of the investigation. Chapter 2 discusses technological innovation and examines the phases of technological change, including participants and factors affecting the change process. The chapter is organized into three sections: decisions leading up to the change, implementation of change, and future changes in technological innovation. The third chapter focuses on how the renovation of DEP was experienced by people on the shop floor: changes in work and attitudes, and consequences realized only after completion of renovation. Chapter 4 describes development of the training programs and procedures. Some problems encountered are highlighted, and possible explanations for them are suggested. Chapter 5 summarizes and integrates findings, discusses policy implications, and indicates further research needs. Appendixes include a representative listing of related work and training materials and schedules. (YLB)

UM-UTEP-84-7

The Development and Utilization of Human Resources in the Context of Technological Change and Industrial Restructuring

Human Resource Development and New Technology in the Automobile Industry: A Case Study of Ford Motor Company's Dearborn Engine Plant

Kan Chen (Project Coordinator)
Joe G. Eisley
Jeffrey K. Liker
Jack Rothman
Robert J. Thomas

Assisted by: Darlene Nichols
Deborah O. Liker
Sherry Borener
Paul Appasamy

The University of Michigan
Ann Arbor, Michigan
U.S.A.

Department of Labor Contract No. J9K3004

Center for Educational Research and Innovation
Organisation for Economic Cooperation and Development
Paris

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Chapter 1

BACKGROUND AND INTRODUCTION TO THE U.S. CASE STUDY

This report centers around a case study of the crankshaft area of Ford Motor Company's Dearborn Engine Plant. To help the reader appreciate the context in which the case study was initiated, designed, and conducted, this introductory chapter will begin with a discussion of the significant changes in the U.S. automotive industry which the authors consider to be relevant to technological change and human resource development. This background discussion will be followed by a description of the preparatory activities that led to the case study.

Background

Over the past decade, a combination of factors has created an atmosphere of change in the U.S. automotive industry and Ford Motor Company. Four factors have been central: (1) the changed economic environment facing the industry, particularly in terms of increased foreign competition, general economic recession, and slowed growth in the market for new cars; (2) the emergence of a strong alternative approach to the traditional corporate human resource development; (3) a generalized pressure to increase labor productivity and product quality and to update product and process technologies; and (4) the need to strike a balance between increased productivity and employment security for industrial employees (both blue and white collar).

As much as the industry might like to respond quickly to all four factors, there are constraints on change. First, the auto companies and the principal auto worker union, the United Automobile Workers (UAW), have a long and stable relationship, which must itself be reevaluated as part of a change strategy. The collective bargaining apparatus developed over the past four decades has proved a time-tested mechanism for debating, amending, and adopting innovative approaches to labor-management relations; yet, at least some of the problems being faced by the industry cannot be effectively dealt with in the tradition of collective bargaining. For example, many of the efforts to reshape corporate human resource policy now in their infancy were introduced in contract negotiations but have had to escape that terrain in order to avoid being hamstrung by adversarialism. Any plans to streamline the organizational structure of auto companies and those of individual production facilities have had to confront the complex system of seniority rights, job classifications, and work rules accumulated over the past forty years. Managers and some union representatives recognize these rules and definitions to be obstacles to a rapid response to changes in the economic environment; yet, seniority rights, in particular, are seen by union members as one of the most important sources of protection from arbitrary and/or discriminatory uses of power by management (see Appendix E for a brief description of major aspects of this system as they relate to Ford's Dearborn Engine Plant). Moreover, seniority protections have increased in importance for many workers as a result of the recent history of economic recession, record unemployment among auto and other industrial workers, and the highly publicized media forecasts of increases in technology-related labor displacement in the decade ahead.

Second, a legacy of past organizational practice and investments represents another obstacle to change in the industry. While it would be an exaggeration to argue that the industry's economic success has led to its competitive and economic undoing, there are many in the industry willing to admit that the U.S. companies' rather slow response to international competition revealed that complacency had spread during an era of economic stability. This complacency was, and to a much lesser extent continues to be, manifested in a standard practice of top-down decision making, unidirectional and highly restricted flows of communication, circumscribed opportunities for technical and/or organizational innovation at the middle-management level, and a segmented process for implementing new programs. The latter, in particular, often left lower levels of the organization in the position of being the last to know about new products, processes, or policies. If organizational practice revealed itself to be encrusted with historical precedent which stifled innovation, it had a retarding effect on the behaviors of individual managers. It warned salaried employees that the only risks worth taking were either "sure bets" or ones which could be shared by colleagues in case they went sour. For those not labeled "promotable," an orientation-to-rules attitude sufficed in the place of risk-taking and only added to the inflexibility of the organization.

Shocks to the system--economic crisis, increased competition, and the need to increase productivity--have nonetheless spurred a reevaluation of the foregoing constraints and, as in the case of Ford Motor Company and the UAW, resulted in efforts to move in the direction of a more adaptable and productive system. Evidence for these efforts can be found in the various programs and new practices which have captured public attention, including: (1) policy pronouncements from corporate headquarters emphasizing a new philosophy of human relations, product quality, and product development (see the accompanying Ford Motor Company report for detail); (2) the 1979 and 1982 contracts negotiated by Ford and the UAW opening new ground for worker participation in decision making, information sharing between company and union, pilot programs of employment security for senior workers, and the development of a joint UAW-Ford National Development and Training Center, among other programs; and (3) the highly visible launching of the process of Employe

Involvement.

More broadly viewed, these efforts constitute a trenchant evaluation and criticism of past practice coupled with a willingness to "experiment" with new organizational practice. However, it should be understood that the experimentation to which we refer differs from the classic scientific model: A few controlled experiments (e.g., pilot programs of guaranteed employment) have been explored; but in the majority of instances consideration of these experiments has been scattered very unevenly throughout the corporation, depending on how individual plants choose to respond to broad mandates from above. A relevant example can be found in the Employe Involvement (EI) process. As described in a joint UAW-Ford publication, EI "...is a process in which local Unions and local Managements work together to jointly create a work climate where employees can achieve work satisfaction by directing their ingenuity, imagination, and creativity toward improving their work and the overall work environment." To date, the EI process has been most visible in the formation of cooperative problem-solving groups. Plant management in the company has little choice about whether to establish EI in their facility. Where they do have some leeway is in the actual implementation of the EI process; e.g., what pace or variations are necessary to adapt to local circumstances. Thus, while no explicit theory of organizational change has emerged, there are definite plans of action.

The success of Ford's plan of action, like that of any organization attempting to consciously alter itself, will ultimately depend on its capacity to do three things: (1) generate data or information about what it is doing and to interpret that information (2) to induce behavior among its personnel consistent with the plan and (3) to institutionalize or routinize changes in behavior which produce results consistent with the plan of action. The first aspect constitutes a problem of operationalizing the theory and developing the capacity to generate and meaningfully interpret the results. The second and third, by contrast, present problems of authority and persuasion—authority to actually instigate the plan; and persuasion as a device to engender a willingness among personnel to participate and, once begun, to continue participating. These last two aspects are critical. Willingness to participate means more than just "suspension of disbelief." Rather, it requires information, a line into the system, as well as some proof that the results of the change plan are sufficiently positive or neutral so as not to inhibit continued participation. Participants in organizational change efforts need to have the experiment explained to them and to see positive results from their participation if they are to continue to participate.

These points are especially relevant in the case of the automobile industry and Ford Motor Company precisely because the intent is to create a more open and responsible organization. Catch phrases like "more openness," "information sharing," and "trustbuilding" have been emphasized in the change process. Employe Involvement has become something of a cornerstone in the Ford's public relations campaign to change the image of past labor relations practice. "Quality is Job 1" has emphasized the importance of improving product quality--a goal which requires better communication between hourly and salaried employees and within the salaried ranks.

One of the areas in which improved communication between workers and management is needed, and to which the new approach to better communications is being put to test, is technological change. Many workers and union representatives recognize the dilemma of the need to shore up the company's competitive position with new technology and the specter of job displacement by new technology. Like other automobile companies around the world, Ford Motor Company has been putting increased emphasis on automation and robotics. True, automation is nothing new, for it has been a long-term trend in all industrial countries, including the United States, for almost forty years. It has profoundly changed the mode of production in both the office and the plant. However, until about five years ago the major use of computers in plant production had been for process control--continuous and batch processes for making chemicals and steel, for example. The impact of automation on labor had been less obvious because these processes employed relatively few workers originally and because the widespread implementation of computer process control took place mainly during a period of economic expansion.

In recent years the growth in computer applications in the plant, including robotics, has shifted toward manufacturing, especially those manufacturing processes which are labor intensive, unpleasant, or unsafe. Moreover, this shift has been accompanied by economic stagnation and increased foreign competition in the manufactured goods market in the United States. The resulting high unemployment is due to all of these confluent forces, making it difficult to disaggregate the relative significance among the contributing factors. It has been pointed out that automation in manufacturing is necessary to keep U.S. industry competitive internationally. New jobs are being created by the emerging industries that produce the hardware and software for automation. However, it is clear that the composition of the industrial work force will be different in both total size and in the types of jobs offered; moreover, the share of jobs found in the manufacturing sector will continue to decline in the coming decades.

As it confronts a changed world market and pressures to improve cost competitiveness, the U.S. auto industry has encountered these problems directly. (See Appendix A for a more extensive discussion of recent research on the impacts of technological change in the auto industry on employment levels and patterns.) Even though the practices of international outsourcing and plant relocation (outside the U.S.) have been subjected to negotiation between company and union, the prospect of capital mobility remains a powerful and potentially negative influence on the process of building cooperation. Less dramatic than the loss of jobs to a foreign manufacturer or a relocated plant, outsourcing to firms with non-unionized workers in the U.S. remains an option for the auto companies and, as a result, a continuing threat to unionized workers.

These questions and fears are not limited to blue-collar, production employees. Technological change and internationalization portend reduction in the demand for supervisory employees (particularly as production is relocated or jobs eliminated) and changes in the skills required of other salaried personnel. In the latter case particularly, the introduction of more extensive (and accessible) forms of information processing and the computerization of many design and evaluation functions could render some salaried personnel redundant. Others could be faced with the challenge of acquiring a new set of skills.

The need to respond to foreign competition while achieving some balance between technological change and employment security will force industry and union leaders to seriously consider new avenues in industrial relations and human resource management. Whether the recent economic "hard times" of the auto industry will actually lead to changes in practice remains, however, unclear. Auto company executives have emphasized their receptiveness to new programs of human resource development by allocating substantial sums for upgraded technical and "human relations" training but, at the same time, have suggested taking employment overseas where there are trainable workers, if labor costs cannot be trimmed and productivity increased. Union leaders have pledged their support for technological upgrading if greater employment security can be achieved for the rank and file; yet some are privately skeptical that, despite industry pronouncements, the two are compatible.

If indeed some balance is to be achieved, a critical factor in the future of the auto industry and other basic manufacturing segments of the U.S. and European economies will be the content of human resource development practice. Rather than being a function whose domain is restricted to the administration of salaried personnel or the supervision of collective bargaining agreements, human resource development must expand its borders to the fields of participative decision-making, information-sharing, skill development, and leadership trai ing at all levels of the enterprise. How such a reorganization will be accomplished and who or what organizations (e.g., companies, unions, government, or educational institutions) will be involved in the change process are the central questions which need to be addressed.

Human Resource Development and Technological Change: The OECD Project

In this climate of internationalization and rapid technological change, the Organization for Economic Cooperation and Development (OECD) proposed a study of the "Development and Utilization of Human Resources in the Context of Technological Change and Industrial Restructuring." The project, according to the proposal circulated by OECD's Center for Educational Research and Innovation (Paris, 10 May 1982), focuses on "the interface between the development and utilization of human resources at the work place and public policies in the fields of education, vocational training, and employment." The main objectives are: (1) to analyze the ways in which human resources are developed and utilized under different economic, social, and cultural conditions; (2) to understand the roles played by the different agents both in governments and in enterprises; and (3) eventually to suggest conclusions with respect to improving the development and utilization of human resources in the years ahead.

Participants in the study are from five major auto-producing nations: United States, West Germany, Sweden, France, and Japan. One company was recruited from each country; these include Ford (U.S.), Volkswagen (West Germany), Volvo (Sweden), Renault (France), and Toyota (Japan). Each company agreed to prepare a report on their human resource policies relating to technological change and to cooperate with a team of outside researchers by facilitating entry into a plant that had recently undergone major technological changes. Another part to this study is a compilation of national and regional (state) policies dealing with human resource development in each country.

Contents of this Report

This report summarizes the findings from the plant-level study. Ford Motor Company volunteered to participate and provided access to the Dearborn Engine Plant (DEP) which was renovated between 1979 to 1981, at a cost of nearly (US)$600 million, to prepare the plant for production of a new four-cylinder engine. This was one of the largest plant renovations in the history of Ford, and the new equipment and machines represented a significant increment in technological sophistication when compared to the old plant.

Through extensive discussions and meetings with close to 100 Ford employees, the research team from the University of Michigan reconstructed the history of events leading up to the renovation and the renovation process itself and then analyzed the consequences of the renovation. The questions we asked arose directly from the parameters of the overall OECD project: How was the decision made, and how were the various parties in the plant informed of the renovation? How did they interact at various stages in the process? What were the employment consequences of the renovation? What were the costs and benefits in human and organizational terms? What was the role of training in the renovation process? What lessons were learned from this experience (e.g., regarding human resource development)? What further technological changes are on the agenda, and what considerations are being made for human resource utilization and impacts? (See Appendix D for a more detailed listing of the questions posed.)

The body of the report is divided into three main sections:

(I) The remainder of this chapter describes in detail how the study was conducted, including the preparatory phase, an introduction to the Ford Dearborn Engine Plant, and a discussion of why the crankshaft production area was chosen for special attention. Chapter 1 concludes with a description of the questions pursued in discussions with Ford Motor Company personnel and documentation of the strategy for investigation.

(II) Chapters 2, 3, and 4 present the findings from the case study. Each chapter corresponds to a segment of the investigation: Technological planning and decision making (Chapter 2), Work organization (Chapter 3), and Training (Chapter 4). While it is understood that these areas of investigation overlap, they are initially presented as separate topics to aid in elaborating the details of the case study. When it is critical to do so, findings from more than one area are presented within a chapter; however, a conscious focus on an integration is made in the fifth and final chapter.

(III) The final chapter, Chapter 5, contains the conclusions drawn by the research team. The intergrated results are initially summarized and key observations are underscored. In closing there is an outline of additional research and a consideration of the policy implications suggested by this project.

Case Study Design

The Preparatory Phase

Between December 1982 and February 1983 preparations were made to undertake the case study. After joint consultation with OECD project staff and selection of investigators from the University of Michigan (representing disciplines as diverse as engineering, technological planning, social work, and sociology), an initial round of meetings was set up with representatives from Ford and the United Auto Workers. Preliminary interviews were arranged at the time and the first round of discussions helped immensely in honing the research questions. Included in this first round of discussions were nine Ford representatives from various levels in the corporation, two elected union officers, and several production workers. The preparatory work was documented in a report issued by the University of Michigan research team in April 1983.

Site Selection and Description

Ford Motor Company's Dearborn Engine Plant (DEP) in Dearborn, Michigan, provided an interesting and useful site for the OECD case study for several reasons. First, as mentioned earlier, because technological changes were undertaken at DEP in the recent past, it was possible to meet with direct participants in the renovation to get their impressions of the plant and their work before and after the change. Second, plant and other company personnel and union representatives had demonstrated active support for, or participation in, training programs related to changing technology. And third, management, union representatives, and many workers at DEP expressed interest in the study and offered their cooperation to the research team.

The plant was built in 1941 by the United States government to manufacture aircraft engines. In 1947, after the end of World War II, the facility was purchased by the Ford Motor Company, initially to be used as a parts warehouse. In the early 1950s, however, it was converted to the production of automobile engines. By the mid-1970s, with the onset of a succession of energy crises and a shift in company strategy, the manufacturing facilities became outdated. Between 1978 and 1980 a

$600 million rehabilitation and expansion converted the plant from the production of powerful, but increasingly unpopular, V-8 engines to the manufacture of more economical 1.6-liter, four-cylinder engines. Major technological changes (described in greater detail in Chapters 2 and 3) were introduced; among the most significant changes were computer-aided automation of transfer, machining, and checking processes. The converted plant has the capacity to produce approximately 4,200 engines per day—one million per year.

In the 1960s, the plant employed as many as 5,000 workers and produced V-8 engines—and parts for other plants. Present employment levels are far lower: 1,500 hourly employees in the second quarter of 1983. That reduction represents the combined effects of lower production levels and technological change and the removal of industrial engine production. Estimates made by plant personnel suggested that even if the plant were to achieve its productive capacity, only three-fifths (or 3,000) of the previous number of hourly workers would be employed. As it presently stands, nonskilled hourly workers must have approximately ten years seniority to keep their jobs in the plant.

The Crankshaft Area

In keeping with the framework suggested by OECD, two units--one involving primarily hourly (production) personnel and the other mainly salaried (supervisory and staff) employees—were chosen within DEP as foci for the case study. The strategy for selecting those units was discussed at a meeting with plant and company personnel, the UAW local unit chairman, and the research team. After a tour of the facilities, two candidates among the production units emerged: the engine hot test area and the crankshaft production line. A group consensus soon fixed upon the crankshaft line. Both areas had undergone massive renovation in which job changes were significant, fewer workers were needed to run the operation, and some training was necessary. The hot test area, however, included very few workers who were there both before and after the change. The crankshaft area, on the other hand, included a number of workers who had been there both before and after the change. Time and resource limitations, along with the desire to document the changes in work organization brought about by the renovation, led to the selection of the crankshaft area for detailed investigation.

Selection of Personnel for Follow-up Discussions

It was decided that the hourly and salaried units should be functionally linked to make the case study more meaningful. One unit selected was all hourly production workers on the crankshaft line. The other unit was a composite of mostly salaried but also some hourly personnel, which included all production supervisors, skilled trade workers, process engineers, plant engineers, training personnel, and higher level managers who had some influence on the crankshaft line. Selecting the hourly production personnel was straightforward: they were the 40 or so workers in both the day and evening shifts assigned to the crankshaft line. The composite group was much more difficult to select. Over the course of several meetings, various managers from plant, division, and corporate levels and union representatives suggested the names of our initial contacts. Later discussions netted more contacts which were subsequently pursued. In the end the researchers were confident that a representative group of the most-knowledgeable persons had been identified.

Over the two months of intensive investigation, the research team met with 87 persons either individually or in small groups (see Table 1 below). This included 40 hourly production employees and 6 hourly maintenance and skilled tradesmen in the crankshaft area, three elected union representatives, and 38 salaried employees at various levels and locations within Ford Motor Company. However, the research team did not seek out workers who worked in the crankshaft area before the renovation but who are no longer there.

Table 1

Characteristics and Location of Personnel Involved in the Case Study*

Employment Site at Time of Study

Employment Status	Dearborn Engine plant	Divisional Level	Corporate Level	Other	Total
Salaried	24	8	5	1**	38
Hourly					
Nonskilled/ Semiskilled	40	--	--	--	40
Skilled	6	--	--	--	6
Other	--	--	--	3***	3
TOTAL	70	8	5	4	87

* This refers to separate individuals with whom we met. Some people were contacted more than once or met with us on different topics. Thus, the total number of discussions is somewhat higher.

** One salaried employee, a training specialist, worked at DEP but was on North American Automotive Operations payroll.

*** Three union representatives (considered for our purposes hourly employees) were officers of the UAW Local (600) which covered the complex of plants of which DEP is a part.

Research Strategy

The research team was divided into three groups for purposes of collecting data. One group was concerned primarily with the introduction of new technology and focused upon selected members of the composite salaried group for their information. A second group was concerned primarily with work organization and held discussions with all the hourly workers and selected individuals among the composite salaried group. The third group was concerned primarily with training and focused upon those individuals that were involved in planning or conducting the training.

Each group had a corollary objective of collecting data which related to the other areas. For example, the group concerned with work organization also explored issues related to training with participants in the training programs and sought to assess what people on the shop floor knew about or contributed to the introduction of new technology. In some cases company or union representatives engaged in discussions with more than one group in the research team's effort to more fully explore the overlapping impacts of change processes.

For the varied discussions necessary to cover the complex of topics developed in the preparatory stage, the research team constructed separate indices of questions to be pursued in each area (see Appendix D for a detailed listing). These indices were subsequently cross-checked to insure that different perspectives (e.g., plant vs. corporate views, hourly vs. salaried employees) on the renovation process (and its aftermath) were included and to minimize redundancy in the individual discussions.

Although a number of factors, especially the need for small engines, led to the renovation of the Dearborn Engine Plant, the most obvious change was the introduction of new technologies, both in product and process. Therefore, we will begin the description of findings from the case study by tracing in Chapter 2 the process of technological innovation before, during, and after the DEP renovation.

Chapter 2

TECHNOLOGY INTRODUCTION

Introduction

In this chapter we will discuss technological innovation, in particular the process by which new technology was introduced at the Dearborn Engine Plant (DEP). We will examine the phases of technological change, including the participants and factors which affected the change process. The chapter is organized in three sections: (1) decisions leading up to the change, including initial planning and preparation; (2) the implementation of change at the plant; and (3) future changes in technology introduction being suggested within the Ford Motor Company based in part on the lessons learned through the DEP experience.

This chapter is based on extensive discussions with salaried professionals--managers and engineers--functioning at plant, division, and corporate levels of the organization. We were interested in obtaining multiple perspectives on the change process, with emphasis on views from the plant itself. However, the reader should be aware that what is conveyed here represents observations and opinions from managers and engineers, not hourly workers involved in direct production tasks. Those views will be presented in the next chapter.

We found that technology introduction is a dynamic but evolutionary process. It emerges from existing technology and continues to change and advance rather than remain fixed between major renovations or expansions. In a large company such as Ford, one can use a model of a spiral to visualize the process of technological change: technology within the company ascends the spiral gradually, moving from plant to plant increments. However, viewed from the perspective of a single plant, change may seem revolutionary—as in a jump from one level in the spiral to another. For example, by the current standards of Ford as a corporate system, changes in the process technology at DEP were an extension of practices already in existence at other engine plants. This may account for the fact that many of those with whom we spoke were more excited about the organizational, managerial, and human relations changes (including intensified training) accompanying the renovation than the renovation itself. While recognizing the importance of technical components, it was emphasized in the discussions that human and social factors are of equal or greater importance. What emerged from our synthesis of comments was a view of the plant as a social system with the need for better integration within and between the various levels and functions through a greater degree of communication, collaboration, and participatory decisionmaking.

Decisions Leading to the DEP Renovation

Predisposing Circumstances and Engine Choice

The decision leading to technological innovation was market -driven and involved complex planning on an international scale. The OPEC oil embargo in 1973-74 and the subsequent rapid rise of oil prices shifted the emphasis from large cars to small cars in the U.S. automobile market. As corporate staff at Ford in Dearborn considered its small car strategies around 1974, the need became apparent to replace both the European Escort and the U.S. Pinto. The "world car" concept as well as limited resources led the company to seek a single basic engine design for its new generation of small cars.

Some 20 small engine designs around the world were examined. An early candidate, a modification of Ford's "surrey" engine, was soon abandoned because it would not meet the increasingly stringent U.S. emission standards; and a 2.3-liter engine was considered too heavy and bulky for frontwheel drive passenger cars. Three engines with different combustion chamber designs survived the winnowing process and received careful consideration and testing in the company's Scientific Laboratories in the U.S. These were: (1) the compound valve hemispherical (CVH) design, or the "Hemi"; (2) the wedge design, also known as the quench type or the bath tub; and (3) a precombustion chamber design, similar to Honda's CVCC engine. The three engines were compared with respect to their size, weight, cost, and fuel economy. The Hemi engine (codenamed "Erika") was finally chosen, not because it was the least costly, but because it was deemed more capable of meeting the emission standards which were being raised in Europe as well as in the U.S. It was believed that the Hemi could meet the environmental standards without a catalytic converter, although this did not turn out to be true. The Hemi engine was also deemed more flexible in terms of redesign for tradeoffs between power and fuel economy.

After the basic choice of the Hemi engine, further development and final design were carried out by Ford's engineers in Europe, as they were more experienced in designing small, fuel-efficient engines which had higher speed and torque than their American counterparts at that time. Important variations were allowed between the Hemi engine for Europe and the same engine for North America in the areas of manifold, mounting, and emissions. The developers in Europe were far removed from the eventual American production site in Dearborn. The European version has been produced at Bridgend, Wales, which has a production volume capacity about half that of Dearborn Engine Plant.

The Planning Procedure

The Ford Motor Company is one of the largest corporations in the world and follows a long-term, multi-based, and multi-level planning process. The planning for its main business, car and truck production, follows a product planning process which has the following five phases: (1) Business strategy; (2) Strategies for marketing, manufacturing, and product development; the last to be followed by (3) Concept development; (4) Advanced program development; and (5) Production program execution (for further details, see the Company Report). In the early stages, planning considerations are focused on such questions as whether and what kind of small cars should be produced and sold in which market segments in the world. As noted earlier, top management and corporate strategic planners decided on producing a small car that would be marketed in both North America and Europe, with minor variations between the two versions to meet somewhat different market objectives and governmental regulations. The Hemi concept which was selected had to be "sold" internally to the Ford operations both in America and in Europe.

During the multi-year product planning process, a number of advisory committees and the central staffs provide support for the Office of the Chief Executive. However, as far as manufacturing and human resources are concerned, these advisory committees, such as the Manufacturing and Supply Subcommittee and the Human Resources Subcommittee, remain on the level of broad policies and strategies. In the case of the Erika engine, the corporate product planning group decided on the volume of the new engine to be produced and where the engine was to be used. These assumptions were then given to the Engine Division to study the manufacturing costs, to estimate the type of facilities required, and to compare alternative sites for making the engine. After this planning was done by the Engine Division and approved by the company, the Engine Division took responsibilities for inviting bids for the production equipment and for managerial and engineering staffing of the chosen plant.

At the early stages of business and product development strategies, human resource considerations were not prominent, but entered only in a subtle way. When location choice for production is considered, a global outlook is first taken to compare labor costs and capabilities in different countries. When alternative sites are compared in the same region or country, the consideration would include labor relations climate, labor quality, as well as labor cost. For example, it was noted that Dearborn had an experienced labor force. In 1977, three years before "Job 1" (the time for the first product to be produced, nominally April 15, 1980, for the Hemi or Erika engine), a 10- to 12-month planning process for site selection and engineering design was initiated. The Erika program marked the <u>first time</u> in Ford that human skills were considered during this early planning phase for two reasons: (1) technology complexity (tight tolerance) and (2) changing management philosophy. This consideration of human skill requirements led to the allocation of a training budget of about (US)$7 million even before the site was selected (see Appendix F for a summary of training cost).

<u>Site Selection</u>

The choice of the Dearborn Engine Plant (DEP) for renovation and production of the American version of the Hemi engine included a complex of economic, organizational, political, and social considerations. Before its renovation, DEP had been producing V-8 engines for large cars and, with the shrinking market for such vehicles, Ford had announced the closing of DEP, with the intention of shifting salaried and hourly personnel to other assignments. The plant was expected to become vacant or be used as a warehouse. Three basic site options had been considered for producing the Hemi engine in America: (1) construction of a new engine plant on a "greenfield" site somewhere in southeastern Michigan; (2) expansion of an existing engine plant, perhaps in Windsor, Ontario, or Lima, Ohio; and (3) conversion of an existing engine plant, such as DEP.

From the standpoint of a tangible cost-benefit comparison, differences among the three options were relatively small (within about 10 percent). Clearly the building-related expenditures would be less for an existing site than for a greenfield site. Except for the cost of demolition, an existing site would be less expensive through its use of existing building structure, parking and roads, boiler house and equipment, and other infrastructural facilities. The savings could be in the order of $50 million. However, this amounted to less than 10 percent of the total projected budget of $600 million for the entire plant, new or renovated. Uncertainty in the various assumptions underlying the total budget could well exceed this approximate amount of savings. Thus, a variety of organizational, political, and social factors became important in decision making.

A number of managers considered it unwise to renovate DEP, both for its restrictive labor agreement and because of the structure of the building. Moreover, the complicated Rouge-wide seniority system (see Appendix E) was considered a barrier to the establishment of a cost effective training program: given that skilled maintenance workers would have to be trained in the details of any new machinery, the Rouge-wide seniority system for the skilled trades could undermine any training effort by allowing maintenance workers in DEP to be "bumped out" (displaced) by workers with more seniority laidoff from another part of the Rouge. Renovation of the DEP building was considered costly and difficult. It is an older building, two stories in structure, rather than one floor as is currently considered optimal; moreover, it was originally designed for a different purpose (i.e., aircraft engine production).

On the other hand, there were factors favoring DEP. For example, permits for environmental protection were readily obtainable for the existing DEP, whereas getting permits for a new greenfield site would be more difficult and time-consuming.

A large pool of trained and retrainable workforce was present at DEP. There were also inherent operating cost advantages at DEP contributed by the Rouge area support activities, such as truck and rail services, plant security, and others. Moreover, the State of Michigan and local governments encouraged Ford to keep DEP in production through tax incentives (e.g., Dearborn froze the assessment level of DEP under renovation). Local governmental officials and the United Auto Workers (UAW) union strongly urged Ford to keep DEP open in order to keep the jobs there, and maintained an active campaign along these lines by making contacts with legislators in the state capitol and Washington, D.C., and holding a demonstration at Ford world headquarters. There were clear indications that the UAW would become more cooperative, and the bumping of skilled tradesmen was actually suspended during the launch period at DEP. The availability of an experienced, skilled workforce at DEP was certainly important and was a known factor, as compared to the uncertain availability of such a labor force at a greenfield site. When Henry Ford II reversed the earlier decision to close DEP, the general perception among those with whom we spoke was that the decision was based mainly on noneconomic grounds: Ford's social responsibility to its employees, the local and regional communities, and to the economy of southeastern Michigan.

The Implementation of Technology

The design of the plant was changed several times in response to alternating company plans. Originally the intention was to have two-thirds capacity for a 1.6-liter engine and one-third capacity for a 1.3-liter engine. That was the way the plant was sized and machinery was purchased. Later, a decision was made that there was not enough difference between the two engines to justify the smaller of the two. This required conversion of 1.3-liter equipment to the 1.6-liter engine standards.

Most of the heavy-part machines were affected. Layouts were changed; the plant was expanded in some areas; and a decision was made not to use some machines previously installed.

Initially the plant was sized for an annual volume of 638,000 engines and machines were specified for that capacity. Later, corporate planners felt that this would not be enough volume and a 1.1 million engine annual capacity expansion program was undertaken. This required enlarging the building. Some machines had to be added, and others moved, and the conveyor lines moved, as well. Despite the intricate planning and modifications in forecasting, market demand has had the plant running at about half its capacity (up until these observations in the summer of 1983). All these changes are disruptive to the production system itself as the equipment is dedicated automation and not especially flexible. We were informed that if other than a four-cylinder engine were required, extreme difficulty would be experienced.

The character and difficulty of the renovation was described by one engineer as follows:

> We had four different engineering groups working on the renovation. When you stack up all the possibilities for error in the time frame we were dealing with, it is a miracle that we did what we did. We cleared out old equipment, demolished (most of the interior of) the building, foundations were installed, new equipment was being installed concurrently with pouring foundations. A new machine was sitting on the floor while construction was going on around it....What happened here was probably the biggest undertaking at Ford.

Evolutionary Nature of the Technology

Although the new process technology and automation introduced in the renovation of DEP appeared revolutionary to some plant personnel, these changes were basically evolutionary in nature within Ford Motor Company. Each of the company's five other North American engine plants (in Lima and Cleveland, Ohio; Windsor and Essex, Canada; and Chihuahua, Mexico) and their counterparts elsewhere in the world undergo some measure of technological updating every few years, usually accompanying product changes. Thus, the latest renovation at any plant would include incremental technological advances beyond the previous successful changes at other plants. The renovation of DEP in 1978-79 made it the most automated automobile engine plant in the world at the time, but its furthest advances have since been surpassed by other plants. The most important manufacturing technologies introduced at DEP include: the profile lathes that make the elliptical cross-section barrel-shaped pistons, the automatic hot and cold engine test systems, the fastener assurance system that monitors and controls the torque applied to fastening bolts, the optical gauge for cylinder head measurements, and the black light tests to check oil leaks. The more important plant engineering technologies include infrared detection of loose electrical connections and the use of liquid nitrogen sleeves to freeze water to isolate pipe segments for repair.

Also new at the plant are a variety of processing procedures--on-line receiving, a carousel system rather than conventional storage bins, computer inputs to keep everything up to date, on-line shipping, and computer-automated highbay warehouses--making for, among other things, more stringent inventory requirements for the number of engine parts produced each day. It is important to note that much of the system was put together through a technological exploration with vendors. Outside vendors constitute a significant force in the diffusion of technological innovations.

The crankshaft area has been highly automated as a result of the renovation. In the crankshaft area, one worker can now handle several grinding stations. As compared to former operations, tolerances are about 60 percent tighter. Consequently, automatic gauging, by electronic contact and non-contact types of gauges, is used extensively to monitor 138 chara istics (compared to 42 previously) to minimize defects in the crankshaft. Another manufacturing technology introduced to DEP that was new to Ford (but not to the industry) is the crankshaft mass centering system. In the more conventional geometric centering system, the rotational axis is established by drilling the centers at selected locations. In mass centering, the crankshaft is spun and the location of the mass center-line is calculated. The centers are drilled in relation to mass on each crankshaft, thus minimizing casting variations and increasing efficiencies at the crankshaft balancing operations. As in the rest of the manufacturing process, the crankshaft area uses programmable controllers (PC) extensively to perform logical decision making for control applications that formerly required relays. With PCs changes in machine control can be accomplished quickly without hard wiring revisions. The PCs also provide the potential capability to communicate directly with a control computer to record production rates, downtime, and scrap counts. However, these changes are not as dramatic as was, for example, the radical "state-of-the-art" departure involved in the hot engine test system.

Organizational Innovation

Given the "evolutionary" nature of technological change in the company, some managers argued that the most innovative aspects of the DEP renovation were not technological, but organizational in character. They pointed to a management style that increasingly emphasizes participation and to the establishment of a new learning center through which many workers in the Rouge complex, not just within DEP, have received training. It is the combination of management style and training, more than the technology, several managers at the division level believe, that resulted in the continuing improvement of product quality and labor productivity at DEP. This will be discussed later in the chapter.

There was agreement that there was little or no use or need for outside consultants. Other Ford engine plants were looked to specifically for ideas, particularly the plant in Lima, Ohio. Expert personnel, including trainers, were shifted in from other parts of the company. Moreover, equipment vendors provided advice concerning particular hardware and participated in the training of operators, both in-plant and at the vendor site. A small degree of outside consultation was drawn upon with regard to the renovation of the building itself, including plant layout and the installation of equipment. These consultants included architectural engineers.

<u>Outcome as Measured against Original Expectations</u>

There was consensus among those with whom we spoke that [illegible] standards which were set as objectives were consistently met or bettered, and by sizable margins. This includes the company's three major objectives: quality, cost, and productivity. The launch date of April 15, 1980, was underrun, with some engines produced on a trial basis prior to this date. The target expenditure of $650 million for the renovation came in at an actual figure of $593 million. With regard to quality, the objective was 15 repairs per 100 engines produced at DEP: it is now down to less than 7 (a 25 percent annual improvement). Most of the repairs are for minor oil leaks due to sealing problems which can be corrected through a modest capital investment. The intent is to match the projected 1986 Japanese repair rate of 3.0 per 100 engines. DEP quality performance the first year after launch was 12 percent better than the last four-cylinder engine production launch in Lima in 1973, despite being a much more complex and sophisticated engine. Quality improvement of crankshaft manufacturing over 1981 is as follows:

	1982	1983
Casting	8 %	79 %
Machining	13 %	78 %

Manpower requirements, overall, have been reduced materially in the last two years, to the point of matching the Japanese level of productivity improvement of 1 percent per month (but not the actual productivity levels). Overhead reduction (supplies, maintenance, etc.) has improved at a rate of approximately 10 percent per year.

A number of reasons for DEP performance excellence were stressed by Ford management: the concentrated training program offered at the plant, EI (Employe Involvement) meetings and the participative management style, intense competition from Japan which has led to a survival mentality, and discussions by managers with hourly workers which emphasize and document the competition issue. As a result, it is stated, motivation and group spirit among personnel is up, and there is better cooperation between hourly workers and management and between the company and the union. Success in plant performance seems to have had a booster effect in further elevating morale and collaborative feelings. There is also better cooperation from suppliers, whose parts have increased in quality. The improved technology, per se, was identified as a source of better overall performance, but human factors received more emphasis from many among those with whom we spoke.

Some hourly people and skilled trades workers have a somewhat different view of the success of the effort (see Chapter 3). They feel that some of the machinery does not work well and that downtime is high. Only the extra capacity of the plant allows such deficiencies to occur without dire consequences, they argue. From management's standpoint, the plant's extra capacity allows managers to employ both production and skilled trades personnel at the levels required to effectively support production. At this level of staffing, which is considered optimal by management, some machines are allowed to be down (inoperative) for periods which some workers feel are inordinately long.

In assessing DEP performance, therefore, it is important to consider the context of production intentions and capacity. As indicated earlier, the plant was built originally to allow production of 638,000 engines per year and later expanded to 1.1 million engines per year. Because of reduced market demand, the plant has been running at about half capacity. The full capacity of the plant has therefore never been tested, and it has the luxury of great flexibility. These are unusual and irregular contributions to performance capability.

All in all, the DEP renovation involved a major implementation of innovative technology. It was evolutionary in character, but had several advanced and unique high-tech features. The implementation was carried out fundamentally through internal resources and without the perceived need for outside consultation, although vendors played a vital part in the process. The outcome substantially surpassed original expectations in multiple dimensions. A variety of internal and external factors contributed to this high performance record, from intensive Japanese competition to excess capacity relative to production demands.

<u>The Diffusion Process</u>

Product technology diffusion during the DEP renovation was basically a top-down process, with fundamental decisions made at the corporate level. Information and parameters based on that decision were transmitted to the division level from which point it was further communicated to the plant level—initially to salaried staff and then to hourly workers. Process technology diffusion, on the other hand, originates at the division level and follows a similar information-flow pattern.

One manager stated the matter this way: "In the fall of 1977...they started to take the equipment out. We didn't know the specifics of it until July of 1978." The plant manager was the primary gatekeeper for information about the shutdown and renovation. Within-plant activities were described by managers in the following way:

> Salaried personnel knew of the changes first through meetings with the plant manager. Then an active, intensive, formal program was carried out to bring the hourly people on board. Meetings started in 1979, perhaps a year or a year and a half ahead of time. Pictures were shown; prototypes were demonstrated. This kind of advanced information and preparation had never taken place before.

The news media presented information through statements by Mr. Ford and local government officials. Thus, in addition to formal procedures, word spread informally through the plant by way of the salaried people, rumors, and the media. Specific technological choices were learned by the supervisors and the maintenance managers about 14 months before Job 1 and by the workers about 12 months before Job 1. The reality of the change was demonstrated to hourly people when equipment was installed by contractors in late 1979 or early 1980. In meetings with hourly workers it was indicated to them that those displaced by new technologies would be reassigned to other jobs in DEP or elsewhere in the Rouge Plant, if their seniority was high enough to keep them from being laid off. Since the plant had been experiencing a steady drop in production since 1975, the impact was not nearly as great as it might have been earlier. Nonetheless, the plant meetings, according to managers, helped to reduce anxiety and resentment.

While many of the salaried employees saw this as a rather exemplary process of participative technological innovation, it appeared to others as more unidirectional and hierarchically controlled. Hourly workers report a picture at variance with that of salaried people (see Chapter 3). The big change for DEP was that hourly workers, mostly members of the skilled trades, for the first time were engaged in training during the pre-launch period, including at vendor locations. However, their role basically was that of recipient of skills rather than participant in decision making. A rationale for this approach was given by a plant engineer who felt more hourly worker participation would have been unrealistic. When asked if hourly employees could have provided greater input in the change process, he responded as follows:

> Realistically, no. I would like to be able to say yes, maybe they could. How can you review with somebody when you don't know what the product or machines would look like? They were still designing the product. In order to review something with an hourly guy, you have to be able to show him pretty good detail. Otherwise, why bother? Talking about generalities is pointless.

Conflict and Resistance

Different personnel groups apparently responded to the change in different ways. Although there was no consensus among those with whom we discussed these matters, some of the claims in this connection will be indicated. Division people were identified as a key stimulus in favor of technological change. Engineers were also viewed as generally favorable. Some plant production personnel up to the managerial level were seen by some as a source of resistance, both because they did not understand the technology and because they perceived risks in getting their jobs done. After the renovation, some of the technologies did not function as expected. When this happened, we were told that one of the production managers wanted the old style equipment restored. Some manufacturing engineers did not believe that millers can work better than lathes. Some older electricians feared programmable controllers or were reluctant to learn them.

On the other hand, a considerable number of those with whom we discussed this question felt that the change occurred in the main in a smooth and cooperative way. Middle management was not reported to be an obstacle to innovation. There were no general disagreements reported across broad categories or units. When disagreements arose, we were told, these were constructive conflicts that were resolved amicably.

We were informed that to the degree conflict and resistance occurred, a variety of means for resolving these difficulties were employed or evolved naturally: EI was pointed to as one means of improving relationships and communications among different groups; e.g., between hourly people and engineers. In some instances more drastic action was taken: Some people were transferred, although no one was fired. The "generic process groups" for technological development, which draw and combine new ideas from engineers at different plants but would leave the decision of implementing the ideas at each plant, served a useful educational function for some salaried people. As adjustments were made and people became familiar with new tools and procedures, the new technology became increasingly accepted.

Among the diverse group of salaried personnel who took part in our discussions, almost all reported that they had participated in one or more training events. The Teleometrics International seminar ("Models for Management), which discusses and encourages participative management style and practice, was mandatory for all supervisory personnel and above. Beyond this, the following training experiences were identified: supervisory institute, computer graphics, statistical quality analysis, tolerance charting, computer spread sheets, SPC seminars, management techniques, and torque monitoring. Training will be discussed in detail in Chapter 4.

From our investigation, we can state that the innovation process, then, largely proceeded downward through layers of the organization. Hourly employees were afforded educational opportunities to prepare themselves for operating and maintaining new equipment. The process was said to proceed in a rather smooth fashion, although there were some conflicts and resistance along the way. A variety of devices, formal and informal, planned and emergent, served to resolve disagreements and obstacles. Training was prominent among these. There was no need to introduce significant changes in promotion procedures to deal with employment concerns.

Future Innovations and Changes in the Innovation Process

Technological Advances Being Considered

The individuals with whom we spoke enumerated a range of technological innovations being considered for future introduction. These changes were said to generally aim at improving quality, reducing costs, and improving the competitive position of the company. Such changes are intended to make the system more flexible, although it is unclear to what extent this is possible. There appears to be a desire to use automation to cut costs and/or to enhance the quality of worklife including safety. However, rigorous cost justification is often difficult. If these changes are brought about, there would be many possible impacts on the salaried as well as the hourly workers. There appears to be a shift to defect prevention rather than detection, which would reduce the need for some expensive equipment. There is an opinion that too much technology and automation was introduced at one time and that more selective approaches should be used in the future. With this as an orientation, let us look at innovations mentioned as possible developments in crankshaft production, in the Dearborn Engine plant generally, and in the broader context of the company.

Crankshaft Production: Some of the manufacturing technologies already accomplished include going: from geometric centering to mass centering, from paper cloth polishing to stone polishing, from stand-alone pin grinding to in-line pin grinding. Envisioned down the road are: a robotic, automatic guided vehicle system (AGVS) for loading crankshaft castings at the beginning of the lines; connection of the Gilman dynamic balancing (geometric centering) machines with the Schenk mass centering machines for feedback adjustment of the Schenk; and laser light balancing. Also mentioned are: tieing into a mainframe computer so general crankshaft quality can be monitored more accurately and centerless grinding for the crankshaft journals. Flexible robots may be used for heavy part moving. There are hopes of using mixed processing, like running two different cranks on the same line. Flexible machining in the crankshaft area is being considered. In addition to more variety on the line, an aim is to achieve greater responsiveness so that new technology can be integrated very rapidly.

The Dearborn Engine Plant: In addition to discussing the crankshaft area, upcoming developments in the wider plant operation were described. Future changes are anticipated in the configuration and the use of programmable controllers which are getting smaller, faster, and smarter. More computers will be used. Computer aided design (CAD) and computer aided manufacturing (CAM) will bridge the plant and the division. One manager indicated that they are continuing to look for ways to improve working conditions and the working environment of the plant.

Those with whom we spoke expected that there will be greater employment of robots, but of a flexible rather than dedicated nature. It can be observed that since the plant is highly automated already, it is hard to justify moving in more robots unless they have a considerable degree of sophistication. The United States has a higher incentive to use robots than Japan due to higher U.S. employee wages. Indeed, it was stated that the U.S. employs more robots currently in auto engine plants than does Japan. In tangible cost-benefit analysis, the requirement for the rate of return is 30 percent for production equipment, but the same requirement is reduced to 22-23 percent for reusable robots.

It was also felt by some that the plant had been overdesigned in its use of high-tech equipment and procedures. Part of the effort in the future will be to unautomate or simplify processes, perhaps requiring smaller inventories. Slower machines may be employed because some of the machines may have been too fast, and netting fewer parts at the end of the day because of downtime.

Broader Developments: Efforts are being made to improve the design of the engine, aiming for more efficient fuel use by making the engine more thermally-efficient mechanically. This includes a lean burn (improving the burning rate of the air/fuel mixture or the surface/volume ratio in the chamber). There is also an intention to reduce friction throughout the entire engine and to reduce the component weights to accomplish a quieter engine through less vibration. Actually, the Hemi engine will soon become obsolete. A slightly larger 1.9-liter engine is projected in order to provide better fuel economy. Electronic fuel injection is being incorporated. A turbo version of the CVH is about to be introduced. By 1987 the engine will be quite different from the 1981 engine.

One product planner felt that the more revolutionary tendencies are in design and materials units, not in the manufacturing sector. The latter are rather passive, responding primarily to the stimulus of necessity rather than ideas. He stated that "we're milking the internal combustion engine for all it's worth." He identified another possible change: the engine-transmission interface will be optimized. Design will take a more holistic perspective, with the overall workings of the auto vehicle being brought together through interactive electronic controls. Regarding materials, there will be an attempt to reduce the number of moving parts and use solid state devices to the greatest degree possible. Things that must move will have less energy loss, reduced friction, and better lubrication. Greater sophistication will be necessary regarding tolerances. More use will be made of thermal plastics and thermal metals. There will be lighter materials with greater resistance to heat.

The rationale for all this is verbalized as better quality and productivity—leading to a better competitive position.

To queries about the reasons for these technological changes, the answers were predictable. The overriding reason given had to do with attaining a better competitive position in the market--selling more cars, increasing profitability and holding on to existing jobs in the company. Several individuals at Ford mentioned that at the time the renovation was planned General Motors was their chief competitor; now it is Japan and, in particular, Toyota.

In addition, other reasons were given which may be viewed as instrumental in relation to the primary one. These included improving the quality of the product, lowering the cost of production, and enhancing the process of manufacturing. Also mentioned was improving the quality of workplace life.

Improving the Process of Technological Innovation

All individuals were asked for their observations concerning improving means of introducing technological change based on what was learned through the DEP experience. These persons were involved at the corporate, division, and plant levels who offered different perspectives. Some major themes included: consensus and commitment at the beginning of the process, sensitivity to external forces, flexibility and risk-taking, integration among all parts of the organization, incremental change, participation, and better use of human resources.

Corporate Perspectives: It is important to obtain consensus and commitment to innovative concepts among the many and diverse units and competencies involved in a new product very early in the front-end stage. The lead time could and should be shortened through this and other means. Various units should be surveyed before a design is developed in order to learn what new technologies might be built into the design; for example, are there new ways of dealing with sheet metal fabrication? Some manufacturing people may need to be stimulated to become more receptive to new ideas being formulated by design and materials people. One view expressed was that new leadership is needed at the very top of the organization, at the board level, in order to promulgate innovation in this current era. This leadership will need to consist of people with broad backgrounds at the operating level in design and manufacturing rather than those with narrow experience in finance.

It is necessary to be attuned to various external forces promoting innovation. The younger generation of buyers are highly sophisticated regarding technology and demand the latest and best in high-tech devices. This, in particular, constitutes a new driving force in the market pushing for technological advances in products. Another driving force is competition from Japan and other countries. The auto industry is now worldwide in scope and is strongly influenced by developments taking place abroad. Still another outside force is the effect of federal government standards and regulations, such as those relating to fuel emission. These serve as constraints in some ways, but also as spurs to innovation by forcing companies to meet them in the most effective ways.

Division Perspectives: Consensus is needed among relevant divisional staff for a smooth change, which means participation by different groupings. Flexibility is needed in strategic planning. There needs to be a detailed analysis of risks and consequences in implementation planning, as well as greater simplicity. Engineers should be encouraged to take risks and enabled to go to conferences, read journals, and learn new production techniques as a way of fostering this trait. A more comfortable lead time is required between design engineering and launching. In this instance, some of the engineering was still taking place during the setting up for manufacturing, causing complications. There should be a closer relationship between engineering and manufacturing. It is also necessary to do things faster in order to cut the time between perceived consumer needs and an available product. One view expressed was that, in order to compete with Japan, people will have to work harder--longer hours, less vacation time, etc.--with significant impacts on style of life (time with the family, etc.) and standard of living for managers as well as workers.

It would be well to rely on the concept of evolving technology--continue with what currently works and make improvements within that framework. It is now deemed more important to make improvement in what you have rather than institute multiple and widespread new technologies.

People and human resources are seen as vital in technological innovation. "It is not just the hardware, but also the software, the organization, and the ergonomics." Hourly workers should be brought in very early in prespecification of new equipment. While engineers would still be in charge, hourly people could be extremely helpful in giving judgements on man/machine interface. At the salaried level greater use has been made of the generic processing system. In this system, while division staff are a key force for new technology, process engineers from all plants as well as the division would meet regularly to discuss emerging manufacturing processing methods. It would remain for the individual plant to determine how agreed-upon changes should be applied in local situations.

With regard to physical layouts, plants should be smaller and cheaper; there should be narrower aisles, fewer conveyors, and less inventory. The following table gives a quantitative contrast between the DEP and the new Chihuahua Engine Plant (CHEP) in Mexico:

Table 2

Comparison of Dearborn and Chihuahua
Engine Plants

	"Old" DEP*	Current DEP**	CHEP***
Area/Engine/Year excluding administration offices - sq. ft.	1.69	1.70	1.06
Investment/Engine Year - $(millions)	410	590	516
Budget Labor Minutes per Engine	278	164	158

* Based on net book values 12/31/77 and production volume adjusted to Erika operating pattern.
** Based on net book value 12/31/78.
*** Based on production volume adjusted to Erika operating pattern.

Plant Perspectives: Some of the previous observations were reiterated and other comments were added. These include many actions which have already been set in motion. Specific comments tend to repeat and emphasize the set directions. It was felt that there should be careful and rather detailed planning. The launch team should become the production team, living with the equipment after it is introduced. This is an incentive to obtain the best possible equipment. Change should be conveyed well ahead of time. The product and production changes should be adequately explained to all concerned parties whose opinions and ideas should be solicited. Intentions and information should be shared on a regular basis. Candor with hourly workers and the union is important. Within reasonable limits, commitments that are made should be held to, even if viewed as somewhat inappropriate or costly in retrospect. This latter point was viewed as important because trust between management and labor is vital for good implementation of innovation. Wherever practical, manpower reductions occasioned through change should be by means of attrition rather than layoffs. One individual felt motivation, sense of ownership, and desire on the part of the work force is perhaps the most salient component of successful change and productivity.

Training was identified as another important factor. But it should not simply be designed and offered. It needs to be explained and "sold" at a level that makes sense to the participant in training. The human relations aspect of a training program should remain in focus.

Engineers need to be given greater incentives to take risks. Currently, requests for new materials or methods have to be justified by detailed cost/benefit procedures. An engineering manager noted that this takes so much time and [illegible] that many engineers become discouraged and give up attempts to innovate. Production management should be involved earlier than heretofore, participating in writing specifications for new equipment. Vendors can be invited to manufacturing improvement seminars during which production problems are explained and vendors are encouraged to design devices that are innovative yet responsive to the real situation.

Lastly, it was stated that innovation should be at a scope which can be absorbed efficiently and effectively in the existing system. It is not necessary to have state-of-the-art across the board. Each new device or technique should be considered piece by piece in terms of practicality, maintainability, and long-term benefit. There may have been too much new technology introduced in the DEP undertaking. For example, a less automated and less sophisticated hot test system as compared with the one at DEP has been installed at the newer engine plant in Chihuahua (Mexico).

It is interesting to note that as we move down from the corporate to the plant level of the organization, human considerations, particularly participation, become more prominently considered as important elements of the innovation process.

In this chapter we have examined technological innovation in terms of early planning decisions, actual implementation, and suggested changes both in the substance and in the process of innovation based on what was learned at Dearborn. The presentation was drawn from discussions with managers and engineers, the professional cadre of the firm. It is important to see the same phenomenon of technological change through the eyes of production and maintenance workers whose perceptions and experiences may be quite different. The consequences of technical change affect them in a profound and particular way. It is to their observations and evaluations that we now turn.

Chapter 3

WORK ORGANIZATION AND LABOR RELATIONS

Introduction

The preceding discussion of technological planning provides insights into the functioning of Ford as a corporation. Product decisions and plans made in Europe and the United States were communicated to the plant chosen to produce the four-cylinder Hemi engine. Within the Dearborn Engine Plant an analogous process occurred. Information and decisionmaking were concentrated at the top of a hierarchical structure and communicated downward in the form of directives and schedules to people at the bottom of the hierarchy—those ultimately responsible for producing the new engine. The organizational structure in this case is paralleled by a large local of the United Auto Workers (UAW), Local 600, composed of all hourly employees in the huge Rouge complex.

In this chapter we will report on our investigation into the renovation primarily from the perspective of those on the shop floor. There are three sections to the chapter. First, we begin with an overview of changes in the <u>organization of work</u> in the crankshaft area and, in the process, analyze how those changes have affected the skill and/or training requirements of particular jobs (e.g., machine operators and maintenance workers). Second, we combine descriptive material with assessments provided by area employees about segments of the change process. Specifically, we cover: (a) <u>changes in production workers' attitudes</u>, (b) <u>changes in organizational structure</u>, and (c) the issue of <u>worker participation in decision making</u> regarding technological change. In the third section we consider three additional aspects of organizational functioning which bear on the development and utilization of human resources: labor-management relations, the organization of maintenance, and Employe Involvement.

The crankshaft operation was selected for intensive investigation through discussions among the research team, labor representatives, and management. During a meeting attended by nearly all salaried and hourly personnel from the crankshaft area (which shut down the line for over an hour), we described the methods and goals of the study. Afterward, we began our discussions with area personnel in an office adjacent to the crankshaft operation. Everyone in the area was given the opportunity to meet with us, singly or in groups of two or three; and nearly everyone did. Though it was clear that we were taking notes during our discussions, we felt that most of what we heard was candid and deeply felt.

Our investigation generated a number of important findings about the process and the consequences of technological change. In the case of the crankshaft area, we found that while the number of production employees had been reduced significantly with the introduction of new automated equipment, the skills required of the direct production workers who remained were not reduced; in fact, an argument could be made that the skill requirements of the machine operators (i.e., "Automation Equipment Operators-set own machine" or A.E.O.-S.O.M. as they are known in the classification schema) and many of the maintenance workers were increased (even if only marginally in some cases). Despite the installation of more sophisticated equipment, the machine operators' tasks continue to require and, more importantly, benefit from the know-how individual workers acquire through performance of their assignments. However, we also found that whether workers actually pick up that know-how is at least partially affected by a variety of factors; including, their assessment of the benefits of automation; their views on the efficacy of supervisory employees; and, in a subtle fashion, whether and what kind of training they receive.

Beyond specific views about the work itself, salaried and hourly employees on the shop floor recognized the necessity of technological advancement and a more consistent emphasis on product quality. Many felt that a concern with the latter was long overdue and acknowledged that a sustained increase in product quality positively influenced their views toward the work and the company. With regard to the extent of worker participation in decision making around the renovation, the findings are somewhat complex. As was suggested in the preceding chapter, the actual involvement of hourly employees in the planning of the renovation was extremely limited. Most of the people with whom we spoke (and who had been in the crankshaft area prior to the renovation of the Dearborn Engine Plant) contended that they were pretty much in the dark until the machines began arriving for installation. A significant subset of the skilled tradespeople and machine operators were employed before the start-up to help test the equipment; this *did* represent an important experience for those workers. However, most reported being *instructed* by vendors in how to work or fix the machines, not *asked* how to help arrange the machines to increase efficiency or to render the area compatible with workers' perceptions of a comfortable work setting. Nonetheless, as was pointed out earlier, worker *representatives* in the form of union officials from Local 600 and the Ford Department of the UAW did engage in intensive efforts to secure DEP as the site for renovation, thus saving some 2,000 jobs at the Rouge.

Labor-management relations in the crankshaft area show themselves to be a positive factor both in the smoothness of the renovation and in the history of the area after the start-up in 1980. Mutual respect between most hourly and salaried employees can be explained both by the relatively high degree of communication that takes place on the floor and by the personal characteristics and backgrounds of higher-level salaried employees in the area. This generally can be attributed to the overall impact on the work climate of the Employe Involvement (EI) process. EI was introduced to DEP in 1980. While a number of problem solving groups were formed, including the crankshaft area, the extensive bumping due to senority-based reductions and transfers made it difficult to retain formal EI group activities. However, the training associated with EI was beneficial to building and maintaining positive relationships. Thus, although formal EI groups were not active in the crankshaft area when this case study was conducted, informal form of participation and dialog were evident.

Changes in the Organization of Work

Major technological changes generally precipitate major changes in the organization of work and workers. Job requirements for workers change as old tasks are taken over or rendered obsolete by technology and new tasks (such as tending the new machines) are created. Assessing the impact of new technology, particularly automation, on manpower requirements, job content, and skill levels is a difficult undertaking—made all the more complex by the public and private policy concerns stimulated by the specter of sophisticated machines displacing human beings.

While we will discuss policy dimensions in the final chapter, it is important here to remind the reader that the issue of skill requirements to run and maintain sophisticated automation was a national concern in the 1940s and 1950s when automation was being introduced at a rapid pace in many industries, including auto. James Bright,* in a study which included an advanced technology engine plant,

*Bright, James R. "Does Automation Raise Skill Requirements?" Harvard Business Review, 1958, No. 36:85-98.

concluded that the new automation was distinctive because it replaced aspects of both physical work and decision-making/judgement formally required of machine operators. Bright found that skill requirements for most jobs were not significantly altered as a result of automation. Certain jobs, such as those performed by the majority of workers in the crankshaft area, were transformed into what he referred to as "new specialists' jobs" which entailed "manning the control systems" of machines, rather than engaging in direct machining tasks as before. In other words, machine operators are fewer in number as a result of the new automation; and the principal activity of those who remain has been specialized to involve a more direct concern with operating the control system of the more soph[illegible] [illegible]s.

Bright's study reminds us that neither current policy concerns nor investigations of the human resource implications of technological change are new. His research underscores the importance of considering the baseline for technological change—an argument echoed in the preceding chapter with our notion of a spiral of technological change. Thus, it is important to recognize that the "old" crankshaft line (before the renovation at DEP) was not devoid of automation. While the new automation is significantly more sophisticated and extensive than that which had been employed previously, it represents in many respects a linear extension in the same type of technology, rather than a decisive break or quantum leap.

Some comparison of new and old jobs and their respective staffing requirements in the crankshaft area will set the stage for our discussion of changes in the content and skill demands of new jobs.

<u>Changes in Jobs and Staffing</u>

The crankshaft lines currently run on two shifts: from 6:30 a.m. to 3:00 p.m. and from 3:00 p.m. to 11:30 p.m. The later shift operates with a skeleton crew of 11-12 production workers and a few maintenance people. Most production workers hold the title of "Automation Equipment Operator — set own machine" (A.E.O.-S.O.M.) or "S.O.M." for short. The title reflects the dual nature of these jobs: workers operate and set the machines to which they are assigned and only those machines. Although many of the workers in the area and their supervisors refer to the task as "job setting" and to the workers as "job setters," the term job setter has a specific meaning in the negotiated system of job classifications: job setters set-up machines for other workers to operate. Thus to avoid the confusion, we will refer to these workers as "S.O.M.s" or "machine operators" with the understanding that they do limited set-up work as well. In this connection it should be noted that S.O.M. is a designated or classified position, meaning that it is considered semi-skilled and receives an increment in hourly wages over jobs which require less training. Machine operators also occupy a slightly more protected position since they cannot be displaced from their jobs (in case of cutbacks) by more senior unskilled workers (e.g., assemblers, stock handlers, or cleaners). Prior to the renovation, the largest category of production worker was the machine operator; but that classification referred to someone who simply ran the machine and relied on a separate worker, a job setter, to set the machine, change grinding tools, etc. The reclassification of the work, according to plant and union representatives, reflected an increase in the duties of those workers (the new machine operators or S.O.M.s) who remained after the renovation.

During the course of the investigation we spoke with nearly all the hourly employees in the crankshaft area. In many respects they provided a mirror of the population of the Ford Rouge complex: Roughly half had completed high school; they averaged close to 21 years company seniority (slightly higher than the DEP average); and several had recently come to the crankshaft area as a result of being bumped out of some other (usually skilled) position. Experience in the crankshaft area ranged from a high of nearly 40 years for one job setter to a low of a few months for another. The bulk of machine operators had an average of three years of experience in the area--meaning that they arrived there during or after the renovation. The skilled tradesmen in maintenance jobs (e.g., electrician, hydraulics repair, millwright, or pipefitter) tended most often to be high school or trade school educated.

In the current operation, rough castings dispatched from a casting plant are hand loaded (with the assistance of an overhead pulley device) at the beginning of the line (see Appendix C). The crankshaft must pass through 18 machine stations where surfaces are ground, oil holes are drilled, other holes are drilled and tapped, and in the final stages the crankshaft is balanced, cleaned, polished, and electronically inspected. If a crankshaft passes final inspection, it is manually unloaded and hung on overhead conveyors; otherwise it is sent to repair bays.

On the old line a considerable amount of manual unloading, transporting, and reloading was necessary throughout the machining process. Many of the machines (in grinding, especially) had to be carefully adjusted and gauged by hand. These adjustments were particularly critical and often tricky because the equipment was easily disturbed and, in later years, so old and run down; much of it was thirty to forty years old when finally scrapped. Machine operators quipped that they always kept paper clips and rubber bands around to make minor repairs on the old machinery. With new automated material handling systems and in-line gauging, the crankshaft loaded at the beginning of the line can (in theory) pass through all operations untouched by human hands. In practice, many crankshafts are touched by human hands; and tinkering with the new equipment is necessary since breakdowns do occur, and minor malfunctions are relatively common. Nonetheless, the introduction of additional automation and in-line gauging (i.e., gauging built into the equipment that automatically checks parts and adjusts machine settings) has meant that fewer people are needed to run the machines.

It is difficult to accurately compare staffing requirements in the crankshaft area before and after the renovation. Table 3 (below) presents the approximate number of hourly workers employed in the area under different conditions: (a) for a single shift running at capacity <u>after</u> the renovation and (b) for a single shift running at capacity <u>before</u> the renovation. These figures should be interpreted with some caution, for several reasons.

Table 3

Approximate Staffing of Hourly Employees in the Crankshaft Area Per Shift (Dearborn Engine Plant)*

Job Classification	After Renovation	Before Renovation
Job setter	2	17
S.O.M./Machine Operator*	22	--
Machine Operator**	--	36
Stock Handler	3	9
Repairman	2	N.A.
Inspector	3	4
Other	3	N.A.
Total	35	66

* Staffing per shift is used as a base to allow a rough before and after comparison. It should be noted, however, that the present crankshaft area runs at approximately 50 percent of capacity. This translates into one full shift (days) and two skeletal shifts (afternoons and midnights).

** Sets and runs own machine.

*** Only runs the machine.

Source: Discussions with DEP crankshaft area personnel.

First, the new crankshaft has smaller surfaces to grind and polish than its predecessor. Second, the plant is currently operating at about half of its capacity and was running closer to full capacity before the renovation. Third, staffing needs are highly variable over time as the downtime of the equipment changes, supervisors learn more about what is needed, and new people are brought in with different capabilities. At the time of the study some people were being retained in the crankshaft area even though the operation could function without them in the hopes that volume would pick up again. As a result, the department frequently loans out workers to other departments. Fourth, staffing levels in the plant and, by extension, the crankshaft area have fluctuated considerably in response to car sales (see Table 4 below). Finally, recent changes in quality control practices independent of the new technology (discussed later) give machine operators greater responsibility for inspecting their own work and further reduce the need for inspectors.

Table 4

Quarterly Employment Levels (Hourly Employees)
at Dearborn Engine Plant, 1977-1983

Year	Quarterly Employment level I	II	III	IV
1977	1919	1969	1952	1893
1978	1861	1931	1165	934
1979	— closed for renovation —			
1980	1147	1417	2116	2498
1981	2698	2701	2651	2607
1982	1641	2268	2257	2187
1983	1507	1424		

Source: Ford Motor Company, Dearborn Engine Plant

Nonetheless, it is clear that automation has eliminated some jobs and altered the content of others. The most dramatic reductions have occurred in the grinding area and in the process of stock handling. In the grinding area one machine operator now does a job which previously required the attention of four. On the old grinders an operator on each machine manually loaded a 65-pound crank, clamped it in place, engaged the grinder, watched a dial on the top of the machine, and disengaged the grinder at the appropriate time. The crank was then unclamped and unloaded. The operator relied on a job setter to ready the machine, to make all but minor adjustments, and to change tools when necessary. Many of these operations are now done automatically by the equipment, eliminating the attachment of one operator to each machine and virtually eliminating the job setter category. An automated loader machine running on an overhead track now comes to the grinder with an unground crank in one "hand," reaches in and grabs the ground crank with the other "hand," and places the unground crank in the grinder. It then brings the finished crank to a conveyor for the next operation and picks up a new unground crank. After some initial grinding, in-line gauging comes out and checks the diameter and taper of the unground crank and signals the grinder how much more to grind. After additional grinding, the gauge comes out again, rechecks the part, and may signal if more grinding is needed. If bad cranks are produced three consecutive times, the grinders are automatically shut down by post-process gauges.

In the case of stock handling, before the renovation the work of transferring crankshafts between operations was divided between workers and machines. At various junctures in the process--particularly in the middle stages of grinding and balancing—uneveness in the output of some machines required stock handlers to off-load and transfer crankshafts between production lines. With the new equipment, the number of stock handlers has been reduced—by 67 percent, if the rough comp sons in Table 3 are any guide.

One might ask why people are needed at all to tend the machines. The answer:

Tools must be checked and changed; the grinding wheels must be "dressed" periodically so they are the right width and "dressed" evenly (after each crank a diamond honer automatically runs over the grinding wheel to clean it); new grinding wheels must be manually installed periodically; quality control checks must be performed including checking parts with manual gauges to be sure the automatic gauges are functioning properly; and, in the case of machine breakdowns, a skilled tradesperson must be called while crankshafts are manually unloaded to be run on a different line or stacked on pallets.

On the old crankshaft line, not only did one operator run each machine, but a job setter would get the machine ready (e.g., adjust its gauging) and change tools as necessary. Stock handlers were available to load and unload cranks using the overhead pulley systems. Cleanup men were keeping the area clean. In addition, quality control inspectors were assigned to the area to check parts. Now, the distinction between machine operators and job setters is blurred. Beyond a few isolated cases (e.g., the insertion of one worker to visually inspect the newly ground crankshafts), each person in grinding is a generalist who sets up the machine, checks gauging, changes tools, inspects the work, loads and unloads crankshafts as necessary, and has four, not one, machines to tend. The person who mounts the grinding wheels also does cleanup and other odd jobs.

Changes in Skill Requirements

Clearly the grinding operations are much more automated than before, but it is important to note that machining operations have generally been among the most highly automated in the automotive industry for several decades. Though the pre-renovation machines were old, they performed many complex tasks automatically and replaced much of the judgement necessary on older non-automated tools. The new technology in the plant further automated remaining manual operations and, through electronics, moved closer to eliminating human judgement in normal operation. However, since "normal operation" is sometimes interrupted by machine breakdowns and hampered by improperly positioned crankshafts or faulty machine adjustments, human judgement is still required to keep the line running. For these reasons we conclude that there was no significant deskilling of jobs.

If there was no significant deskilling, can we assume that skill requirements were substantially raised? The answer is no, though if anything, skill requirements increased slightly. While this answer may appear to be evasive, the problem is in the phrasing of the question. The question assumes skill requirements can be ranked on a single dimension and jobs compared in this way. In fact, skill requirements are a multidimensional phenomena. Some skills became obsolete (e.g., the minor repairs needed to keep the antiquated machinery running were no longer necessary) while new skills were necessary. For example, job setters in the old crankshaft operation did little or no stockhandling.

Perhaps the best summary of the change in skill requirements is to say that the task scope of the new machine operators/S.O.M.s expanded as they took on responsibilities previously performed by other less-skilled workers and some additional learning was required to interpret and operate the control panels on the new equipment. Watching the control panel and reacting to various problems that occur in the day-to-day operation of the machines requires mental alertness and a specific knowledge of the peculiarities of each machine. The machine operators/S.O.M.s are counted on by maintenance workers and engineers to explain the events preceding a machine breakdown and to assist in diagnosing problems. A dedicated machine operator knows the machine better than anyone else in the plant. At least one worker explained (with obvious pride) that on several occasions he has been called in from vacation to get his machine running again after a serious breakdown.

The formal training given to machine operators includes a general orientation to gauging, changing tools, and other job-related tasks; but (as will be discussed in greater detail in Chapter 4) many of the machine operators were not impressed by this general training and felt the most valuable training came at the hands of vendors with whom they worked to initially set up and qualify the machines. Machine operators estimated that a few hours of training was all that was necessary to learn the basics of setting up the machine (i.e., for a mechanically oriented worker) but qualified this by saying that at least three months of experience is necessary to learn the specifics of the machine enough to feel comfortable running it and dealing with the various machine jams and breakdowns.

Beyond the task requirements needed to run the new machinery, other recent changes are beginning to influence the organization of work in the crankshaft area. Among the most visible changes are introduction of statistical process control (SPC) and Employe Involvement (EI), elimination of production standards, and implementation of a new computerized tool change program. Models for each of these innovations from Japan were mentioned in our conversations with salaried employees; however, it was emphatically denied that the DEP programs were copies of the Japanese models. While a detailed discussion of these programs is beyond the scope of this report, they will be discussed below as they relate to changes in work attitudes and participation in technological change.

Overall, skill requirements changed, yet it is also clear that there was significant skill transfer from the old crankshaft operation to the new operation. The design of the new four-cylinder crankshaft is not unusual; the only significant exception is found in the particularly close tolerances required to accommodate the high speed of the engine. Hence, past experience in the machining of crankshafts was a valuable asset for production workers; and, even though the sophisicated electronics and automation on the renovated current line were new, the product and the basic machining operations remained the same. One way to further examine skill requirements of the job is to consider the mix of education and work experience present in the current staff.

Workers' Experience and Skill Base

Arrangements negotiated between management and the union allowed for a significant overlap in hourly personnel in the crankshaft area before and after the renovation. At the time of our study, slightly less than half of the machine operations working in the area had been there before the renovation. As is shown in Table 5 (below), machine operators had a median of 3 years in their present jobs (roughly the time since the start-up after renovation); but the average time-in-job of 6.6 years reflected the fact that a portion of the present work force had been there substantially longer. These latter workers, in particular, played an important role in the transition between the old and new production systems. Skills they had acquired in operating the old equipment were valuable in setting up and diagnosing problems in the new. In fact, this skill base had a broader impact: Many of the experienced workers helped train (in an on-the-job, informal fashion) those operators brought into the area after the renovation.

Table 5

Selected Characteristics of Hourly Personnel in the Crankshaft Area

	Age		Years in job		Years in company	
	Avg.	Median	Avg.	Median	Avg.	Median
Machine Operator/ S.O.M.	45.8	41.8	6.6	5.0	21.4	18.2
Other*	40.6	40.5	2.7	2.4	20.6	18.4
Skilled Trades	38.3	39.0	7.4	7.1	21.7	20.2

*Includes stockhandlers, repairmen, inspectors, oilers, cleaners.

Direct experience in the crankshaft area was not, however, the only skill base management had to draw on in constructing a labor force for the renovated operation. Of the majority group which had not been in the crankshaft area before the renovation, half had had prior experience in general machine operation as job setters and machine operators (e.g., in some other facet of engine production, operating mechanical equipment in the stamping operation, etc.) or, in at least two cases, as skilled tradesmen. The remainder had experience in a variety of other activities mostly in the Rouge complex; including assembling, warehousing, stock handling, and inspection. Thus, as one machine operator suggested, the majority of workers had learned "machine sense" at some point prior to their arrival in the crankshaft area.

An important corollary point can be drawn from the data presented in Table 5: All categories of workers (machine operators, skilled tradesmen, and others) have had work experience in areas outside the crankshaft and often outside DEP altogether. This helps explain why, for example, there should be such a disparity between the "years in job" and "years in company." One worker, whose employment history was typical of machine operators in the area, had spent 2 years in the stamping plant, 8 years on the engine assembly line, 6 years as a job setter in the engine block area, and 2 years in the fuel tank operation before arriving in the crankshaft area. His overall seniority was 21 years, though he had been a machine operator/S.O.M. in the crankshaft area for little over 3 years.

Any explanations for why workers' employment histories resemble a mosaic of different jobs would, of course, have to take into account the unique circumstances, abilities, and behaviors of individuals. However, the fact of the mosaic represents the combined impact of three factors in the structure of the auto industry and Ford Motor Company. First, the seniority system (see Appendix E) agreed upon over the years between management and the union has made it possible for hourly workers to acquire employment security even in the face of cyclical trends in car and truck sales. Moreover, it has allowed workers some discretion in choosing jobs by establishing a procedure for filling job vacancies in different aspects of the production process—enabling the applicant with the highest seniority (in most cases) to move from one job to another (e.g., to acquire more skills, escape the boredom of an unchallenging job, or to seek a more acceptable work environment). Second, the cyclical market for cars and trucks and the changes in production technology have contributed to the mosaic of employment histories through the company's internal adjustment of staffing levels and manpower distribution. As product lines grow or decline and new techniques absorb or displace labor, employees are shuffled internal to the organization largely with an eye toward matching available skills with job requirements. In some instances, the seniority system stands as an obstacle to the most efficient reallocation of labor during an adjustment; in others, informal ties between managers, union representatives, and/or workers may intervene with the same effect. However, the fact of adjustments through reallocation of existing personnel further contributes to the variety of workers' job experience.

Third, and finally, the peculiarities of the Rouge complex play a role in explaining the mosaic. Given the variety of production operations concentrated there, the Rouge can almost be viewed as a car company by itself. And, since the UAW-Ford contract allows for workers to move or be moved among facilities within the same level (subject, of course, to the stipulations of the seniority system), workers in the Rouge complex can have worked in facilities as diverse as the steel mill, stamping plant, assembly plant, glass plant, and the engine plant. Other locals, which may include one or two plants, would not provide the opportunity or rationale for such diverse work experiences.

Variations in the employment experience of workers in the crankshaft area have contributed to the rich skill base available to the company for purposes of adjustment. Moreover, the fact that workers have, on average, spent the bulk of their working lives at Ford offers testimony to the utility of what is generally referred to as an internal labor market. Yet, diversity in experience does not necessarily translate into an equivalent breadth in skills (especially when work tends to be broken into routine, repetitive, and restricted tasks); diversity in experience does not necessarily guarantee that there will be an efficient matching between skills already acquired and skills expected on a new job; and finally, diversity in experience does not necessarily predict that workers will be more (or less) satisfied with their jobs or positive (or negative) in their assessment of the company's utilization of them as a human resource. For this reason, we turn now to the findings from our discussions with workers about their jobs in the renovated crankshaft area.

Changes in Job Content and Production Workers' Attitudes

Pressed to assess their present jobs in light of the previous arrangements, most workers argued that the new jobs were satisfactory, the new technology an improvement, and the increased emphasis on product quality long overdue. However, summary evaluations do not capture the mixed feelings many displayed when we probed deeper. With few exceptions, production workers recognized the need for faster and more sophisticated equipment, but few were sanguine about the costs of new technology, particularly in terms of jobs lost. One machine operator who regarded the new machines as a vast improvement over the old system nonetheless argued:

> Well, it is all fine and dandy—automation and all that—but in terms of the blue collar worker out there on the floor, it is less stability for us. When you see a piece of equipment come in, you know somebody has got to go.

The specter of displacement by a machine often blends with the insecurities, caused by the recent history of fluctuating employment levels (see Table 4), contracts without significant economic gains, and the relocation of some engine production in Mexico, to foster distrustful attitudes toward the company. One worker with over twenty years at Ford echoed a familiar refrain in the crankshaft area:

> You got to know it's not going to be too long before they come up with machines that don't need job setters. Even right now they're trying to reduce some jobs to S.O.M. (set own machine, a lower-paid, less-skilled classification), because they say you don't need a job setter to do it.

It is interesting that comments such as these, though critical in their assessment of the company's responsibility to long-time employees, have come from people whose high seniority makes them much less vulnerable to layoff.

When the focus is shifted to how workers assess the nature of their jobs in the renovated crankshaft area, a different (though not necessarily contradictory) viewpoint emerges. Most of the workers with whom we spoke seemed ambivalent about the impacts of the renovation on their jobs. While most agreed that the work was less physically demanding, there was no clear consensus on whether the jobs were more challenging by comparison to the old system. Typical was the case of a machine operator who runs a grinding machine. In comparing his new job to the one he performed before the renovation, he suggested:

> You have to know more now. You have to know a little bit about everything . . . . Automation eliminated physical work. It is easier now, but you do have to understand the machine. The physical work was better before (doesn't like a lack of exercise). It was routine and not complicated.

When asked about the variety of tasks he performed and whether he ever gets bored, he said:

> There would be more variety if I had less seniority and was moved around. It is still boring. If everything is running okay, you have nothing to do. If you have a lot of trouble, time flies. It wasn't really boring before. You had to meet a production number, and then you could go to the lunchroom and play cards. It is more boring now.

Comments such as these were common in our discussions and emphasize the fact that the question of changing skill requirements defies simple generalization. Two principal problems are manifested: (1) many aspects of individual jobs and work organization changed concurrently; and (2) different people experience the jobs very differently. For some workers, responding to the needs of their machines is a full-time job (i.e., recalling they now have responsibility for several machines while they used to have only one). Others who are more competent at running the machines, have fewer machines assigned to them, or have less troublesome machines, still need to stay by the machine in case something goes wrong. Some workers find these long stints of inactivity terribly boring, especially since there is no one with whom they can talk close at hand. They relish the "good old days" when operators, stockhandlers, jobsetters, and cleanup men worked in close proximity. At least one worker liked best the idle periods during which he could relax and work on crossword puzzles.

The earlier comment about playing cards toward the end of the shift was a reference to the old "performance standard" system under which employees were expected to produce a fixed number of good parts each day. After producing this number (based on estimates of average worker capabilities), they were free to spend the remaining time on the shift as they desired. The new "bell-to-bell" system requires working at a "reasonable" pace as needed to produce quality parts for the entire shift. Some found the old system more challenging because they had an incentive to work at the fastest pace possible, as in a game.

Most of the machine operators agreed that the [illegible] is more complex, in part because they have to understand the basics of the new machine (i.e., dials, indicators, some basic electronics, and the metric system). Reportedly, once these basics are mastered, there is still a lot to learn about the operating characteristics of a particular machine as "these machines each have their own personality."

Learning the "personality" of a machine can offer a challenge but not all workers pick up the challenge. Our discussions revealed that those who saw mastering the idiosyncracies of the equipment as a source of stimulation tended also to be people who were introduced to the machines during the renovation process itself. These veteran machine operators had helped the equipment vendors qualify the new machines. They picked up many tricks of the trade, and it was clear that this experience deepened their identification with the machines and led to a level of pride not evident among those not involved in this personalized indoctrination period. In particular, machine operators on the evening shift—most of whom came into the area after the renovation—lacked the strong identification and pride of the veterans and were frequently criticized by those on the morning shift. As one worker put it:

My biggest headache is trying to figure out what the afternoon guy has

> left me. I don't know if the machines are messed up until I run them. He doesn't mark it on the line-up chart. He is not mechanically oriented.

Although such comments are heard in other multi-shift manufacturing operations, "unevenness" in the willingness of workers to learn their machines has partial roots in the nature and quantity of training they receive, as we will note in Chapter 4.

Skill requirements are particularly intangible, but even the issue of lifting requirements is not straightforward. In an earlier quote a machine operator noted that he does little lifting now compared to before; some people, however, do a lot of lifting each day as their machine breaks down or the machine ahead of them breaks down and they must stockpile crankshafts. One man claimed he does much more heavy lifting now than before when he had a stockhandler. Now he must do his own lifting; and since this was not designed into the "normal" operation of the line, he does not have the aid of a pulley system. He typically lifts 100 or more crankshafts a day (at about 25 pounds each) which he finds extremely wearing.

Downward mobility strongly influenced the work attitudes of those workers who had been laid off from the skilled trades or even supervision. For example, one machine operator who had completed the skilled trades apprenticeship program (including after-work classes) ended up back in production at the engine plant at less than his former wages as a result of layoffs elsewhere in the Rouge complex. He was quite bitter about the step downward and considered his four-year apprenticeship program a lost investment—time he could have spent with his family. This person and several others who had worked in far more intellectually or mechanically demanding jobs found machine operating positions routine and demeaning. For them, retirement could not come too soon.

In spite of these assessments, there was general agreement among production workers that the new emphasis on quality was indeed real and that it enriched their jobs. They felt greater pride in their work and also felt a greater sense of control.

The control comes from having some information (e.g., control charts and additional gauging) to know whether they are producing a quality crank or not. Moreover, they can now refuse to run bad parts, even if their supervisor suggests otherwise, because of systems introduced that deter supervisors from taking such action (e.g., a phone line through which they can anonymously identify supervisors ordering them to run bad parts).

Though the recent increased emphasis on quality is significant, it is clear that statistical process control is not being used as effectively as it might be. Most machine operators are now checking their own quality; however, few are keeping their own quality "control charts." We were told by supervisors that some machine operators have not learned to compute averages and record data on the charts. Responsibility for collecting data from the machine operators has therefore been given to one hourly employee who now makes up the charts. The result is that workers on the line may be getting feedback on the functioning of their machines from the charts--but not in a participative fashion and thus do not have the additional responsibility the approach implies.

Questions about the effectiveness of SPC were put to workers, supervisors, and union representatives. Their responses indicated that, like other aspects of change in organizational practice, there are quite divergent perspectives on the subject. Nearly all of the production workers understood SPC to be aimed at increased product quality; yet, less than half of those with whom we spoke actively used the control charts to monitor their machines. Some felt they were inadequately trained to effectively employ the SPC methods; others felt more comfortable with older, "hands-on" methods for monitoring their equipment. A small minority felt that the additional duties associated with SPC should be remunerated and, therefore, would not perform them until wages were raised. One union representative confirmed that SPC was "a touchy issue" precisely because it involved the addition of responsibility without a traditional increment in wages. While he implied that ironing out the conflict might take some negotiation, he also noted that the union supported efforts to increase quality. Managers and supervisors, on the other hand, denied that SPC had anything to do with adding work and argued instead that SPC offered workers the means to more effectively monitor their machines. The problem with SPC, one salaried employee told us, was that "past efforts at quality control usually ended up pointing the finger at individual workers. We used SPC to count people's mistakes." Now, he argued, SPC is used to help people do their jobs instead of punishing them.

Another recent procedural change seems to take considerable discretion away from machine operators/S.O.M.s. Prior to the renovation, a separate classification of workers, job setters, were employed to change tools in the machines. Immediately after the renovation, machine operators/S.O.M.s replaced the job setters but continued to use their own judgement to decide when tools needed changing on their individual machines. There were guidelines, but some machine operators claimed they could tell when the tools need changing by looking at the cranks; others said they can hear when the tools need changing. Now, however, a computer program is used to keep track of tool changes and to schedule new changes according to frequencies specified by tool manufacturers. The same person who keeps up the control charts is responsible for the tool change program. He uses the computer output to tell machine operators when to change their tools. Although the architect of the program, a process engineer, assured us that it is only intended to provide guidelines, these "guidelines" are interpreted as rules by workers in the crankshaft area. To machine operators, this computer program threatens to take over one of the few decisions they are expected to make. Some workers strongly resent this loss of autonomy and feel their judgement is superior to the simplistic decision rule used by the computer.

Changes in Organizational Structure

Although, as was mentioned earlier, the renovated crankshaft area has yet to operate at its full capacity, the single-most-striking change coincident with the renovation has been the reduction in the number of hourly workers. One of the most important changes in the organizational structure of the crankshaft area to flow from this has been a reduction in the number of supervisory positions. Quite simply, it was difficult to justify the use of that much nonproductive labor in an area marked by more automated parts-checking and a substantial reduction in the number of hourly employees. Beyond this effect of the new automation, Ford as a corporation has undertaken a campaign of reduction-in-force in the salaried ranks. Within the engine plant this move, spurred by declining sales and the recognition that the union expected the company to share the burden of market conditions, has taken the form of the elimination of one layer of supervision in the crankshaft area--the general supervisor--and several production supervisors (formerly referred to as "foremen"). While, in fact, the general supervisor in the crankshaft area was converted to a "manufacturing planning specialist" or technical assistant to the area superintendent and continued to perform the principal duties of the general supervisor, we were assured by the plant's management that they fully intended to eliminate the title and reassign the duties of the general supervisor.

The elimination of some production supervisor positions and the removal of a layer of salaried personnel has had some effect on communication in the area. Just how much effect is unclear; however, in large part, due to the general agreement among both hourly and salaried workers in the area, communication has not been a problem <u>at that level</u>. The elimination of some supervisor positions hand the removal of a layer of salaried personnel was in fact designed to improve communications. As we will go on to point out, the high degree of technical familiarity with the machines evidenced by the area superintendent and his own generally outgoing personality has built a solid foundation for communication and information sharing between salaried and hourly employees. However, changes in the structure of supervision have not, as yet, independently contributed to an appreciable increase in the quality or quantity of information people on the shop floor (especially hourly workers) receive about company plans, plant performance, or most importantly, the future of employment in DEP and Ford Motor Company.

Worker Participation in Decision Making Regarding Technological Change

Although new approaches may result from the DEP experience, it is relatively clear from our investigation that worker input about the type or the extent of technological change at the time of renovation was not considered a tactical or strategic concern for management at the Dearborn Engine Plant. A segment of the work force did indeed participate in the process of renovation, and their training at the hands of the equipment vendors was a valuable part of the renovation process. However, as was described in Chapter 2, the formal involvement of the hourly labor force in decision making about technological change was mainly in the realm of formal and informal union-management discussions. The core of worker involvement was the important but rather distant negotiations and lobbying which were undertaken by union representatives to see to it that the construction of a new engine facility took place in the Rouge complex. Our discussions with production workers in the crankshaft area indicated that few workers knew, until the last moment, whether the engine plant would be saved or eliminated, whether their jobs would remain after a renovation, or what the technology of the new crankshaft area would look like. And, while the union was intensely involved in the decision-making process about the location of new engine production, the actual contours of the new technology--(i.e., the number of jobs saved or eliminated, the kinds of skills which would be required, or the organizational changes which would likely accompany a significant alteration of the machining process) were not made explicit until after the equipment was installed. Even though the company and the union followed an accepted practice of renegotiating their local agreement (covering the engine plant) in 1979, it was not until many months later that enough was known about the extent of change to realistically incorporate changes in the production process into the language of the contract.

To suggest that neither workers nor the union were actively involved in decision making about the type or extent of technological change is not to ignore the fact that the production labor force was involved in the renovation. In fact, the union and company agreed to involve workers in several important ways. First, a crew of skilled tradesmen (e.g., in the maintenance and construction trades) were employed during the renovation to physically overhaul the building and install the new equipment. This agreement helped keep jobs in the Rouge complex which might otherwise have been subcontracted and enabled some workers to have direct exposure to the new machinery. Second, an accord was reached which enabled machine operators to have recall rights back into the engine plant when the renovation was completed. This meant that the skills of 117 workers who had been trained in the area could be saved and, potentially, augmented in the process. And third, a number of machine operators who had worked in the engine plant prior to the shutdown for renovation were kept in the plant to assist in the process of bringing the new equipment up to capacity. The attention these latter workers received, in particular, made the experience a valuable one for them individually and for the company as a whole. However, that experience was unique (both in terms of the training and the extent of renovation) and has not been and will not likely be repeated. This is the case for two reasons: (1) There is not likely to be a renovation of equal magnitude in this facility again for at least some years to come and (2) the kind of attention shown to nonskilled workers (especially workers in classified jobs, in this case machine operators) has not been continued after the renovation because it is not needed. We will return to these two themes in particular when we consider in greater detail workers' assessments of the training program in the next chapter.

Labor-Management Relations

Labor-management relations in the area seemed to be a positive factor in the plant's efforts to undertake large-scale technological change. From the side of production supervision (including the superintendent, his assistants, and the supervisors with whom we spoke), there appeared to be great respect for the men working in the area. Although, the superintendent, in particular, was quick to point out that any organization or production area is going to have its "bad apples," he also stressed that the men who worked in the crankshaft area were marked by their singular willingness to cooperate and see to the efficient functioning of the area. The relatively high degree of informality in most dealings we observed or heard about between management and workers reflected an important aspect of camaraderie in the area. This can also be attributed (if only partially) to the consistently good economic performance of the area.

Nonetheless, it can be reasonably argued that one of the main factors underlying the "good feelings" is the respect accorded to the superintendent which derives from his familiarity with the area, his relative long tenure in the crankshaft operation, and his good working relationship with his workers. This man, in particular, is representative of a "vanishing breed" in the plant and, by some accounts, in the company as well. That is, he was "raised" in the crankshaft area. He began working there in his first full-time job, as a job setter. He worked his way up the ranks; and though he was transferred around the plant somewhat, he did the bulk of his supervisory internship there. Thus, he has had the unique experience of having been an hourly job setter, supervisor, general supervisor, and finally, superintendent all within the crankshaft area. This has been a major factor in his ability to keep the area running smoothly (by his own admission) and in his capacity to relate to the hourly workers in his area. By contrast, his replacement (announced as we were completing our investigation) did not have comparable experience. If the kind of technical ability to respond to the workers' needs that the veteran superintendent has is at all a factor in his good rapport with the workers in the area, then some loss of that rapport is likely to be felt with his departure.

We saw evidence of some tension in the attitudes of workers toward recent arrivals among first level supervisors. With few exceptions, machine operators complained that recent arrivals were not well trained in the jobs workers did and actually posed an obstacle to the efficient functioning of the area. One major form this took was in workers' frustration in getting quick, correct response to problems with their machines. One segment of the hourly group of machine operators has strong working knowledge of their machines; thus, when they want a malfunction corrected, they do not like to explain the problem to supervisors inexperienced in crankshaft production to get the assistance of the maintenance supervisor. Others, including those less well versed in the operations of their machines, find inexperienced supervisors a hindrance in getting their machines fixed. In some instances it is because they cannot explain to the supervisor what is wrong and he, in turn, cannot diagnose the problem independently. This causes frustration for both sides. In other instances neither can identify the problem; and since the supervisor might not adequately communicate what is wrong to the supervisor of maintenance, the job might not be done in the appropriate priority. In situations such as these, the lack of adequately trained or experienced supervisors can cause inefficiencies, frustration and, one might expect, friction between workers and management. The problems created by this situation and their implications for training will be further analyzed in Chapter 4.

The Organization of Maintenance

Whether speaking to upper management, engineers, production supervisors, or machine operators, one commonly hears strong opinions about the skilled trades and the way they are used. Skilled trades workers in the auto industry, as in other settings, occupy a unique position. They are vital to the efficient functioning of the plant and its hundreds of millions of dollars in equipment. To maximize return on its investment in equipment, Ford has also invested heavily in its skilled trades training program; the Rouge, for example, boasts one of the best skilled trades training programs in the country, including intensive night courses at nearby Henry Ford Community College and the expanded resources of the DEP Learning Center (see Chapter 4 for more details on the latter). To recognize their special skills and to avoid losing them to a labor market perennially in demand of skilled labor, Ford pays a substantial wage differential to tradesmen. Thus, training and pay set skilled tradesmen apart from other hourly employees.

The division of labor in American automobile facilities amplifies the significance of the skilled trades precisely because it has accorded all maintenance and repair tasks to the relatively small core of electricians, plumbers, pipefitters, tool and die makers, and the like. While lines of demarcation between skilled and nonskilled workers have evolved over time into a body of local custom, they have also been formally sanctioned in the language of union contracts. Every local agreement recognizes the special status of the trades and outlines, among other things, the right of tradesmen to file a grievance when they find a non-tradesman (hourly or salaried) doing a tradesman's job. The trades also have a separate seniority system. Moreover, only members of the trades negotiate and vote on their own local agreement and that of other hourly workers as well.

In addition to their centrality to efficient plant functioning and their special status in union contracts, the trades are often envied for their apparent autonomy in performing their tasks. It is not uncommon in many production facilities (in and out of the auto industry) to find skilled tradesmen sitting, talking, or otherwise unoccupied while other workers (e.g., machine operators or assembly line workers) move rapidly in pace with the machinery. Many production workers (including the majority of those with whom we spoke in this study) resent the apparent "idleness" of the trades. Even though some recognize that idleness is often the product of how tradesmen have traditionally been used (i.e., largely to deal with the unpredictable machine breakdowns and other emergencies as they arise), the trades' relative autonomy, challenging work, better pay, and greater job security make theirs an enviable position.

Relations between the skilled trades and salaried personnel--particularly production management--often waver between cooperation and conflict. The crankshaft area and DEP more generally are no exception. In our discussions with both sides at DEP, we heard accounts of tension arising from three principal sources: (1) turnover in the trades caused by layoffs in other areas of the Rouge—resulting in fluctuating levels of experience among the tradesmen, (2) cutbacks in budgetting for skilled tradesmen—resulting in (from the viewpoint of the trades) increased work loads and (from the viewpoint of production supervision) insufficient skilled labor to conduct programs of preventive maintenance, and (3) demands from management for increased flexibility in work rules to allow simpler maintenance to be performed by non-tradesmen—resulting in complaints from the trades that their already dwindling numbers and employment security were being further threatened.

The trend toward increased technological sophistication is not likely to erode the bases of tensions between the skilled trades and other segments of the plant population. The increased use of sophisticated and expensive, but sensitive, equipment only underscores the importance of the trades. An example, drawn from our discussions within the crankshaft area, illuminates the problem. Several maintenance workers themselves complained bitterly about the lack of preventive maintenance and claimed they were spending all of their time "fighting fires." They attributed this to employment cutbacks and to an organizational structure that gave production management authority over maintenance supervisors. The area maintenance supervisor's decisions can be overruled by the area superintendent whose overall performance is judged on quality, productivity, and cost. The maintenance workers were convinced that without extensive preventive maintenance the machines would virtually fall apart within five years. One supervisor put it more mildly, suggesting they would increasingly have "critical breakdowns."

Currently, machine breakdowns are relatively common occurrences, but can be absorbed by switching lines since the plant operates at half capacity. Even though this may have resulted from a deliberate choice based on overall cost consideration, it is hard to imagine how this will continue to be absorbed if sales pick up or a new engine program is put in the plant (one is currently planned for 1984). Given Ford's stated emphasis on <u>long-term investment</u> in people and technology, it would appear that a more substantial commitment to extensive maintenance should be a high priority.

Employe Involvement

The formal process of Employe Involvement (EI) began in 1980 at DEP. In 1981 EI groups were created in the crankshaft area. However, the initial effort was hampered by two factors: (1) a series of layoffs which caused frequent turnover in group membership; and (2) a strategy of organizing group activities -- across functional departments instead of within departments — which gave insufficient focus to problem-solving efforts. Extended training in the principles of EI and problem solving have been instituted in recent months; but at the time of our investigation, there were no formal EI activities in the area. This should not be construed to read that there is no interest in EI. In fact, most workers, when asked, argued that there was a need for more communication and joint problem solving in the plant, the company, and the industry. When asked if they got enough information about how the plant or the area was doing, financially or otherwise, most workers responded negatively. They argued that more information was necessary for them to believe that the company was sincere in its expressed desire to increase product quality and to include workers in the decision-making process. Several workers, when asked, admitted to having their hopes about the future of the plant and the 1.6-liter engine dashed in the wake of the downturn in production in 1981 and tended to disbelieve the announcements made by top management after that experience.

While the need for more information was by no means a unanimous request among all hourly workers with whom we spoke, it was presented as a common theme. Some cited the need to have more information about the future of the plant and its product lines as a cue to their own future employment security. In the wake of fluctuating sales and employment levels, many suggested that their need to plan for the future was undercut by the lack of information they received from the company. Others admitted that the melange of new programs being implemented in the company and in the plant (such as EI, SPC, and other new practices) was probably part of some company plan to gear up for the future; but at the same time, they could not precisely intuit their intent from the existence of these programs. The lack of a coherent statement of intent bothered some workers: Some were skeptical that all the activity amounted to anything new; others implied that they would not participate fully until they received some explanation. This was evidenced to some extent in the uneven participation in the SPC charting.

Management representatives countered workers' somewhat negative assessment of information sharing by pointing to the regular talks given by plant managers detailing the "state" of the company and the plant, to the company newspaper, and to the encouragement given superintendents and supervisors to be more responsive to hourly workers. Several salaried employees attempted to explain the apparent gap between what they provided and what workers reported in traditional terms: The more workers got, the more they wanted. While that explanation was not intended to deride workers' appetite for information, it did underscore how valuable a commodity it is in this hierarchical setting.

Beyond the issue of how much information is necessary to engage the willing participation of workers, the single-most-important question remains job security. Though it might be argued that the residue of hesitance will pass with some measure of stabilization in the industry, there should be little doubt that the degree to which workers can count on having a job in the near future will be a major factor in shaping their response to company efforts to adapt to market conditions. It is here that company and union negotiations will be most critical; and yet, ironically, it is also the point at which communication between management and labor is furthest removed from the day-to-day experience of the shop floor—i.e., the place where communication, information sharing, and problem solving are most critical.

This chapter has focused attention on how the renovation of DEP was experienced by people on the shop floor: changes in their work, attitudes, and consequences realized only after the renovation was completed. Training and decisions about its content and potential consumers clearly constitute a significant element of human resource development in technological change—and to some extent, workers' assessments in this chapter have provided one view of the relevance of training. In the next chapter we look more closely at the role of training in the DEP renovation.

Chapter 4

TRAINING: RESULTS FROM THE CASE STUDY

Introduction

Training was recognized as a concern from the moment the decision was made to renovate DEP. Staff members from the Management and Technical Training Department were assigned to DEP in a Training Launch Team to plan and carry out the training of production and skilled trades workers and their supervisors. As was mentioned in the preceding chapter, a certain core group of the work force was retained in the plant during the renovation period; they were provided training that was developed or chosen by both vendors and members of the Training Launch Team. Later, but still early in the process, two persons from the Management and Technical Training Department were assigned part-time to DEP to give seminars on team building within the launch management group. This training was eventually expanded to include all levels of management.

In general, the training was on time and, from a training viewpoint, the start-up of production went well. This was particularly true for the skilled trades: The Training Launch Team concentrated considerable efforts on the maintenance employees both because they were essential to keeping the equipment running and because many of the control systems were new. Other efforts were directed to job setters, new supervisors and other technical support people. Management team-building was successful but, perhaps, less smooth--in part because training was superimposed on the peak work load generated by planning and conducting the renovation. As was suggested in Chapter 3, production workers, especially the machine operators, gave mixed reviews to the training they and their supervisors received. In a few instances, hourly workers' views differ from the trainers' and managers' assessments of the quality and quantity of training. This appears to have stemmed from a difference between what training was required for each job (that training was in fact provided) and the training which some would like to have had. In general, employees were trained to the extent the plant considers to be required by the duties to be performed. For example, the skills required of machine operators did not change substantially.

In this chapter we will describe in some detail the development of the training programs and procedures. In so doing, we will point to some of the problems encountered in this particular case (i.e., the renovation at Dearborn Engine Plant) and suggest possible explanations for them. The respective assessments of both trainers and trainees are also provided.

Background

Ford's hierarchical structure was evident in the manner in which employee training programs were constructed to meet the needs of the renovated plant. After the decision had been made to renovate Dearborn Engine Plant, rather than build in a "greenfield" site or expand another facility, a Management Launch Team was assembled to plan the renovation and to bring the plant up to planned production levels. At about the same time (in the spring of 1978) a Training Launch Team was assembled with direct responsibility for planning and carrying out the training of all production workers, skilled tradesmen, their supervisors, and superintendents. It should be noted that overall responsibility for training in the company's engine plants lies with the Engine Division.

The task before the Training Launch Team was clearly defined: to ensure that the workers and their supervisors would be trained on time to carry out their duties when production began and to be prepared to meet all demands as production increased and eventually stabilized. It was decided that training would begin as soon as the technology was chosen and ould overlap with the renovation.

The need for training was recognized from the beginning; but considerations of training were not significant in decision making about the choice of technology, the organization of the work, or manpower needs. T is, training was accepted as something that must be done once all those other decisions were made. Neither the trainers nor the trainees were consulted about what technology should be used or what skills would be needed in the workforce. It should be noted that many of the decisions on what technology to pursue had been made at the divisional and corporate levels before the decision to renovate the plant was reached.

Training Launch Team

The Training Launch Team for the DEP renovation was assembled from among the employees of the Management and Technical Department. The leader and members of the team were familiar with the technology being introduced (two members had a skilled trades background and one came from supervision) and were professional consultants in the planning of programs and curricula.

The Training Launch Team approach had its origin earlier at the company's Livonia (Michigan) transmission plant. It achieved its full flowering during the DEP renovation and has been continued there and initiated in several other plants (Essex, Chihuahua, Batavia, and again in Livonia). The Training Launch Team approach is now the preferred means for the introduction of major new product or manufacturing technological innovations throughout Ford Motor Company. Howe not in all instances have plants allocated the resources to fully implement this desired approach.

The Training Launch Team Leader reported directly to a supervisor in the Management and Technical Training Department. Technically, therefore, he and the four original team members were not employees of the Dearborn Engine Plant. Later in the program two DEP employees were added to the Team. Within DEP the Team leader functionally reported to the Manager of Industrial Relations. Although things had to be cleared with two managers, this dual reporting did not appear to create any significant problems since the Team had a clear and (in concept) simple mandate and a common interest with DEP management to get the job done on time. Generally, the Team was given the resources, responsibility, and freedom to carry out its task as it saw fit.

Training by the Launch Team during the Ren

During its first six months of operation the Team conducted a needs analysis. Principally, it worked with the engineers at the plant and Division levels and with vendors to find out what new equipment, technology and skills were to be introduced. In general, certain groups such as electricians, machine repairmen, plumbers/pipefitters and technical support people required substantial training. Other groups such as job setters, gauge and layout specialists, and hot test stand operators also required new skills. Most machine operators and assemblers required little in the way of new skills (except metric training). The Team depended a great deal on its own experience in determining what skills would then have to be taught and how they would be taught.

Initially, the core group of workers were informed of the training to be conducted and scheduled to attend appropriate sessions. Progress reports were made through periodic program reviews and recognition was provided through a newsletter. The original plan was to train all the DEP work force including new supervisors. Additionally, skilled trades were in high demand; one hundred apprentices were to be added to the existing apprenticeship program. However, this plan was abandoned when the economy turned down, auto sales ebbed, fewer new people were added, and skilled trades workers became available from other locations.

Training falls into four distinct categories: (a) production, (b) semi-skilled, (c) skilled, and (d) supervisors. Production workers from assembly operations in the plant were given minimal classroom training. A four-hour orientation program was given, followed by several hours of on-the-job training for very specific work tasks. When new equipment was being introduced, semi-skilled workers participated in vendor-supplied training; after that they were trained by internal instructors. Among this group were machine operators and machining supervisors. They got from four to six hours of orientation plus forty hours of course work in-house and as much as forty to sixty hours of vendor training. Major segments of this training included (1) organization, product orientation, and plant operations, (2) basic machining and tool control concepts, and (3) specific equipment training for set-up, sequencing, start-up, safety and minor maintenance.

The major training effort was focused on the skilled trades. As shown in Appendix F, three quarters of the training budget was earmarked for indirect labor. Most of the training was either an individual (self-instruction) format or a group interactive, hands-on format rather than traditional lecturing. The Training Launch Team initially relied heavily on vendors for equipment-specific training. Vendors usually offered instruction on-site, but on occasion tradesmen were sent to vendor training off-site. At the time it was unusual for hourly workers to be sent off-site. After the introduction of the new machines, the DEP Learning Center was established as a part of the renovation to be a central site for the training. The Center took over nearly all the training, using training materials developed by both the vendors and internal staff. On the low end, this may involve, for assemblers, as little as eight to twelve hours of training while on the high end, for electricians, this may involve several hundred hours. This high level of training included a combination of topics spread over a period of several months. (The flow chart and contents for electrician training are given in Appendix F.)

Supervisory training for new supervisors (e.g., the crankshaft line has several production supervisors and one maintenance supervisor per shift) included several weeks of supervisory training and three to five weeks of additional specific technical training. Experienced supervisors were used as resources in developing the supervisory training program. Four new task oriented programs were also introduced: production, maintenance, quality control, and materials handling. (The flow chart and contents for supervisor training is given in Appendix F). Generally, supervisors are expected to have the same skills as the workers they oversee and, therefore, are given the same technical training (in addition to supervisory training). As we found in the course of this study, maintenance supervisors tended in the past to come out of the skilled trades; more recently, however, some are college graduates who may not have the hands-on experience or mechanical know-how of past generations of supervisors. Even after initial training in the Learning Center, they may not be sufficiently well developed to enable them to earn the respect of the people they supervise. Part of the reason some of those being supervised have questioned the adequacy of supervisory training may be traced to differences in the backgrounds of supervisors.

While no direct benchmarks of training effectiveness have been established, there are several objective indirect measures of effectiveness—reject levels have been reduced, downtime improved, direct quality improvement measured. However, no control group was set up to provide a more classic type of evaluation. While some pre- and post-testing was done, the main evidence of effectiveness remains job performance as expressed by supervisor and operational performance feedback. Within the courses in the Learning Center there often is self-testing (e.g., self-paced programmed learning and equipment simulators are self-testing). Since the programs are self-instructional, a failure in self-testing usually results in the student going back over the material. Records are kept on training completed; on-the-job performance is verified by completion of task certification sheets for specific equipment systems. Contractual agreements between the company and the union do not provide for individual monetary rewards, but other incentives are provided. Job satisfaction and supervisor praise are the main ones. Certificates of completion of specific programs are awarded. These provide recognition and have a positive impact on employee pride. They can also carry weight when seeking work with another employer.

The Learning Center and Its Program

The Learning Center in DEP was planned and is currently staffed by a Training Launch Team with support from other plant personnel. Originally, the Center was to turned over to DEP once a steady state in training was achieved. As yet, however, this has not happened; it is still operated by the Launch Team. One reason given is that job bumping within the Rouge complex puts a burden on the Center which is greater than that which should be borne by DEP alone. Another is the continued introduction of new, higher levels of technology.

The Center maintains an extensive inventory of programs, primarily for the skilled trades. Many of these were developed by vendors; however, the Center staff continually develops new programs, material, and training aids (e.g., manuals and tapes). The design of the programs follow the educational methods and philosophy of the Management and Technical Training Department. Most of the courses are self-paced and make liberal use of audio visual materials. Where appropriate, equipment simulators have been introduced. While the material is organized to meet the needs of worker groups, nearly all instruction is individualized. A listing of video tapes and training programs available in the Learning Center is given in Appendix F. A review of this list establishes how specific and technical the material is. The bulk of training is specifically targeted for technical skills; however, in recent months the Learning Center has begun to develop a basic skills program which will enable interested employees to improve their reading, writing, and mathematical skills. Outside DEP, the UAW-Ford National Development and Training Center has begun a comprehensive program of training and retraining for hourly workers.

Training from the Viewpoint of Production and Maintenance Workers

Overall, the training program received mixed reviews from the hourly workers in the crankshaft area. What was encountered, in fact, was a set of responses (ranging from strongly positive to strongly negative) which varied by the type of worker responding (e.g., machine operators vs. the skilled trades) and by the dimension of the training program being discussed. To report our findings concisely, we will begin with machine operators' perceptions and then consider the evaluations made by the skilled trades.

In considering the views of machine operators, it is important first to distinguish between assessments of training during the renovation process and training which took place afterward. When asked about their experiences with training during the renovation process, those machine operators who were around at that time responded quite favorably to the training they received. One worker, in particular voiced strong approval for the opportunity to work with equipment vendors. ... in his perspective, it was an unparalleled experience: Not only did he feel part of a team dedicated to an entirely new endeavor, but he was able to go off-site to receive training at the vendors plant. While no one else was quite as enthusiastic, many remarked that having the opportunity to question venders, about technical matters-- whether or not they actually did so—made them feel as though respect was being given to their experience. For s..me workers, as we noted in the previous chapter, the attention they received provided an incentive to "invest" themselves in mastering the new equipment--to the extent that one worker painted a nickname on his machine.

By contrast to that aspect of the training experience, however, a majorit... of production workers suggested that both the quality and the quantity of training had lagged in the post-renovation period. Our efforts to probe deeper i.to this apparent decline in enthusiasm revealed two factors which may help explain the

First, it was clear that the experience of the renovation was unique N... had observed or participated in as massive an overhaul of a roduction facility as the one which accompanied the renovation. During that time, many of the formal rules of interaction between salaried and hourly workers were suspended, and a sense of camaraderie developed. The routinization of work practices and the reformalization of work roles (instiga d in part by the negotiation of a new local agreement) diminished that camaraderie and, in many respects, crystallized the renovation as a unique experience. Thus, for those who had taken part in the renovation, that period looked better as time passed. For those who arrived in the area afterward, the exp ence was distant; their perception of the area was colored more by the more traditional experiences they had had in other ...s of DEP or the Rouge.

A second factor influencing production workers' assessments of the training program had to do with the scope of the training itself. There was training offered to people who came into the crankshaft area in the basic principles of machining and additional instruction was provided in the operation of individual machines. While many thought this forty hour course was "helpful" or "interesting", few found it immediately useful in doing their jobs or helping them master the intricacies of their machines.[5] The following comment was typical:

> They do have training materials, but you can't learn the job off films. You can go up there and see films, but you can't learn by watching TV. It doesn't show you all the mistakes the machine can make.

Comments about the lack of specificity in training carried over to the instruction workers received with regard to their particular jobs. For example, one machine operator offered an explanation echoed in many of our discussions:

> There are certain steps you can't follow (in the machine manual) because, if you do, you'll be way out in left field. Each machine has its own personality. Even though they're identical, they have their own personality. What works on A-line I wouldn't think of trying on C-line. The manual will get you out of trouble, but nine times out of ten it won't clear (or correct) the problem.

Several important issues underlie the preceding comments:

(1) General training tends not to be highly rated because it seems to have only a tenuous connection to workers' specific job assignments. General instruction in the basics of machining may in fact be a valuable addition to the skill base of the labor force (and, for workers who are not members of the skilled trades, a distinct departure from past practice in the auto industry); but if there is no ready and visible link between that instruction and what workers are expected to do on a daily basis, it's unlikely that general training will be valued by workers. At the time of our study, we did not detect that kind of link being made.

(2) Audio visual aids and operating manuals may provide a foundation for more job specific training; but as we were told repeatedly, there is no substitute for instruction from experienced employees combined with "developing a feel for the

machine." The connection between this and workers' assessments of the training program are important, but indirect. We found from our discussions that workers do learn the "tricks of the trade" which enable them to operate their machines; but most often they reported learning them from other workers. While such a practice need not be seen as inefficient or inappropriate, it does rely on the continued willingness of workers in the area to serve as trainers. This, in fact, has become a recognized and integral part of the Ford training strategy. Supervisors, whose formal responsibility it is to train workers in their specific jobs, were not credited with performing that task. By contrast, they were generally viewed as inexperienced with the machines and, as we noted in Chapter 3, occasionally an obstacle to getting the work done. In other words, if supervisors could not be helpful as trainers, then workers' negative assessments of supervisors would likely be carried over to the training program as a whole. Today, more often, supervisors and their employees are trained in technical skills updating together.

(3) Worker evaluations of training progams—including the general and specific components—are likely to be affected by the kinds of work experience machine operators bring to the job. Although we did not have time to adequately pursue differences in workers' assessments based on their type of work background, one aspect did seem relevant: Workers who had a background in machining jobs (particularly those who had been in the crankshaft area prior to the renovation) stressed the importance of their past experience in adapting to the new equipment. For example, we were told:

> You take the experience from the old job and apply it.

Another veteran summed it up this way:

> I did a few other jobs before I ended up (in his present job). They wanted us to run it by the book, but when you ran it by the book, it was scrap. So, I ran it by experience.

In other words, formal training paled by comparison. As one relatively recent arrival (who had little prior machining experience) put it:

> You have to learn from OTJ training really. The Training Center helps you. You can learn a whole lot but not about actually running (the machine).

Thus, the training program is saddled with the dilemma of appearing as insufficient from the perspective of both experienced and inexp[illegible]d workers, but for different reasons. Here, it is important to note that t[illegible]ning as conceived was never intended to provide fully operational skill to operators, but to provide basic knowledge and to accelerate and enhance on-the-job training.

Training capacity and curricula appears to be much less an issue with regard to the skilled trades/maintenance work force. One thing came through quite clearly from our discussions in regard to the experience of the skilled trades in this area: there has been and remains an excellent training program for enlarging and/or updating the skills of the tradesmen. Management recognized the need for a maintenance crew capable of understanding new and complex automation and electronics which far exceeded in sophistication the technology of any other plant in the Rouge. It is important to note here that the system of training for the skilled trades has been deemed important, not only because of the economic need to have the machines running as smoothly and as continuously as possible but also because one of the sorest points in the relations between the union and the company has been the subcontracting of maintenance work to vendors and other contractors. The extensiveness of the training program for the trades reflects the concern of the union and the company to maintain jobs for the Ford tradesmen.

There is, of course, a unique situation in the Rouge Complex which has tended to undermine some of the advantages of the Engine Plant's extensive training program for the trades. As we noted in the preceding chapter, the Rouge-wide system of seniority based on bumping and bidding plays havoc with the efficiency of the training effort at DEP. Downturns or layoffs in any one of the adjacent facilities (e.g., the steel mill, stamping, glass or assembly plants) will result in laid-off tradesmen bumping into DEP at unpredictable intervals. Every time a tradesman is bumped out of DEP, a new tradesman arrives and has to be trained both in the general mechanics of the job he is expected to perform and in the new technologies and skills which have been introduced with the renovation (e.g., any of a number of new electronic control systems). Then, if jobs reopen in the area from which those workers were laid off, they will return and take their new training with them—at the expense of DEP. It was hinted in our discussions that management (most likely maintenance superintendents) in the plant may forestall training in an effort to avoid "paying the cost" of training a recent arrival (taking a tradesman off the job) and seeing that investment leave when the tradesman is called back to his previous job. Thus, in the case of those tradesmen who complained that they did not get enough access to the training center, it might be that someone is holding back on releasing them for training for fear that they will leave soon. This could also account for one of the major headaches described by training people: the difficulty in getting production supervision to release their workers for training.

The situation with the trades and the plant's dilemma of "serving as the training ground for the whole Rouge complex" is not likely to be resolved at any point in the near future. In the meantime it seems that the training system is indeed working to bring the tradesmen up to the level necessary to maintain the equipment.

Training Outside the Plant Floor

It is characteristic that professionals such as managers, engineers and accountants participate in various training exercises throughout their careers, and this is encouraged by their employers. Such things as attending professional society conferences, reading trade journals, and attending short courses are normal parts of a professional job. A certain subset of this group will also opt to take formal college credit courses and often work toward higher degrees. For the most part this is not highly structured by the employer—a pattern followed by Ford.

Early in the renovation period it was found that, while various members of the staff had maintained adequate technical skills by this informal approach to continuing education, the new situation called for some new approaches to teamwork. It was pointed out that the Management Launch Team was not chosen specifically because of their mix of complementary skills. They were, in fact, a mixture of new people selected by the newly appointed plant manager and others held over from the old engine plant who needed time and support in order to blend together smoothly in the stressful situation of a complete plant renovation. Therefore, two consultant from the Management and Technical Training Department were retained by DEP to help develop team skills among the Management Launch Team members. The first phase of this process involved conducting seminars on leadership style and communications (Teleometrics I: Models for Management), in order to help the participants understand their leadership style and how it is perceived by their subordinates. The second phase included data collection (through private interviews and questionnaires), feedback to the Team, and problem identification within the organization. Causes were addressed and actions planned. Initially this two-phased process was done only with the top management of the Launch Team, but later it was extended to all superintendents and section supervisors. Eventually, this team building effort was extended to include first-line supervisors.

Planning for the renovation was in full swing when this training program was implemented; thus, it was imposed on top of an already heavy work load. The training occurred while the decisions about new technology were being made and manpower planning was in progress. This differed from the approach used with the production and maintenance workers and their supervisors wherein a substantial amount of training was done during a period of limited production.

While a series of private interviews and discussions were held and questionnaires distributed, the knowledge and experience of the training consultants were the primary resources to implement the interactive team building exercise. Feedback was provided through formal sessions with subordin[illegible] and evaluation forms. Among upper level managers, satisfaction with this team building remains an important consideration in the sustained management training in the plant. It should be noted here that the heavy reliance on personal satisfaction as the basis for the evaluation of continuing education is not peculiar to Ford or even to the automotive industry in the United States. Rather, it is characteristic of nearly all professional continuing education.

Other Considerations Regarding Training

Training needs were addressed well in advance of the introduction of new technology but certainly after the new technology was chosen. Because training considerations were not included in the choice of new technology, there is a proliferation of the varieties of new equipment, each piece chosen by the engineers to optimize their particular function or operation. A union represent[illegible] ll as the members of the training staff pointed out that, had worker needs [illegible] ties and training been considered earlier, wiser choices could have been made.

The UAW leadership was kept informed and cooperated but played a limited role in the design and development of training programs, and did not raise any major collective bargaining issues on training at the beginning of the renovation. More recently, issues of training have appeared in collective bargaining, and there is evidence of increased interest by workers. Part of this is fueled by the threat of even further layoffs and concern for those already laid off. The 1979 national agreement contained a New Technology Letter (dated 10-4-79) which stated obligations of the company when new technology was introduced. Since the most recent national agreement (1982), provision has been made for additional training to be administered under a new UAW/Ford National Development and Training Center. The first implementation of this was training for laid-off workers in areas with job potential outside of the automotive industry.

The general opinion is that skills required of production workers have changed by becoming more mental and less physical but the skill level has not changed substantially (perhaps with a hint that they have gone down a little). On the other hand, the skill levels of skilled tradesmen have gone up, particularly where electronics is involved.

Almost all training is done within exisiting job categories. Little opportunity is provided to move to higher level classifications, particularly during this layoff period when new jobs simply are not opening up.

Generally, everyone concerned has reacted favorably to the training program. There was some apprehension at first. Some supervisors were reluctant at times to remove workers from the line for training. There were other temporary rough spots that apparently were ironed out with little travail. For example, there were some union-related jurisdictional problems, and some vendors had inadquate courses. It was reported that only two or three out of a hundred skilled tradesmen refused the offered training. And, of course, the Rouge complex bumping agreement causes a lot of training traffic not always beneficial to DEP. The UAW has suggested more centralized training at Rouge in exchange for less bumping rights, and steps are being taken to move in this direction. No changes are planned in policy or organization with regard to worker training; however, there is a lot of new technology coming in, e.g., robots, that must be dealt with. The training program appears to be a permanent addition to DEP.

Chapter 5

CONCLUSIONS AND IMPLICATIONS

In this final chapter, we will first summarize and integrate the findings presented in Chapters 2 through 4. We will then discuss the policy implications of those findings and indicate further research that would be worthy of consideration.

Summary and Integration of Findings

Technology Introduction

Technology introduction in Ford Motor Company is a dynamic but evolutionary process. It emerges from existing technology and continues to change and advance, rather than remain fixed between major renovations or expansions. In our case study of the Dearborn Engine Plant (DEP) renovation, the decision leading to technological change was largely market-driven and involved complex planning on an international scale. In other words, changes in both product technology and process technology were not the major driving force for change, but rather were keyed to a long-term (6-7 year), multi-based and multi-level planning procedure.

At the early stages of the planning procedure, human resource considerations were not prominent, but entered only in a subtle way. These considerations became more important and specific as site selection for production of the new engine was decided. The consideration of worker skill requirements for the DEP renovation was earlier than in any previous Ford project (3 years before Job 1) because of tighter production tolerances and because of changing management style. The early consideration and allocation of a substantial ($7 million) training budget seemed unprecedented.

The choice of DEP for renovation and new engine production included a complex of economic, political, social and organizational considerations. From the standpoint of a tangible cost-benefit comparison, differences among the major options were relatively small (within about 10%). Thus, the less tangible factors became pivotal in the site selection ultimately made by Henry Ford II.

In implementing the renovation, maximum use was made of internal personnel; they worked along with outside human resources, including architectural engineers, equipment vendors and others. The results of implementation apparently met or improved upon the original targets of cost, quality and productivity. The target expenditure of $650 million for the renovation came in at an actual figure of $593 million. With regard to quality, the objective was 15 repairs per 100 engines produced; it is now down to less than 7 repairs per 100 engines (a 25% annual improvement). Overall, manpower requirements have been reduced by 25% in two years (averaging better than 1% per month).

Technology diffusion during the DEP renovation was basically a top-down process, with the fundamental decision made at the corporate level, then transmitted to the division and then to the plant—initially to the salaried staff and then to hourly workers. Supervisors and maintenance managers at the plant learned about specific technological choices 14 months before Job 1; workers were informed about 12 months before Job 1. The big change for Ford in the case of the DEP renovation was that hourly workers, mostly members of the skilled trades, for the first time were engaged in training during the pre-launch period.

By and large, the technological innovation process proceeded in a smooth fashion, although there was some resistance along the way. Plant production personnel (including managers) were seen by some as a source of resistance, both because they did not understand the technology and because they perceived risks in getting their jobs done. A variety of devices, formal and informal, planned and emergent, served to reduce disagreements and obstacles. Training was prominent among these.

A range of technological innovations, including flexible robots, are being considered for future introduction. These innovations are considered necessary to improve the company's competitive position in terms of product quality, production cost and efficiency in the manufacturing process. Improvements in the technological innovation process _per se_ are also being considered. Such improvements fall under such themes as: consensus and commitment at the beginning of the process; sensitivity to external forces; flexibility and risk-taking; integration among all parts of the organization; incremental change; participation; and better use of human resources. Of course, people at different levels of the company have different perspectives in this regard. In general, as we move down the levels of the company, human considerations, particularly participation, become more prominently considered as vital elements of the innovation process. The climate within the company and the industry is clearly moving toward further improvement in communication and worker participation in decision making.

Work Organization and Labor Relations

The total employment of hourly workers in DEP is substantially below the level it had achieved in the 1960s. Although the reduction represents the combined effects of lower production levels and technological change (especially automation), estimates made by plant personnel suggested that even if the plant were to achieve its current production capacity, only 60% of the previous number of hourly workers would be employed. In our case study focused on the crankshaft line, the employment impact of automation was most evident on the grinders. There used to be 25 grinding machines and 25 operators. Now there are 16 grinding machines and 4 operators per shift with production capability approximately equal to the old machines. One person now does a job which previously required the attention of eight.

Theoretically, the highly automated crankshaft line can run with little or no worker attention. Since "normal operation" is frequently interrupted by machine breakdowns, crankshafts not positioned properly, tools needing to be changed or adjusted, etc., a considerable degree of human judgement is still required to keep the line running. For these reasons, there was no significant deskilling of jobs. While some workers do get more bored now (as compared to their previous experience before the renovation), most workers find their new jobs more satisfactory—if only because the area is cleaner and there is less heavy lifting to be done. They are for the most part, supportive of the new technology and the new management emphasis on product quality, the latter being long overdue in the opinion of many. However, most are very aware of the social costs of more productive equipment (in terms of jobs lost).

There are certainly variations in workers' assessment of their work experreince before and after the renovation. For example, most machine operators feel that the job is now more complex, in part because they have to understand the basics of the new machines. Those machine operators who helped the machine vendors qualify the new equipment have a better mastery of the idiosyncracies of the equipment and a higher level of pride than those who have not had similar opportunities. And, production workers who have to do much heavy lifting of crankshafts when the machines break down find the work extremely wearing.

Reduction of positions has applied to supervisory personnel, as well. This reduction has taken the form of the elimination of one layer of supervision in the crankshaft area, the general supervisor, and several production supervisors (formerly referred to as "foremen"). However, changes in the supervisory structure have not, as yet, increased the flow of company information to the workers on the shop floor.

Labor-management relations in the crankshaft area seemed to be a positive factor in the plant's efforts to undertake large-scale technological change. One of the main factors underlying the "good feelings" is the respect accorded to the superintendent which derives from his familiarity with the area and his relatively long tenure in the crankshaft operation. On the other hand, some production workers complained that newly arrived first-level supervisors are not well trained in the jobs done by the workers and thus constitute an obstacle to the efficient functioning of the area. There is also disharmony between the skilled tradesmen and other personnel (from management to non-skilled workers) in the plant. While this situation is by no means unique to DEP, it seems to stem from the power held by the trades without commensurate status and authority. The skilled maintenance workers themselves complain about the lack of preventive maintenance resulting from the company's recent cost-cutting efforts.

While Employe Involvement (EI) is a significant program being promoted by UAW and Ford on a company-wide basis, there was no formal EI activities in the crankshaft area at the time of the study. This was due to the difficulty of maintaining formal EI activities while some early participants had been bumped due to seniority based job reductions and transfers. Most workers in the area did express a need for more communication and joint problem-solving, suggesting that more information was necessary for them to believe that the company was sincere in its expressed desire to increase product quality and to involve workers in decision making. Beyond the issue of how much information is necessary to engage the willing participation of workers, the most important question remains job security.

Training and Human Resource Development

The Ford Motor Company used the occasion of the DEP renovation to develop an explicit training policy and plan related to the introduction of new technologies which reflect major changes in production methods and procedures. An earlier training plan (at the transmission plant in Livonia, Michigan) was revised and extended to include the Training Launch Team and the Learning Center program for DEP. This plan has since been adopted in essentially the same form at other plants, particularly in the Engine Division. Responsibility for both the policy and the plan is located high within the company and the Engine Division. It was imposed upon DEP from above but, apparently, with the full cooperation of DEP management. There is little evidence of grass roots or shopfloor input into the various decisions made with regard to training. Decisions were made at higher levels and passed down to lower levels to be carried out. However, there were few complaints about the process from those to whom the decisions were passed.

The new technology was selected by the management upon the advice of their engineers and other professionals. The trainers were then informed of the choices and given the task of preparing the workers to use the technology. There is little or no evidence of any influence upon the choice of technology by either the trainers or the trainees (workers). In a few cases, this has led to poor choices of technology or, perhaps more correctly, in the implementation of the new technology. More feedback, if obtained early enough, would probably have resulted in greater efficiency. In general, the training of production workers, skilled tradesmen and their supervisors for the introduction of new technology was timely and went smoothly. The usual difficulties were taken care of quickly and efficiently. Some part of this success must be attributed to the long lead time provided by the complete shutdown of the plant and the retention of many workers during this shutdown period. This success certainly is the reason Ford has extended the plan to other plants.

The Management Launch Team was selected and almost immediately went through a period of peak work load in planning and carrying out the renovation. Training (primarily team-building) had to be imposed on top of this peak work load. It appears that more care in the selection of the Management Launch Team (i.e., looking for more complementary skills) and in their preparation before attempting to plan and conduct the renovation would have been highly desirable; this is a recognition of the fact that they had never been through a launch before. The assessment of training needs, the conduct of the training, and the evaluation of the effectiveness of the training were all placed in the hands of a small group of professional trainers. The assessment of needs and the evauation of the results remain a largely indirect process; production performance measures (e.g., reject levels, machine downtime, and quality records) do exist but provide rough surrogates for direct evaluation of the efficacy of training. Even without a systematic and objective evaluation of training, more feedback from the consumers of the training program—from the trainees to the trainers—would be desirable.

From the case study focused on the crankshaft area we found that training of "unskilled" and "semiskilled" workers since the renovation has lagged in terms of quality and quantity when compared to the experience of the renovation itself. The machine operators in the area seem to feel that training, as presently organized, was neither particularly useful nor sufficiently broad in scope. They tend to rely largely on other hourly workers or production supervisors to learn their jobs. Also some of the newly arrived supervisors are ill-equipped to train workers as these supervisors are insufficiently experienced in crankshaft production themselves.

The training for skilled tradesmen and the maintenance work force appears, on the contrary, much less problematic. The trainees generally regard the present training program as excellent for enlarging and/or updating their skills. What does remain a problem for the training of skilled tradesmen is the Rouge-wide system of seniority based on bumping and bidding. Because of this system, the maintenance superintendents and supervisors are reluctant to release a tradesman for training when the latter is perceived to be someone who may be callled back to his pervious job during or shortly after his training.

Integration and Cross-cutting Observations

A number of observations can be made that are either common to or cut across all the three aspects of our case study; viz., technology introduction, work organization and training. First of all, the basic planning and decision making process in Ford Motor Company has not changed significantly from its traditional paradigm which, according to our knowledge, is shared by all the major auto companies in the United States. In this paradigm, the rationale and the process of product development begin with corporate strategy formulation, followed by product planning work and human resource considerations, in that order. In the context of our case study, similar rationale and process begin with the technology introduction decision, followed by work reorganization and training programs, in that order.

On the other hand, practically all the Ford people with whom we have spoken, ranging from high-positioned managers to engineers to plant supervisors, skilled tradesmen and production workers, felt that the most innovative aspects of the DEP renovation were not just technological. The "social" (organizational and managerial) changes were equally if not more important. These changes included, in particular, the new participative management style and the establishment of the new Learning Center at DEP. While all recognize the importance of combining the social and the technological innovations in order to compete internationally, not everyone is satisfied with what has been done to date. Nor does everyone know how to make concrete progress in this direction from his own purview.

The importance of socio-technological innovations is well recognized by people above the level of those with whom we have talked in this case study, and this seems to be the case on the part of both labor and management. The policy letters issued since 1979 by top management on quality, productivity, employe involvement and technological innovation (see the Company report for detail) certainly provide testimony to this point. In our discussions with high-level managers and engineers, they candidly stated that Ford's target of competition had shifted in the last few years from General Motors to Toyota. Hundreds of Ford people—workers, union representatives, engineers and managers—have visited Japanese automobile companies. They all consider Ford's technology ahead of the Japanese, but believe that the Japanese are ahead on the human side of the enterprise. The UAW-Ford Employe Development and Training Program (EDTP) is solid evidence of the willing cooperation between management and labor to make simultaneous progress on social and technological change.

From what we have observed, Ford's product planning, in both technological and human resource dimensions, has been global in its perspective. The company's decision rationale with respect to technology has shifted from principally short-term financial approaches to increased consideration of long-term company goals and qualitative judgements (e.g., more weight is given to the less tangible contribution of technology to product quality). With respect to human resources—especially training and employe involvement—both Ford and the UAW have made policy statements that are clear and have been heard by all concerned parties. However, strategic plans for implementing these policies appear only now to be emerging and will probably be expanded and operationalized as times goes on.

Admittedly, the case study we have made has been focused only on a limited area within a particular engine plant in Ford Motor Company. Generalization from a case study is always hazardous. The crankshaft area in DEP is more or less a showcase of automation. However, its technology is not particularly revolutionary and has been duplicated and improved elsewhere. The superintendent in charge of the crankshaft area was a veteran of the operation and was well-liked by his subordinates. We did not interview those workers who were in the crankshaft area before the renovation but are no longer there. However, we have spoken with all present workers in the area, including those who were not particularly satisified with their work. With DEP as a part of the Rouge complex, the Rouge-wide seniority system has played havoc with the training program in DEP. However, this problem has only accentuated the underlying conflict between job security and productivity. The point we wish to make here is that the choice of DEP's crankshaft area for our case study has not make our findings less valid than if we had chosen some other area. Although the generalization of results from our case study, like any other case study, cannot be taken as definitely applicable to Ford company wide, nor to the entire U.S. automobile industry, our findings can be used either as indicators of how things are going in part of the industry or as hypotheses for larger and more rigorous studies.

Policy Implications and Research Suggestions

This case study has demonstrated that the processes of technological innovation and technological introduction are intimately tied to an organization's conception of human resource development and its role in the planning process. Even in the absence of an explicit policy emphasizing the "place" of human resource development, decisions are made about human factors at each step, from strategic planning about product markets to the physical location of new machines and tools. In the past, decisions about the employment of human resources were, for the most part, accorded a relatively low priority: they could be parcelled out to an existing industrial relations hierarchy to be dealt with when the actual implementation of new equipment was to take place. Thus, human resource considerations fell victim to divisions between different organizational functions (e.g., between industrial relations and production supervision and, within a division or plant, between layers of the same function). Moreover, people whose work ultimately impacted upon other segments of the organization (e.g., engineers) were far removed from observing the effects of their products on other people; the traditional animosities between engineers and production workers being a good example of this.

In light of recent shocks to the U.S. automobile industry and the appearance of strong competition from Japanese firms, human resource development has come to have a higher profile at Ford and other companies. Yet, as this case study has shown, there is room for improvement even in showcase situations. Quite simply, human resource "management" was practiced in the DEP renovation; that is, when human resources (i.e., the existing body of skills, experience and ability residing in the personnel of the company and the plant) were considered, they were considered principally as resources to be utilized and assigned to various company tasks; including human obstacles to be overcome, and on[illegible]y as resources to be fostered and strengthened. Human resource "development," by contrast, should emphasize the nurturance of individual and group skills, experiences and abilities both for the good of the organization and for the good of the individuals and groups involved. This implies a perception of employees not just as resources to allocated, but as participants who can contribute if and when they are actively drawn into organizational processes, particularly those involving change. This is especially important if, as Ford and other companies state, they seek to generate a willingness on the part of all employees, salaried and hourly, to commit themselves product quality and competitiveness.

In this regard, the research team thinks it would be useful for human and social considerations to be taken into account in the early planning and design phases. Staff and union representatives with a "development" (rather than a "management") perspective on human resources should be added to the planning and design cadres to project human considerations as factor to be reckoned with. In this way, the brunt of human resource development would not have to fall entirely on those in the lower echelons of the firm. This might well be augmented by a closer integration between the various subsystems of the organization. Engineering and manufacturing should be more closely linked and better articulated. One suggestion along these lines is to have the Launch Team constitute the initial production team, as well. To the same end, there needs to be a better working relationship fostered between hourly and salaried personnel. Employe Involvement is a first step in this direction but does not, to date, seem to be working in the crankshaft area at a sufficiently high level of development to provide a solid foundation for two-way communication.

Training programs should also be given earlier and closer attention in the process of technological innovation. Programs need to be constructed well enough in advance to allow for continual feedback and evaluation at different levels within the organization. Moreover, training packages need to be interpreted for target audiences so that there is a sufficiently clear rationale for trainees to participate, a real connection between what they are trained to do and what their jobs actually entail, and broader commitment from the company to train in such a way that people can develop their skills an expand their opportunities for broader and more responsible work in the enterprise. The Employe Development and Training Program could provide a base for such an undertaking, but it must be constructed with a clear vision that training should not be limited to only technical necessity.

A change in the company's philosophy of human resource development will, however, require an unequivocal change in the practice of the union, as well. While it is clear that the recent hard economic times forced the union to rethink its reliance on highly restrictive work rules and job classifications, a "partnership" in human resource development between the company and the union will necessitate further changes. The comments of machine operators in the crankshaft area--both about their work and their attitudes toward members of the skilled trades--indicate an impatience with strict delineations of job responsibilities and, with them, restrictions on their ability to learn and contribute to the process of building quality products. Programs of human resource development--whether in the form of "pay for knowledge" schemes or more radical adaptations of the Japanese pay/skill grades--will require a measure of flexibility from the union which, to this point at least, has not been particularly evident. One clear stumbling block to human resource development will be confronted in the insistence on job security for the skilled trades (by the skilled trades) and lesser guarantees for non-skilled workers. Unless the union is willing to deal with this inequality internally, it will not be in a position to act as a positive force in human resource development. One example of this was demonstrated clearly in the DEP case study: the relative intransigence of the skilled trades in the Rouge complex with respect to the seniority system has rendered the Learning Center much less efficient than it could be.

Suggested Additional Research

One clear item for a future research agenda comes out of our case study: more systematic and comparative research needs to be done on the socio-technological issues we (and, we suspect, our counterpart teams in the four other nations) have identified. In particular, we would specify the following topics as important for further investigation:

(a) the sources of resistance to technological change, i.e., at all levels within organizations, not just those on the shopfloor or in the office.

(b) effective planning and implementation of sociotechnological innovations in which appropriate organizational and human skill changes will take place simultaneously and coordinated with technological changes.

(c) different experiences of firms in different industries, different segments of the same industry (e.g., manufacturers and suppliers in the auto industry), and firms of different sizes and ages.

(d) the optimal mix between centralized training (e.g., through central facilities) and decentralized (shop floor) training.

(e) realistic and critical evaluations of the strengths and weaknesses of programs designed to foster employe involvement and (among salaried personnel) participative management.

(f) development and evaluation of new incentive systems to encourage sociotechnological innovations and employe involvement.

Additionally, we feel the findings from this case study should provide a basis for workshops including auto industry, UAW, Department of Labor and Department of Education representatives, along with the U.S. research team, to explore the policy implications of the research and work to develop an agenda for future policy research and development. Specifically, we would suggest a two-step approach. The first workshop should be attended by the people who have been directly involved in the case study and Ford executives in policy-making positions. The purpose will be to: (1) share and clarify the diverse perceptions of problems uncovered by the case study; (2) identify positive steps for different people within Ford (not just those involved in the case study) to work together toward the new policy goals enunciated by Ford and the UAW; and (3) to identify national policy implications. The second workshop will involve officials from the U.S. Departments of Labor and Education, and state and local governments to discuss state, national, and local policies on training and education related to automaton, on the basis of the findings of the case study and the first workshop.

APPENDICES

APPENDIX A: Recent Research on Issues Related to the OECD/DEP Study

Although this case study report is presented as a relatively self-contained analysis, we relied on a body of comparative research to help provide questions and directions for our research. To avoid making the text of our report overly technical — given the broad nature of our expected audience — we decided to cite only a few of the more important references in the report itself. However, listed in this appendix is a representative sampling of some of the more recent work related to ours.

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APPENDIX B: FORD'S DEARBORN ENGINE PLANT

The Dearborn Engine Plant (DEP) is located in Dearborn, Michigan, at the Ford Rouge Complex. The plant was built in 1941 by the U.S. Government to manufacture aircraft engines. In 1947, after the end of World War II, this plant was purchased by the Ford Motor Company, initially as a parts warehouse and, since the early 1950's, mainly to produce automobile engines. The construction of the plant is unusual for an engine plant in that it is a two-story manufacturing facility.

By the mid-1970's, the manufacturing facilities in this plant, where V8 engines had been built for large passenger cars and trucks, became outdated. Between 1978 and 1980, a 600-million dollar rehabilitation and expansion converted the facilities to produce 1.3/1.6-liter engines, accompanied by significant technological changes, especially in the form of computer-aided automation. About 5,000 people had been employed to work in DEP. It is said that Mr. Henry Ford II was involved in making the decision to locate the new facilities at DEP, instead of some new location, in order to keep the work force in Dearborn. The plant has the capacity to produce about 3,000 engines per day, or about one million engines per year. Practically all workers have over 10 years experience due to a considerable reduction in personnel in the plant and in the Ford Rouge Complex based upon seniority.

The plant provides an interesting and useful site for the OECD case study for several reasons. First, significant technological changes took place at DEP fairly recently and within a relatively short period. It is therefore feasible to discuss with various parties to get their impressions of the plant and their work, before and after the plant renovation. Second, many people at the plant have been interested and actively support or participate in training programs. In fact, there is a new learning center located within DEP. Furthermore, the management, the union representatives, and many workers at DEP have expressed interest and willingness to cooperate with the researchers in the OECD case study. This last point is certainly important; and it was achieved through the efforts of the key people at DEP as well as the company headquarters who are in Ford's Employe Involvement (EI) program.

In recent years, the Ford Motor Company and the United Auto Workers (UAW) have both recognized the need for technological progress, on the one hand, and the potential impact of such progress on the function performed by the unionized workers on the other hand. To deal with this issue jointly, a National Committee on Technological Progress, consisting of equal representation from the Company and and UAW, was established after the 1979 agreement. The Company also promised to make available appropriate specialized training programs for employees to perform new or changed work resulting from introduction of new technology.

More recent (1981) policy documents from Ford's top management have explicitly stressed technological innovation and productivity improvement. One could take these as indicators of company policy trends, shifting relative emphasis from such short-term goals as cost reduction toward the longer-term goals of technological leadership and human resource development. The policy letter on productivity includes such statements as "Productivity improvement is achieved through a blending of human, capital, and material resources;" and "Employees are provided appropriate training and a secure, participative work environment." This research will provide an opportunity to examine how these policies are reflected by what actually took place at DEP, as perceived by the various parties both at the plant level and at the division and higher levels.

In keeping with the OECD project guidelines, two units—one involving primarily hourly workers and the other mainly salaried workers—were to be chosen within DEP as foci for the case study. This was discussed at a meeting involving the plant as well as the company headquarters personnel, the UAW local unit chairman, and the research team. Those who were present at the meeting (and two previous ones) are listed in at the end of this appendix.

Between the two obvious candidates for the production unit, viz., the hot test area and the crankshaft line, a group consensus emerged for selecting the crankshaft line. Both areas had undergone massive renovation in which job changes were significant, fewer workers were needed to run the operation, and some training was necessary. The hot test area, however, included very few workers who were there both before and after the change. The crankshaft area included a number of workers who had been there both before and after; therefore, it was the logical choice. If time and resources had permitted, the hot test area would also have been a useful area for study, since it differs in several interesting ways from the crankshaft area.

It was believed that the hourly and salaried units should be functionally linked to make the case study meaningful. The decision was therefore made to consider one unit to consist of all the hourly production workers on the crankshaft line. The other unit was to be a composite of mostly salaried but also some hourly workers, including all the production supervisors, skilled trades workers, the process engineers, and the plant engineers, all of whom have some work functions on the crankshaft line. Although the focus of the case study was on DEP's crankshaft area, numerous discussions were also held with personnel at the company headquarters and at the Engine Division in order to collect all the relevant information. The technical description of the crankshaft line at DEP is given in Appendix C.

Participants in the Ford-SEARIM Meetings

Ford Motor Company

Headquarters	
John Reese	Director, Union Affairs
Ernest Savoie	Director, Labor Relations Planning and Employment
Bill Pickel	Supervisor, Employe Involvement Planning
Robert Shook	Engine Division Employe Involvement and Training Manager
Dearborn Engine Plant	
Eugene Wise	Plant Manager
Walter Richburg	First Vice-President, Local 600, UAW
Roy Goines	Industrial Relations Manager, DEP
John Shaw	Plant Engineering Manager, DEP
Miro Suga	Process Engineering Manager, DEP
Gary Kavanagh	Area Manager, DEP
Jerry Thom	Area Manager, DEP
William Kirkpatrick	Shift Operations Superintendent, DEP
Tom Lobeck	UAW District Committeeman, DEP
Mike Fras	Superintendent, Crankshaft Area, DEP

University of Michigan - UTEP/SEARIM*

Faculty	
Kan Chen	Professor of Electrical and Computer Engineering
Joe G. Eisley	Professor of Aerospace Engineering
Jeffrey K. Liker	Assistant Professor of Industrial and Operations Engineering
Jack Rothman	Professor of Social Work
Robert J. Thomas	Assistant Professor of Sociology and Faculty Associate, Center for Research on Social Organization
Research Assistants	
Darlene Nichols	Sociology Ph.D. student
Sherry Borener	UTEP Ph.D. student
Deborah O. Liker	Research Assistant
Paul Appansamy	UTEP Ph.D. Student

*UTEP = Ph.D. Program in Urban, Technological and Environment Planning, an interdisciplinary and intercollegiate program with the University of Michigan.

SEARIM = Socioeconomic Aspects of robotics and Integrated Manufacturing, a unit within UTEP.

APPENDIX C: Technical Description of Crankshaft Machining Process

The crankshaft machining process is best described in terms of the sequence of different operations which are performed. The following text briefly discusses each operation.

Note: (1) At the time of this study, there were three lines of operations (op) #10 - #80, all for the 1.6-liter engine.
(2) Operation (op) #110 was originally set up for additional seal grinding. It has since been combined with op #85 -- rough grinding of the main bearings and the rear seal.
(3) Op #140 was originally set up for fillet rolling; it has since been eliminated.

Operations

#10—"mill ends"—rough milling of ends to get the approximate length.

#20--"mass center"—this is the Schenck mass balancing system. If done well, there is no need for mass removal at op #150. The system wiggles the crankshaft around to determine the centering line and then to drill the holes at both ends automatically.

#30—"mill notches"—the notches are required for later steps of the turning operation. The crankshaft will be grabbed by fixtures at these notches since end driving is not desirable. The notches serve no useful function in the car. Tolerance: .005".

#40--"quality casting"—this step is to verify that the castings do not have bulges, etc., which may damage the expensive tools in op #50. The verification is done by spring-loaded fingers.

#50—"turn mains"—machining the mains to desirable dimension around the main axis.

#60—"turn pins"—machining the pins to desirable dimension, turning around the main axis with tools controlled by cams.

#70—"drill oil holes"—the holds are drilled at a slant angle from the pins to the mains. Each hole is drilled in 4 sequential steps in order to speed up the production line. This creates some manufacturing problems in lining up the drills in the later steps with the partially drilled holes.

#80--"finish ends"—to drill holes, machine flanges, etc., at both ends of the crankshaft.

#85—"rough grind main bearings and rear seal"—using grinding wheels to get ± .0004" tolerance.

#90—"finish grind mains"—grind to ± .0003" on the mains, including size and tapering (of 3 diameters on each of the five mains).

#100—"grind poste and front seals"

#120--"grind pins"--the grinding rotation is now centered around each of the pins, with the mains at both ends rotated off center (offset = the "throw" between the mains and the pins).

#130--"finish turn and mill"--milling the crankshaft key and timing notch, also deburring the key and oil holes.

#150--"balancing"--Gilman system: checking dynamic balance and removing weight by drilling in two steps: the first set removing metal near the center, and the second set near the ends of the crankshaft.

#160--"polish"--use polishing cloth at DEP versus paper polish elsewhere (paper breaks more frequently).

#170--"flush"--use high pressure wahsing solution to get rid of fine loose metal in oil holes. The operation is enclosed in a closed chamber.

(Between ops #170 and #180: back pressure air gauge to detect broken drills in oil holes, or even absence of oil holes).

#180--"wash"--wash with coolant to bring crankshaft to ambient temperature for inspection (made by Durr).

#190--"gauge"--45 readings from air-to-electronic gauges: automatic inspection of the mains and manual inspection for the pins and other characteristics.

Comments on new technologies in the crankshaft area:

(a) Robots are being considered for loading crankshaft castings.

(b) Gilman dynamic balancing is not to be replaced by another Schenk mass balancing. What makes sense would be to tie each of the Gilman machines to one of the Schenk machines for feedback adjustment of the Schenk. Currently there are 3 Schenks and 4 Gilmans. A crankshaft may be balanced in any combination of Schenk and Gilman--no ID# for individual cranks.

(c) Laser light balancing may be considered for replacing Gilman balancing system.

(d) Optical gauge (by DeFracto) is not in the crankshaft line. It may be used to check polishing output (after op #160).

(e) Contact gauges (Marposs) are used in the grinding process.

(f) The 138 characteristics are checked throughout the entire line, not at a single point on the line.

(g) Statistical Process Control (SPC) is done off line at the superintendent's office.

(h) Programmable controllers (pc) are used on almost every machine. The exceptions are ops #30 (notch miller), #160 (polisher) and #180 (washer).

(i) Dedicated robots (by Brettrager of Saginaw, MI) are used to do pick-and-place operations in the grinding area.

(j) Flexible robots are being considered for both oil hole deburring (op #130) as well as loading the front end of the line (op #10).

(k) Monorail conveyor adjustments for "raise and transfer" are probably at the towers near the grinding area.

Other comments:

(a) The overall tolerance of the final product is .0005" at the mains and the pins.

(b) After operation #90, one out of every 15 crankshafts is manually checked with gauges.

(c) An optical comparator (made by Scherr Tumico) is used to check one crankshaft carefully for each shift. The display gives a 20:1 enlargement for easy reading.

APPENDIX D: DETAILED LISTING OF RESEARCH QUESTIONS BY AREA

This appendix lists the principal research questions in the three areas suggested by OECD; viz., Technology Introduction, Work Organization, and Training.

I. Questions on Technology Introduction

The questions were grouped according to the following framework:

	Decision Leading Up to Change	Actual Process of Change	Changes on Current Agenda
Rationale or Performance	A1	B1	C1
Social Process	A2	B2	C2

A1: Decisions Leading up to the Change—Rationale or Performance

1. What led to the decision to develop the new engine? What other options were considered? Why was DEP chosen for the renovation instead of other engine plants? Did this include aspects of implementation?

2. Was a cost-benefit type of analysis done on the DEP renovation?

3. Did the new technology, as conceived, involve more or less simple adopting of existing methods or did it require more marked innovation/invention? Was the new technology compatible with existing procedures and norms at Ford?

4. Did employment and human resources factors affect the selection of DEP? Was there a deliberate consideration of acquiring the skill requirements from external versus internal labor sources? What rationale was used in comparing the pros and cons of these two generic sources? What were the constraints, if any, in considering external and internal human resources? Was there any explicit decision made to acquire certain ratios between the two sources in each category or in aggregate? Were there differences among different organizational levels concerning preferences for internal versus external labor sources? Did any of the changes undertaken require approval by the union?

A2: Decisions Leading up to the Change--Social Process of Change

1. What were Ford's corporate planning procedures and process that led to the decision of the renovation of the Dearborn Engine Plant? Who were the key individuals and units involved in the decision? What was the general time line and stages of planning?

2. At what level did the consideration of human resource development first appear? At what point in time in technological planning did this consideration enter? What were the various positions taken concerning employment implications by occupational category? How did these divisions manifest themselves? What argumentation tactics, if any, were manifested? Were there any mechanisms for conflict resolution? Were there any lingering dissatisfactions?

3. Did the Ford people in various relevant positions participate in changes about

training? If so, at what level of training? What group (salaried, hourly, managerial)? What was each one's role or contribution?

4. At what point was there an actual design of a technological package? Who introduced this initially? What other levels considered it? What was the organizational potential for innovation?

B1: Actual Process of Social Change--Rationale or Performance

1. Did the technology, as actually designed, involve simple adoption of innovative technology or "reinvention"? Was the new technology, as developed, compatible with the actual norms and procedures of the organization?

2. Were any outside consultants used regarding the shift changes in training or labor relations? How much did the experience of changes in the Lima Engine Plant affect the way things were done at DEP?

3. How far have the results matched up to original expectations in terms of cost, quality, engineering time, energy, inventory, downtime, etc., at the plant level of DEP, and at the level of the crankshaft unit? If the results have differed, to what is this attributable?

B2: Actual Process of Change—Social Processes That Occurred

1. At what point did each of the different personnel levels learn of the change? Which ones were actually involved in decision making and in what ways?

2. Were there different perspectives or conflicts among the levels? How were these treated (resolved, ignored, overridden)? If some levels did not participate in actual decision making, at what point were they informed, how were they informed, and how were their questions or concerns dealt with? Was feedback taken into account, and what time line was provided for the provision of feedback?

3. What were the various positions taken concerning employment implications by occupational category?

4. Have you taken training? If so, what courses or programs? How did you learn about them? Were you assigned or did you volunteer? Has the training contributed directly to your job performance? Indirectly? Not at all?

5. How were the differences dealt with? What level of satisfaction was reached? Was resistance encountered based on employment concerns? Were innovation and promotion procedures introduced to alleviate or deal with employment concerns? Were there any lingering dissatisfactions? How far has monitoring and evaluation had an impact on subsequent developments? What levels were involved in evaluation and in what ways?

C1: Changes on Current Agenda--Rationale or Performance

1. What further technological changes are being considered or introduced?

2. What is the rationale for the change?

C2: Changes on Current Agenda--Social Process

1. What are you doing differently now in introducing change as a result of your experience at the DEP?

2. Are there changes taking place in the monitoring and evaluation of results, as measured against original expectations? If yes, what are these changes and why are they being made? If so, should some changes be made and for what reasons?

3. What are the main factors that are being considered in evaluation procedures?

II. Questions on Work Organization

A. Questions for Hourly and Salaried Employees Directly Involved in the Production Process

The primary objective was to assess the effects of technological changes on changes in the job content, work groups, lines of authority, work attitudes, recruitment/selection procedures and communication patterns.

1. Changes in job content.
   a. Task Variety - Is there more or less variety in tasks required as a result of the change?
   b. Task Complexity - Does the job involve more or less complex hand/eye coordination? Decision-making?
   c. Feedback Generated - (by task itself) - Do the workers know how they are doing? Do they see some change in the product as a result of their efforts?
   d. Autonomy - How much latitude do the workers have in choosing work methods, deciding the sequence of operations, and pacing the work? Can they control their own breaks?
   e. Task Significance - To what extent do the workers feel the job "really counts?" Does their job have considerable impact on other people inside or outside the organization?

2. Changes in work groups. Does the work require the workers to talk and work with any new people? Do they have more or less of an opportunity to talk and work with others? Did any of their friends get transferred or laid off as a result of the recent changes? Do they still have an opportunity to see their friends inside or outside work?

3. Lines of authority. Do workers have more of an opportunity to participate in significant decisions? Is there a change in reporting relationships? Is there a change in management style? Is the work more or less closely supervised or monitored (include mechanical checks and controls)?

4. Job status. Do workers feel more or less respected under the new circumstances?

5. Worker safety and health. Is the new job more or less hazardous? As the physical working conditions (e.g., noise, lighting, need to bend in uncomfortable ways) improved or more unpleasant?

6. Job satisfaction. Is the job more or less satisfying? If there is a change, to what can it be attributed?

B. Questions for Salaried Employees and Skilled Trades Support Units

1. Has their status changed in the plant? Are they taken more seriously by management? By production workers?

2. Questions above on job content apply here as well.

3. Do they have more or less authority? Are their recommendations used more?

4. Have communication patterns changed? Do they work more closely with design engineers? Do they work more closely with first-line supervisors? Production workers?

5. Have there been changes in recruitment/selection? For example, are they hiring more people with computer experience or other specialized knowledge?

6. Are they more or less satisfied with their jobs? More or less secure in their jobs?

7. Have work pressures increased? Do they feel pressured to learn more rapidly than was true in the past? Do they feel threatened by the speed of change?

C. Questions for Union and Company Personnel in Management and Labor Relations

1. Union involvement in the change process. When did union first learn of the proposed changes and what has been the level of participation/involvement in the implementation of the change? What mechanisms, if any, were established to make sure of worker input into the change process?

2. Union-management harmony of conflict. Has the crankshaft change resulted in more or less conflictful relations between management and union personnel? Have there been conflicts over specific dimensions/issues of the change and not others?

3. Reactions to change. How has the union responded to these changes? What in general were union membership reactions to these changes? What major grievances, if any, arose from these changes? Were any new provisions added to the contract due to these changes?

4. Restructuring in management and labor union roles in the post-change period. To what extent is the job of the union steward and foreman different now than it was before? What changes in job content, if any, occurred as a result of the change?

III. Questions on Technological Change and Training

A. General Training Policy

1. Is there an explicit training policy linked to the introduction of new technology?

2. Who has the responsibility for the development and implementation of training policy?

3. Have any new institutions been created for the planning and implementation of training policy? Are they enterprise-based or cooperative (e.g., with other private or public institutions)? How are they funded? How are they related to union/management negotiated decisions on future training needs and facilities?

B. Training Policy and Decision Making about Technological Change

1. How far was training policy integrated into planning the introduction of new technology?

2. When do training needs get considered in the timing of technological developments?

3. Was training provided in advance of introduction of new technology? If so, how far in advance? To whom? By whom?

4. What levels of training personnel are involved? Coorporate? Divisional? Plant?

5. Who are the parties involved in making decision regarding the timing and content of training?

C. Data Bases and Decision Making about Technological Change

1. How are training needs analyzed and defined? What sort of data are used in decision making? What role do seniority and bumping procedures play in decision making about training needs and sites?

2. What skill inventories (if any) does the company maintain? Has the new technology led to greater specificity/generality/polyvalence in skills?

3. Are decisions about training needs made in terms of individualized learning programs, work group programs or unit-wide programs?

4. How are decision made about the location of training?

D. Contents and Duration of Training

1. What are the characteristics of the contents of training required, or highly recommended, for various personnel (management, salaried workers and hourly workers) as a result of the renovation?

2. Are social skills considered important for management, salaried and hourly workers? If so, how are these skills being developed for these personnel through

training?

3. Are basic educational skills (English, mathematics, etc.) included any of the training modules?

4. What had been the minimum duration of training required for management, salaried and hourly workers in DEP before they were considered sufficiently upgraded to perform their functions after the renovation?

E. Training, Technological Change and Employee Reactions

1. What have been the workforce reactions to implications of technological change for their own training? Does this vary by skill level, former job or job classification? What has been the union's involvement in and reaction to training for technological change?

2. How does decision making about training needs and training programs relate to matters of collective bargaining?

3. How does training for and following technological change relate to programs of Employe Involvement? To new method of statistical quality control?

F. Distribution and Evaluation

1. How is the training distributed between occupational categories? What impacts have training programs had on skilled trades apprenticehship programs?

2. Who are the major providers of training?

3. What changes in training provision (form or content) are expected with the development of the FORD/UAW National Skills Development Center?

4. How is training evaluated (e.g., at corporate, divisional, plant and individual level)? How are the results fed back to those involved (as trainers and students)? What rewards or incentives are involved (e.g., internal promotion, or a universally valid qualification or credential)?

APPENDIX E: Relevant Aspects of Union-Management Agreements Covering Dearborn Engine Plant and the Rouge Complex

A full explanation of the rules and regulations pertaining to employment in the U.S. auto industry cannot be accomplished in a few pages. The 1982 collective bargaining agreement between Ford and the United Automobile Workers fills 221 pages by itself; that document is supplemented by local agreements for each of the company's major facilities. Local agreements can run several hundred pages in length themselves. Thus, rather than attempt an exhaustive review, we provide here a brief summary covering one important segment of labor practice: the seniority system. This summary attempts to describe the major features of the seniority system and to indicate their application to the Dearborn Engine Plant and the Rouge complex.

A central provision of the labor contract negotiated between the UAW and the automobile manufacturers is the seniority agreement. Seniority rights are extended to all hourly employees after they have worked for the company beyond a specified probationary period. The seniority system protects employees from arbitrary treatment in times of shifts in employment levels (e.g., during periods of reduction in the work force) and provides a measure of employment security which increases with time in the company.

However, as one might discern from the amount of attention it commands in the collective bargaining agreements, seniority is an important mechanism in a variety of other labor practices. For example, seniority plays an important role with respect to movement between jobs (i.e., what is referred to as bidding): employees are free to apply (bid) for posted openings in jobs and the relative seniority of the applicants is used as a filtering device in determining which applicants are eligible. In the case where seniority is equal, or a case can be made for the special qualifications of a less senior applicant, seniority considerations may drop out of the process; however, relative seniority tends to remain one, if not the central, factor in decisions to fill vacancies. Seniority also counts heavily in applications for change of shift (or efforts to avoid being moved from one shift to another).

Seniority provisions usually apply to the unit or facility in which the person is employed, not to the company as a whole. In other words, an hourly worker achieves and accumulates seniority in the facility (one plant or a set of allied plants) which constitutes the local bargaining unit. Thus, an employee in Plant "X" at Ford Motor Company will accumulate seniority there if, by agreement of the company and the union, Plant X is considered a separate unit. The employee's seniority applies only to Plant X. In case a work force reduction occurs, workers will be laid off in order of seniority, from lowest to highest, and recalled in the opposite order. The employee at Plant X, however, has priority over other laid-off Ford workers (i.e., from outside Plant X). More than one plant can be included in the unit; but, even in those cases, priority is usually given to employees from individual plants.

The seniority system is also connected to distinctions that are made between different categories of jobs. Roughly speaking, there are three general groups of jobs outlined by the collective bargaining agreement: non-classified jobs (e.g., assembler); classified jobs (e.g., semi-skilled jobs like that of job setter, production checker or inspector); and the skilled trades (e.g., electricians, tool and die makers, machine repairers, and millwrights). An employee accumulates general seniority in the plant or unit in which he/she works; additionally, he/she accumulates seniority in a job group. Hence, someone may have 15 years seniority at Plant X, but only 5 years seniority as an electrician if he/she has only been an electrician for 5 years. Moreover, seniority in a job group serves as a selection mechanism for determining the order of lay-off in cases where different job groups are differentially effected by a work force reduction. Hence, someone with 5 years seniority in the skilled trades will be laid off before someone with 6 years seniority in the same trade. Seniority by job group tends to follow the same organizational boundaries as general seniority (by plant or unit). There are some unique cases, however.

The Rouge complex is one such case. In the Rouge, seniority tends to be based first by plant or unit and secondarily by job group--<u>except for the skilled trades.</u> Seniority calculations for the skilled trades units (broken into construction and maintenance, tool and die, and transportation) cover the <u>entire</u> Rouge complex (including the steel mill). As a result, bidding for job openings and the shifting (bumping) which occurs during times of reduction or expansion in employment take place across all the plants in the complex. For example, reductions in employment at the steel plant (the jobs most favored by many skilled tradesmen) will result in a process of bumping down the seniority list among tradesmen and, consequently, a shifting in skilled trades personnel from plant to plant in order of seniority. Likewise, when the steel plant rehires (or openings develop as a result of retirements there), bidding will follow with movement to fill the chain of vacancies created.

APPENDIX F: Training Budget, Representative Flow Chart and Contents

This appendix contains three sets of materials: (1) summary of the training budget (and actual costs through June 1979) for the renovation — Erika project; (2) the flow chart and contents of training for new supervisors and (3) the flow chart and contents of training for technical indirect labor (espeicaily electricians). Although much more information about training materials has been made available to us, we only excerpted the representative materials which are referred to in the text of this report.

F.1 Training Budget and Costs

ERIKA TRAINING BUDGET - COST SUMMARY

ITEM	PROJECTED COSTS	ACTUAL 1978/79 COSTS THROUGH JUNE 1979	BALANCE REMAINING
Management/Supervisory	→ $ 377,515 (1)	$ 16,655	$ 360,860
Technical/Professional	51,895 (2)	9,795	42,100
Indirect Labor	→ 4,866,027 (3)(4)	496,509	4,369,518
Direct Labor	264,202 (3)	464	263,738
Other Associated Training Program Costs	775,248	245,622	529,626
TOTAL	$ 6,334,887	$ 769,045	$ 5,565,842

NOTE:

(1) Includes travel and living expenses, consultant fees, seminar and facility costs. In addition, this figure only reflects salaried wages for new hourly supervisors for seven (7) weeks at an average salary of $1500 a month.

(2) Includes travel and living expenses, seminar and facility costs. Salaried wages are not included in this figure.

(3) Hourly training includes both travel and living expenses and average wages paid per hour including 85% fringe and $1.37 COLA.

(4) Indirect labor costs include $3,549,000 for training 100 new apprentices. Approximately $1,115,000 of this has been saved due to the delayed hiring (Feb thru June 1979) of these apprentices.

ERIKA TRAINING BUDGET - ESTIMATED COST SUMMARY

MANAGEMENT/SUPERVISORY	PROGRAM COST VARIABLES	PROJECTED NUMBER TO BE TRAINED	PROGRAM COST PER PARTICIPANT	TOTAL PROGRAM COSTS
o Hourly Supervisor Development Program	1) $1500 base rate 2) Seven-week training period	107	$ 2,625	$ 280,875
o Potential Problem Analysis Seminar	$103 per person	40	103	4,120
o Team Building	Facility Costs $2500 per program (3)	41	927	38,000
o Salaried Supervisor Institute	$350 per person	50	350	17,500
o Hourly Supervisor Institute	$225 per person	107	225	24,075
o M.S.S.S. Assessor Certification	$495 per person	11	495	5,445
o Problem Analysis Seminar	$ 75 per person	100	75	7,500
TOTAL MANAGEMENT/SUPERVISORY TRAINING COSTS				$ 377,515

ERIKA TRAINING BUDGET - INDIRECT LABOR

ITEM	PROJECTED COST	SPENT	BALANCE	DESCRIPTION	RISK
Vendor Training at Vendor Facility	$ 241,998	$ 3,030	$ 238,968	Vendor visitations by skilled tradesmen to learn trouble-shooting techniques during debugging of equipment.	High risk - timing becomes a problem - minimal time to train personnel at Dbn. Eng. Plt.
Vendor Training - Skilled Trades at Dbn. Eng. Plt.	360,912	9,710	351,202	On-the-job training conducted by key vendor personnel during machine installation, debugging and tryout	High risk
Vendor Training Non-Skilled Trades at Dbn. Eng. Plt.	388,880	0	388,880	On-the-job training conducted by key vendor personnel during machine installation, debugging and tryout	High risk
Apprentice Training	3,549,000	364,000	3,086,000	Corporate apprentice training program	High risk
Hourly Orientation	70,092 *	0	70,092*	6-hour orientation to Dbn. Eng. Plt.	Medium risk
Relay Logic	11,160	5,342	5,818	See training summary on page 44	High risk
Basic Electronics	60,102	12,799	47,303	See training summary on page 44	High risk

ERIKA TRAINING BUDGET - INDIRECT LABOR

(cont'd)

EM	PROJECTED COST	SPENT	BALANCE	DESCRIPTION	RISK
sic Hydraulics	$ 15,184	$ 0	$ 15,184	See training summary on page 44	High risk
sic Pneumatics	18,705	0	18,705	See training summary on page 45	High risk
oblem Analysis Seminar	89,280	0	89,280	Training program that concentrates on a systematic approach to problem solving	Low risk
ogrammable Controller nematic Interpretation	5,994	0	5,994	See training summary on page 46	High risk
ansition to Metric	47,880 *	1,476	46,404*	See training summary on pe ge 45	Medium risk
ndamentals of Gasoline gines	6,840	1,152	5,688	See training summary on page 45	Medium risk
INDIRECT 'ABOR ING COSTS	$4,866,027	$ 496,509	$ 4,369,518		

rage hourly wage calculated at $18.00 including 85% finge and $1.37 COLA

F.2 New Supervisor Training

NEW SUPERVISOR TRAINING - SEVEN (7) WEEKS

The Hourly Supervisor Program has been developed to provide an effective and efficient way to train supervisors of hourly employes. There are various reasons why improved training has become an important issue within the Company. Governmental regulations and strict specifications must be followed and met by our product. The hourly work force, having become more knowledgeable, educated and aggressive, has increased pressures on management and supervision.

The objectives of the Hourly Supervisor Program are:

- To provide systematic learning guides which will enable the hourly supervisor to perform the entry level skills of his/her job correctly and efficiently.

- To provide the hourly supervisor experience through which he/she can acquire the necessary skills to perform the technical and administrative responsibilities required in his/her position.

The seven (7) week program centers around specific supervisory tasks and need-to-know information provided through task certification by an instructor supervisor and classroom instruction conducted by designated functional area representatives.

First Week

During the initial phase of the program, the new supervisor will complete a Plant Orientation and Familiarization. The remainder of the first week of training will be divided between being on the floor for the beginning and end of the shift and attending Functional Area Presentations. The on-floor training is important here to help the trainee adjust to the environment and begin working on Shift Start-Up and Shift Completion tasks.

EW SUPERVISOR TRAINING - SEVEN (7) WEEKS
cont'd)

econd through Fifth Weeks

The trainee will spend the majority of time during these weeks completing tasks. The trainee will complete all the critical tasks and as many of the administrative/general tasks as possible. Also during this period, the trainee will attend sessions in Demonstration Modeling and Job Instructional Training. Demonstration Modeling deals with seven typical situations the trainee will encounter when dealing with his/her employes. Job Instructional Training shows the trainee how to break a job down into elements and how to instruct an employe to do a new job.

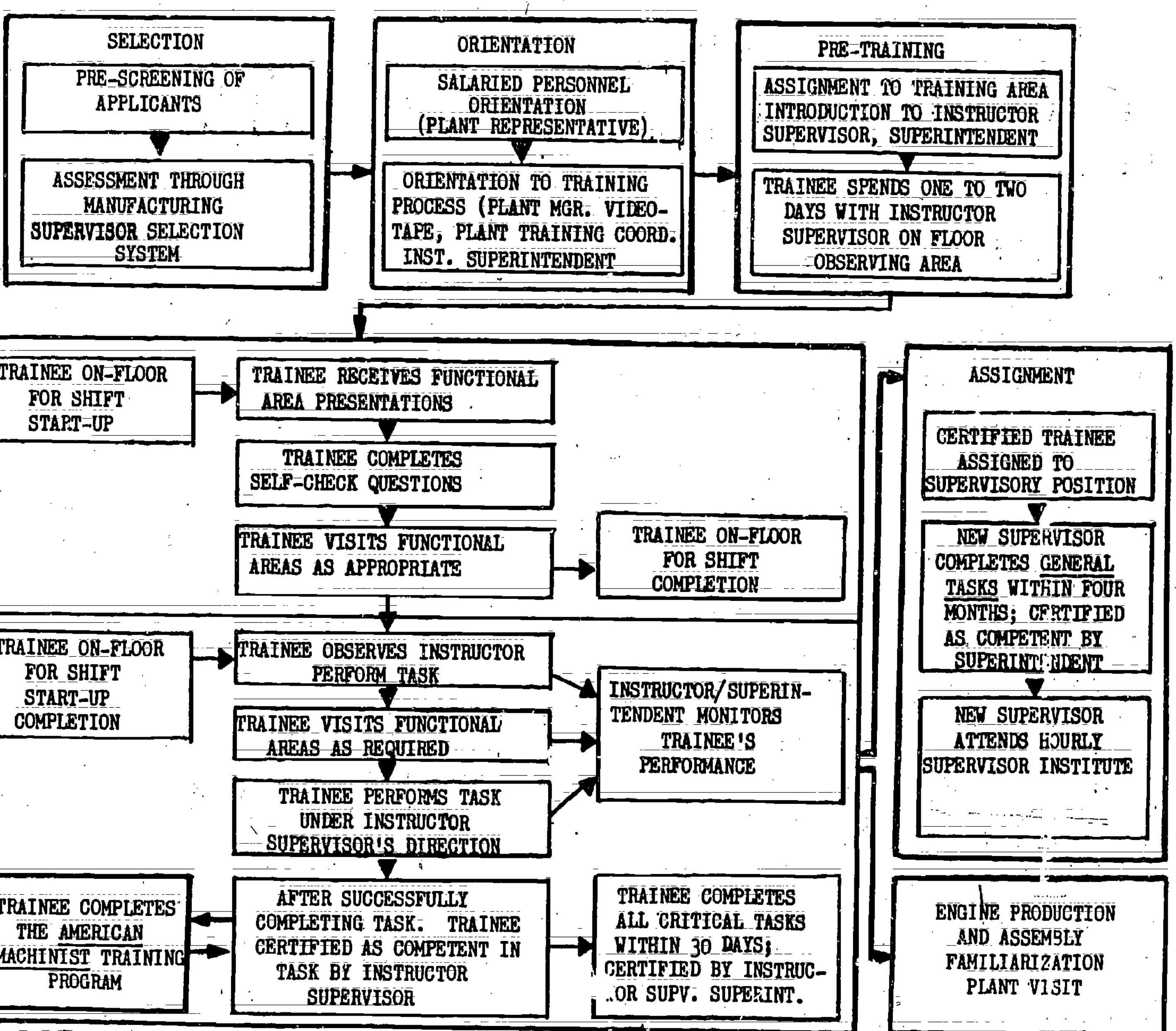
ixth and Seventh Weeks

The new supervisor will be assigned to visit another engine plant for production and assembly familiarization. The trainee will observe experienced, capable supervisors in various areas perform their jobs to acquire knowledge and understanding that can be transferred to his/her job at Dearborn Engine.

In addition to completing the in-plant training phase and other plant visits, all new hourly supervisors will be scheduled to attend the Hourly Supervisors Institute.

DEARBORN ENGINE PLANT

HOURLY SUPERVISOR DEVELOPMENT PROGRAM



TENTATIVE SCHEDULE FOR NEW HOURLY SUPERVISORS

Assignments	Hours to Complete
Week One	
• Orientation	6
• Plant Familiarization	2
• Shift Start-up and Completion	7.5
• Functional Area Presentations	16
• Machine Technology - Fundamentals of Machining	8.5
Week Two	
• Certification on Critical Tasks	36
• Demonstration Modeling	
- Introduction	1
- Situation #1, Meeting the New Employe	3
Week Three	
• Certification on Critical Tasks	35
• Demonstration Modeling	
- Situation #2, Assigning Work	2.5
- Situation #3, Handling a Complaining Employe	2.5
Week Four	
• Certification on Critical Tasks	35
• Demonstration Modeling	
- Situation #4, Correcting Personal Work Habits	2.5
- Situation #5, Discussing Potential Disciplinary Action	2.5

TENTATIVE SCHEDULE FOR NEW HOURLY SUPERVISORS
(Cont'd)

Assignments	Hours to Complete
Week Five	
• Certification on Critical Tasks	19
• Demonstration Modeling	
- Situation #6, Giving Recognition to an Average Employe for Performance	2.5
- Situation #7, Helping the Employe to Learn the Job	2.5
• Job Instructional Training	6
• Additional Machine Training at Tool and Die Plant	10
Weeks Six & Seven	
• Visit to Other Engine Plants	80
Within 90 Days of Assignment	
• Attend the Hourly Supervisor Institute	40

F.3 Technical and Indirect Labor Training

TECHNICAL TRAINING

The new and expanded use of advanced technology in the Dearborn Engine Plant requires extensive training for both salaried and hourly personnel responsible for set-up, operation, maintenance and troubleshooting of equipment. This section is intended to provide a list of technical training programs, both in use and planned, designed for the personnel of the Dearborn Engine Plant. Included is a summary of various training programs presently in use.

This section is intended to show Vendor/Supplier/In-House Training Programs and Dearborn Engine Plant personnel who will require these various training programs.

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General Programs

- Fundamentals of the Gasoline Engine
- Transition to Metric

Fluid Power Programs

- Air Logic
- Basic Hydraulics
- Basic Pneumatics

Electrical/Electronic/Computer Programs

- Allen Bradley Programmable Controllers
- Cutler Hammer Adjusto-Speed Motors
- English Logic
- Introduction to Mini-Computers
- Modicon Programmable Controller
- Numa-Logic Solid State Controls
- PDP-11 Computer
- Programmable Controller Schematics
- Ramsey Solid State Controls
- Relay Logic Troubleshooting
- Solid State Electronics
- Tandem-16 Computer

TECHNICAL TRAINING PROGRAMS
(cont'd)

Vendor and Supplier Training Programs

Vendor	Equipment
Arcade Tool Co	Dial Machine
A T & T	Cold Test
Barnes	Drill Machine
Beach	Air Test
Bendix	Gauges
Cincinatti Milicron	Broach
Crankshaft Machine	Turning Machine
Cross	Transfer Line
Detroit Broach	Broach
Eaton Kenway	High Bay Stacker
Eitel Press	Straightener
Ekman	Assembly Equipment
Ex-cell-o	Seat Finisher
Farval	Lube Systems
J. N. Farver	Lube Systems
Federal Product Corp	Auto Grader
Gilman	Assembly Equipment
Gisholt	Balancer
I.M.F.	Flusher
Impco	Polisher
Ingersoll-Rand/ Hamilton Test Systems	Hot Test
Ingersoll-Rand	Assembly Equipment
I.T.T.	Grader
Kingsbury	Various Machining Operations
Lamb	Transfer Line
Landis	Grinders

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ECHNICAL TRAINING PROGRAMS
cont'd)

• LaSalle	Transfer Line
• Marposs	Gauges
• Mattison	Grinder
• Micromatic	Hone
• Motch & Merryweather	Various Maching Operations
• Nagle	Assembly Equipment
• National Acme	Cutter
• Otto Durr	Washer
• Oxy-Metal	Phosphate Coater
• Place	Transfer Line
• Ranshoff	Washer
• Shenck	Mass Center
• Synder	Transfer Line
• Surf Tran	Chemical Deburring
• Sys-T-Mation	Transfer Line
• Taylor & Gaskin	Washer
• Turner Brothers	Assembly Equipment
• Electro Arc	Tap Disintegrator
• Centri-Spray	Debur & Washer
• Welduction	Induction Hardener
• Advance Weight Specialists	Weight Checker
• Babcock & Wilcox	Broach
• Safety Flow	Washer
• Industrial Metal Fab	Transfer Line

NDIRECT LABOR TRAINING PROGRAMS

- Industrial Lift Truck Training Plan
- Final Inspection Gauging Fundamentals
- Print Reading (Process Illustrations)

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TRAINING PROGRAM SUMMARIES

y Logic - The relay logic program has been developed to enable participants to maintain and bleshoot relay logic systems. The objectives of this program are to assist the participants to:

Identify components and relate the physical object to the symbol.
Interpret relay schematics.
Maintain and troubleshoot relay systems such as the mills and washers on the cylinder block line.

program will also prepare participants to accept programmable controller training on Modicon and n Bradley systems.

c Electronics - This program is primarily designed for maintenance personnel who will service pment with solid state electronic controls. The program participants will learn the fundamentals olid state electronics as well as develop troubleshooting skills to diagnose and correct electronic ts. The objectives of this program are to enable the participants to:

Identify typical solid state symbols.
Interpret solid state electronic schematic diagrams.
Maintain and troubleshoot equipment with solid state electronic controls such as the electronic gage systems located on the cylinder block line.

c Hydraulics - The hydraulic program has been developed to qualify Hydraulic Repairmen to maintain troubleshoot hydraulic systems. The objectives of this program are to enable the participants to:

Identify typical hydraulic components.
Interpret hydraulic circuit operations from schematic diagrams.
Logically troubleshoot a typical hydraulic circuit and determine the component which is malfunctioning.
Perform tests to determine operating condition of hydraulic components.

TRAINING PROGRAM SUMMARIES
(cont'd)

Basic Pneumatics - The pneumatics program has been developed to qualify pipefitters to maintain and troubleshoot pneumatic systems. The objectives of this program are to enable participants to:

- Identify typical pneumatic components.
- Interpret pneumatic circuit operations from schematic diagrams.
- Logically troubleshoot a typical pneumatic circuit and determine which component is malfunctioning.

Metrics - This training program provides participants with a view of why industry is beginning to use metric measurement. Presentation of the simple terms (meter, litre, gram, milli, centi, kilo, Celsius) most employes will encounter at work is highlighted. Explanation of the International System of Units (S.I.) and how it applies to employes is also provided.

Fundamentals of Gasoline Engines - This program covers all of the systems of the basic piston engine, i.e., induction, compression, exhaust, valve train and camshaft, lubrication, cooling, and crankcase ventilation. Ignition and carburetion are covered only to the extent necessary to explain functioning of the total engine system. This presentation also covers typical construction and functioning of engines used for automotive applications.

Allen-Bradley 1 (Basic) - An introduction to Allen-Bradley Programmable Controller (P.L.C.) familiarizes electrical personnel with the concept of controllers and their applications as directed toward industry. All electrical personnel will complete this program prior to visiting vendor facilities during the de-bug and tryout period.

Allen-Bradley 2 (Advanced) - An in-depth program will totally familiarize electrical personnel with P.L.C.'s. The participants will learn detailed component descriptions and troubleshooting procedures. Participants will be exposed to basic programming and troubleshooting utilizing a CRT programming panel.

RAINING PROGRAM SUMMARIES
cont'd)

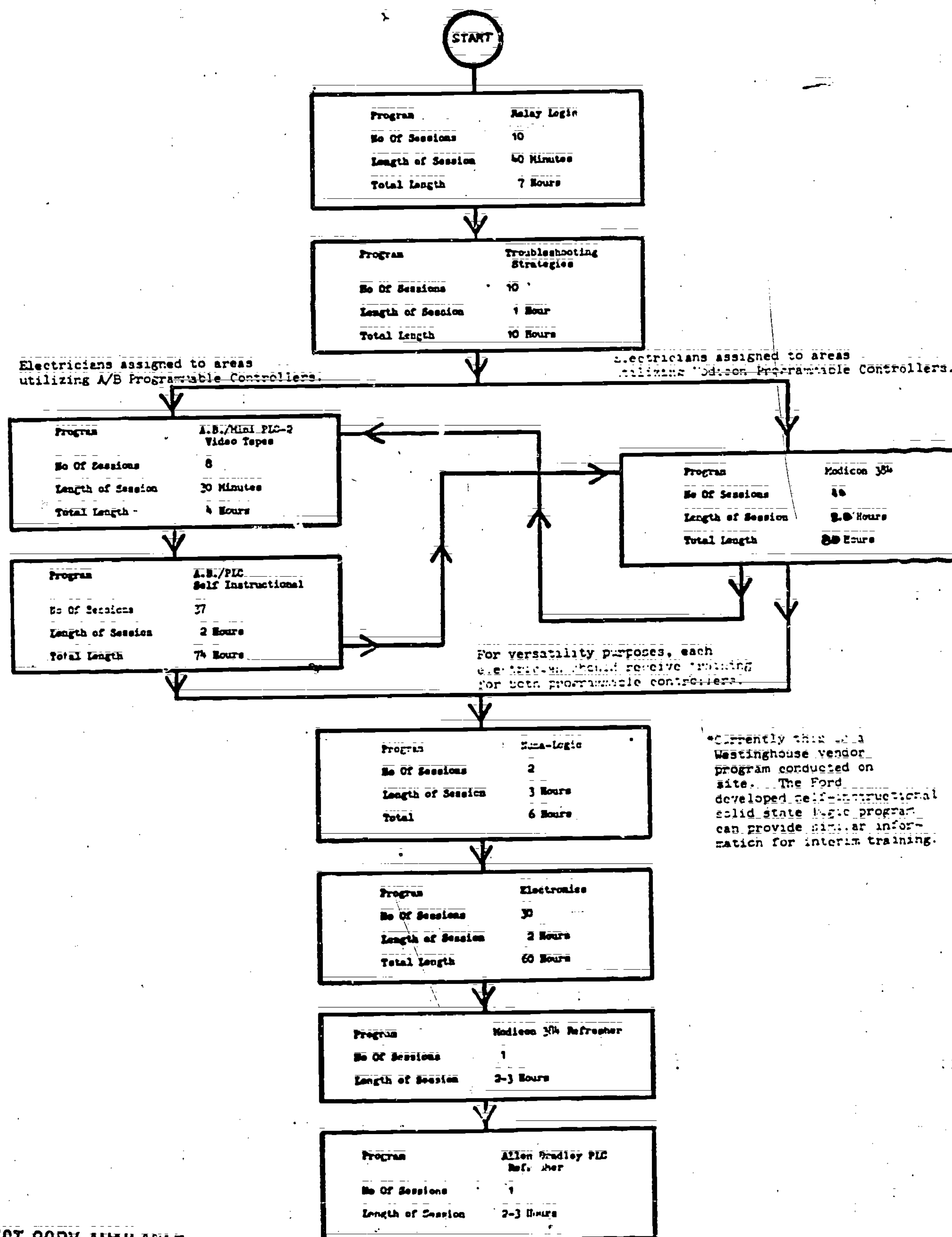
odicon 1 (Basic) - An introduction to Modicon Programmable Controllers familiarizes electrical ersonnel with the concept of controllers and their applications as directed toward industry. ll electrical personnel will complete this program prior to visiting vendor facilities during he de-bug and tryout period.

odicon 2 (Advanced) - An in-depth program will totally familiarize electrical personnel with pro- rammable controllers. The program participants will learn detailed component descriptions, nstallation, mounting procedures and troubleshooting of basic components such as the power supply, rocessor, and input and output modules. Participants will be exposed to basic programming and roubleshooting utilizing the CRT programming panel.

rogrammable Controller Schematics - A program will be developed that will enable participants to nterpret controller schematic diagrams and utilize them as troubleshooting aids. All electrical ersonnel will be required to complete this program and be certified through the completion of pecifically defined tasks.

Flow Chart of Technical Training for Electricians

This flow chart describes the sequence of training program for electricians assigned to Dearborn Engine Plant.



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