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ABSTRACT

This pilot research project analyzes the role related classroom instruction plays in training journeymen in three Boston area trades-machinist, electrician, and operating engineer. Information was gathered from apprentices, journeymen, apprentice coordinators, and others by means of personal interviews and/or mail questionnaires. The data were used to estimate the impact of related instruction on individual job performance. The principal hypothesis was that related instruction has multiple roles, varying by trade and the particular objectives of different sponsors. It was possible to identify the independent effect of related instruction on job performance. In all three crafts the primary objective of related instruction was to equip apprentices with the technical knowledge and manipulative skills to become versatile all round journeymen. Only in the electrical trade did related instruction seem to offer a significant explanation of the variation in individual performance. It was almost impossible to coordinate related instruction with on-the-job training in construction. In the machinist trade, the degree of coordination varied from firm to firm. (Author/SA)

THE ROLE OF RELATED INSTRUCTION IN APPRENTICESHIP TRAINING (A Pilot Study)

by

Steven M. Swanson
Irwin L. Herrnstadt
Morris A. Horowitz

A Report to the
Office of Research and Development
Manpower Administration
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Department of Economics
Northeastern University
Boston, Massachusetts 02115
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16. Abstracts This pilot research project analyzes the role related instruction plays in training journeymen in three Boston area trades, machinist, electrician and operating engineer. Information was gathered from apprentices, journeymen, apprentice coordinators, and others by means of personal interviews and/or mail questionnaires. The data were used to estimate the impact of related instruction on individual job performance, as measured by hours worked and/or foremen's evaluations. The principal hypothesis was that related instruction has multiple roles, varying by trade and the particular objectives of different sponsors. Since related instruction could be separated from the on-the-job training component of apprenticeship and other training methods, we were able to identify the independent effect of related instruction on job performance. In all three crafts, the primary objective of related instruction was to equip apprentices with the technical knowledge and manipulative skills to become versatile all round journeymen. The principal conclusion was that the effect of related instruction on the performance of apprentices and journeymen differed in each trade. Only in the electrical

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trade did related instruction seem to offer a significant explanation of the variation in individual performance. It was almost impossible to coordinate related instruction with on-the-job training in construction, because of the nature of the industry. In the machinist trade, the degree of coordination varied from firm to firm, depending on the mix of work and the interest in training an all round man.

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PREFACE

This study was authorized by the Office of Research and Development, Manpower Administration, United States Department of Labor, in the spring of 1971, and work was started on May 1, 1971. The purpose of the research was to study the contribution of related classroom instruction in apprenticeship, and to make recommendations for the improvement of such instruction, where it was deemed necessary. An important objective was to research the effects of classroom instruction on the training of the craftsmen in the trades under study.

While we recognized that the role of related instruction could vary by geographic area, industry and trade, we limited our study, because of financial reasons to three trades in the Boston area. Our original selection of trades was made after a number of conferences with the staff of the Office of Research and Development, and because of the importance of the construction industry to apprenticeship, two trades were selected from that industry and a third from a non-construction trade. Despite considerable efforts to obtain the cooperation of the unions involved in the trades originally selected, we failed to gain the support of one union. We were then obliged to drop that trade from our study and to select another. The three trades finally selected were machinist, electrician and operating engineer.

The basic information for the study was obtained through personal interviews with apprentices, journeymen, apprentice coordinators, instructors, educators, government administrators, as well as representative employers and union officials for each craft. Additional information was gathered by mail questionnaire from journeymen in the three trades.

The focus of this research on the related instruction component of apprenticeship was a result of a number of discussions with Dr. Howard Rosen, Director of Research and Development, Manpower Administration, and Mr. William Paschell of Dr. Rosen's staff. They participated in the original design of the study and offered significant suggestions in developing the methodology that was finally used. Their aid and encouragement were important to our final completion of this research. When Mr. Paschell left the Manpower Administration in the summer of 1973, he was replaced by Mr. Lafayette Grisby, who offered considerable comments and suggestions on the first draft of this report. To these persons, and others in the Office of Research and Development, we give our thanks.

At each of the various steps of our research we had the assistance of many persons. To all we owe our gratitude. Invaluable help was rendered by the apprentices and journeymen who responded to our questionnaires and to the unions, companies, and educational institutions responsible for their training. Special mention must be given to the following individuals and organizations:

Construction

Hoisting and Portable Engineers, Local 4, International Union of Operating Engineers--Joint Apprentice and Training Committee, Boston, Massachusetts: Joseph S. Grande, Apprentice Coordinator

Joint Apprentice and Training Committee--Electrical Industry, Boston, Massachusetts: Robert R. Regan, Director of Training, and James L. McCoy, former Assistant Director

Local 4 and Branches, International Union of Operating Engineers, Boston, Massachusetts: Walter J. Ryan, Business Manager

Associated Builders and Contractors, Yankee Chapter, Waltham, Massachusetts: Charles B. Lavin, Jr., Executive Director

Associated General Contractors of Massachusetts, Newton, Massachusetts: William D. Kane, Manpower Specialist

Builders' Association of Greater Boston, Boston, Massachusetts: Louis Chaitman, Executive Vice President

Electrical Contractors' Association of Greater Boston, Inc., Boston, Massachusetts: Dana H. Malins, Manager

Corcoran Construction Corporation, Milton, Massachusetts: John M. Corcoran, President

M. B. Foster Electric Company, Boston, Massachusetts: James R. Curley, Manpower Coordinator, and Joseph T. Norton, Manager, Construction Division

Wallace and Lee, Inc.: Norwood, Massachusetts: Joseph T. King, Executive Vice President

Walsh Electric Company, Stoughton, Massachusetts: John R. Walsh, Owner

Harvard Electric Company, Boston, Massachusetts: Harvey L. Freedman, President

Interstate Electric Services Corporation, Burlington, Massachusetts: Joseph E. Trodella, Vice President

Manufacturing

Avco Missile Systems Division, Avco Corporation, Wilmington, Massachusetts: V. S. Belpedio, Manager, Manufacturing Department, W. E. Christie, Chief, Fabrication Section, and A. P. Cameron, Personnel Representative

Barco Engineering Company, Malden, Massachusetts: Walter Stevenson, General Manager

Boston Edison Company, Boston Electrical Operation Department, Boston, Massachusetts: Vaughn C. Zulakan, Assistant Chief, Electrical Operations

Boston Naval Shipyard, Charlestown, Massachusetts:
Santo J. Passalacqua, Employee Development Specialist, A. J. Mullin, Head, Training Department, both of the Employee Development Division, and D. C. Healy, Director of Industrial Relations

Dyko Tool and Die Company, Watertown, Massachusetts:
Alexander Dyko, Owner

Foxboro Company, Foxboro, Massachusetts:
Ralph M. Whipple, General Foreman, Tool Maintenance and Tool Storage Department

General Electric Corporation, Lynn, Massachusetts:
Gilbert K. Richter, Manager, Personnel Practices, and Robert F. Spousta, Manager, Apprentice Training

Gillette Company, Safety Razor Division, Boston, Massachusetts:
Philip J. DeConinck, Group Manager, Equipment Manufacturing Group, Raymond E. Townsend, Manager, Apprenticeship Training of the same Group, and Joseph C. Pedula, former Manager, Wage and Salary

Hansen Engineering Company, Lynn, Massachusetts:
H. Harold Hansen, President

Hawkes Grinding Tool Company, Boston, Massachusetts:
Earl R. Lane, President

J. W. Moore Machine Company, Everett, Massachusetts:
Robert H. Moore, Jr., President, and Salvatore F. Sirino, Assistant Superintendent

Nettco Corporation, Everett, Massachusetts:
Charles O'Connell, former Purchasing Agent, and John Lennon, President

Northeast Manufacturing Company, Stoneham, Massachusetts:
Harvey J. Lobdell, President

Northeastern Tool Company, West Haverhill, Massachusetts:
Richard A. Breault, President

Polaroid Corporation, Cambridge, Massachusetts:
Raymond G. Ferriss, Manager, Training and Education Department, Robert B. Hickey, Training and Education Specialist, David S. Walsh, Training Consultant, both of the Training and Education Department, Frederick A. Moseley, Skilled Trades Supervisor, Cambridge, and Robert C. Peterson, Skilled Trades Supervisor, Norwood

Palmer Manufacturing Corporation, Malden, Massachusetts:
Anthony A. Fiore, Treasurer

Western Electric Company, North Andover, Massachusetts:
Thomas J. Luby, Jr., Department Chief, Tool Construction, Maintenance and Inspection, and Frederic L. Bume, Section Chief, Tool Maker Training, Department of Tool Construction, Maintenance and Inspection.

Government

Boston Public Schools, Boston, Massachusetts:
Hebert C. Hambelton, Associate Superintendent, Ambrose Alphonse, Director, Apprenticeship and Industrial Training, and Jeffrey J. Keating, former Director, Vocational Education and Industrial Arts

Bureau of Apprenticeship and Training, Boston Regional Office:
James J. Haggerty, Director, Frederick R. Smith, Assistant Director, Dominic Sangiovanni, Federal Field Representative, and John V. Chatlik, State Supervisor

Massachusetts Division of Apprenticeship Training, Boston, Massachusetts:
John J. McDonough, Director

Massachusetts Department of Education, Division of Occupational Education, Boston, Massachusetts: Alfred F. Hoyle, Senior Supervisor, Apprenticeship Training

Without the exceptionally capable and unflagging efforts of Sharon E Keith, Research Associate, and Daniel C. Calore, Research Assistant, the project could not have been completed. Ms. Keith, and later Mr. Calore, were responsible for day-to-day operations and contributed to data manipulation and analysis. Both were sources of excellent ideas and suggestions. To both of them we are indebted, as we also are to Ms. Domenica E. Mayberry and Ms. Rosalie N. Parechanian, who labored assiduously and ably over the typing and proof-reading of the manuscript.

Finally, our thanks to those individuals and organizations who preferred to remain anonymous, but whose help was as valuable as that of those cited above.

Steven M. Swanson
Irwin L. Herrnstadt
Morris A. Horowitz

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CONTENTS

KEY FINDINGS

1. The two main training components of apprenticeship, on-the-job training and related instruction, are separate entities. Although ideally they should be integrated both in timing and substantive content, individuals have had the on-the-job training component and not the related instruction, and still served an apprenticeship of fixed length. Moreover, some persons attended related instruction classes, typically at night, either in private or public trade (or technical) schools, independently of apprenticeship.

2. The primary goal of related instruction in the three trades studied is to provide the skills and technical knowledge needed to make an all round craftsman. An all round craftsman is one whose breadth and flexibility ensures steady work and imparts the capacity to successfully handle unusual situations and use new technologies.

3. Related instruction also has other goals, whose importance will vary by trade. These goals are:

- -- to provide the background for promotion
- -- to substitute for on-the-job training which cannot be given at work
- -- to insure acceptance by fellow journeymen as a competent craftsman
- -- to instill identification with the trade
- -- to instill personal self confidence in the individual's skill
- -- to review material of prior school work
- -- to prepare in advance for on-the-job training

4. In the electrical trade, these secondary goals were to substitute for training not possible on the job, to identify with the trade, to be accepted by fellow craftsmen, to instill self confidence, and to provide the background for promotion. In the operating engineers, the goals were a substitute for on-the-job training and advance preparation for work tasks, especially those of the oiler. Among machinists, the secondary goals were advance preparation, self confidence, promotability and review of previous education.

5. The major determinants of the goals of related instruction are the structure and content of the work process in the trade, and the presence of a union.

6. Some journeymen in each trade did not have formal related instruction or did not have courses in the context of apprenticeship. Yet they had acquired the skills to work in their trades. Nearly all apprentices and journeymen agreed that related instruction in apprenticeship was valuable.

7. Whether trade skills and knowledge were acquired through related instruction or through other means seems to have made no difference in the journeymen's performance, as measured by amount of employment for construction or by supervisors' ratings in machining.

8. With the exception of the electrical trade, grades or performance in related instruction did not influence hours worked, which was used as a proxy for on-the-job performance. In addition, among the operating engineers, journeymen's

evaluations of apprentice performance at work was unrelated to the apprentice's record in related instruction.

9. Again, except for the electricians, the time needed to become a journeyman was not affected by whether a craftsman had had related instruction.

10. The largest share of the cost of related instruction is borne by apprentices in the form of time spent in class and on homework.

11. The higher the probability of recapturing the costs of training, the more likely a firm will be to invest in training. If related instruction provides general skills which are valuable to a wide range of employers, a firm will be reluctant to invest in such training.

12. Although attempted, coordination between related instruction and on-the-job training was not achievable in the construction trades, but was achieved in the machinist's trade. Coordination is achievable only in trades where the work mix is varied and the flow predictable, and those responsible for training can make work assignments.

13. Programs gave little credit towards related instruction for previous education or work experience that was closely related to the trade. While a large percentage of electrical and machinist apprentices had related courses or work experience before entering apprenticeship, few received any credit towards related instruction.

14. The quality of related instruction courses offered by JATC programs and by large corporations rate the highest. In the unorganized sector of construction and in smaller machine shops, attendance at related instruction is voluntary and what little progression there is from course to course is a personal decision. The inadequate curricula offered by the public schools account for the poor record among unorganized contractors and small machine shops.

15. In all three trades, informal sources of information about apprenticeship and the occupation were more important than formal sources. High school counselor's and the state employment service played a minor role.

CHAPTER 1
INTRODUCTION AND METHODOLOGY

A hallmark of apprenticeship training in the United States is related instruction in which apprentices attend formal classes for a specified number of hours each year of their apprenticeship. Some or all of the class hours are on unpaid time outside regular working hours and may be provided, as well as conducted, by employers, employer associations, joint labor-management committees, trade unions, and local public school systems. Classes can be in the form of lectures in a traditional classroom or practical work in a shop.

The provision of "education" for apprentices can be traced back to Colonial America and to England before that. Masters were responsible for the general education of their apprentices, who typically were minors.[1] Evidently the goal was imparting enough basic literacy and arithmetic to meet the demands of the particular craft. Unlike this earlier prescription, related instruction today does not provide general education but subjects directly tied to the technical or vocational aspects of the apprentice's trade. Nonetheless, much of related instruction can be interpreted as general education in the fundamentals of the trade itself; moreover, as later discussion will show, part probably includes some general education in the original meaning of the term.

Despite its association in this country with apprenticeship, related instruction is not unique to apprenticeship or to the United States. Formal classroom presentation of material of direct relevance to the trade being taught also appears to be an integral part of nearly all vocational training and education in the United States, Western Europe (and no doubt Eastern as well) and in much of Latin America. Its almost universal use would seem to document the significance of related instruction to all kinds of vocational training programs.

Again, despite the undeniably close association of related instruction with apprenticeship, remarkably there has been no systematic examination of their interrelation. In particular the exact nature and role of related instruction has not been subject to vigorous investigation. What little information exists has been the byproduct of research into other aspects of training or into trade union policy, impressionistic in nature, and limited to a few geographic areas and industries (almost entirely construction). These very sparse observations have cast doubt on the quality of related instruction, that is, on its implementation.[2] There have been disquieting accounts of apprentice reluctance to attend classes because of ineffectual teaching, the repetition of previously acquired material, and the irrelevancy of substantive content. However, there has been no evidence to deny the value of properly executed related instruction or even its necessity.

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1. See Seybolt, Robert Frances, Apprenticeship and Apprenticeship Education in Colonial New England and New York, Arno Press and The New York Times, New York, 1969.

2. Strauss, George, "Related Instruction: Basic Problems and Issues," Research in Apprenticeship Training, The University of Wisconsin Center for Studies in Vocational and Technical Education, 1967.

In fact, related instruction can have both advantages and disadvantages for apprentices. The question then is: Which set predominates? Do the benefits outweigh the costs?

Apprenticeship and Related Instruction Defined

Apprenticeship usually is defined as a program of fixed duration combining systematic on-the-job training with coordinated related classroom instruction. A formal indenture is signed by the employer and the apprentice. There also are periodic wage increases at specified times that gradually reduce the difference between the apprentice rate and the journeyman's.

The two main training components of apprenticeship, on-the-job training and related instruction, are separate entities. Although ideally they should be integrated both in timing and substantive content, it is possible for an individual to have had the on-the-job training component and not the related instruction, and still to have served an apprenticeship of fixed length. It is also possible to have had similar on-the-job training outside of apprenticeship with or without related classroom instruction. Moreover, some persons attend related instruction classes, typically at night, either in private or public trade (or technical) schools, independently of apprenticeship. Thus, the on-the-job portion of apprenticeship can be taken without related instruction, just as related instruction classes can be taken without the on-the-job training of apprenticeship.

Statistical techniques permit the analysis of the role of on-the-job training apart from related instruction and vice versa, because men can have either one or the other, or both.

It might be argued that the on-the-job training of apprenticeship is unique because it is reinforced by allegedly coordinated related instruction, and that on-the-job training without such coordinated related instruction, but nonetheless with related classes, is not the same. Our findings are that such coordination need not or (in construction especially) cannot occur, and in practice often has not occurred. Because we can distinguish between related instruction and on-the-job training, we can test the impact of each separately, as we have done in this study.

Our tests compared men who had on-the-job training in apprenticeship with what was planned as coördinated related instruction, men who had on-the-job training outside of a formally designated apprenticeship who took related courses on their own, men who had no formal on-the-job training but attended appropriate classes of their own choosing, and finally men who had formal on-the-job training but no classwork. Except for apprentice electricians, the tests showed no significant difference in the job performance, as measured by weeks worked in the case of construction workers, or elaborate foreman ratings in the machinist trade.

The Pros and Cons of Related Instruction

The superiority attributed to apprenticeship, compared to other forms of training, in part flows from its related instruction component. The relative advantages of apprenticeship to both the employee and employer are more skill, breadth, mobility, and promotability. The implication is that the differences are substantial ones. Advantages accrue to the individual worker in the form of higher wages, steadier employment, and more advancement, and to the employer and society in the form of either greater productivity, better quality, or both. Further, apprenticeship furnishes the employer a pool of future supervisors, technicians and other management personnel.

A simple rationale for related instruction is that it enables the apprentice to absorb more readily and to better retain what he has been taught at work, because it (1) provides the "theory" that "explains" trade technology and work practices, and (2) introduces the apprentice in advance to the equipment, tools, materials and methods he will encounter at work. Knowing the reasons for, and acquiring early familiarity with, trade techniques is assumed to reduce waste of materials, damage to equipment, and injury to the person, and to economize on the valuable time (and patience) of supervisors and journeymen. An added premium perhaps is that the better prepared the apprentice, the easier, and thus the more enjoyable (or less tedious), the task of the teacher (journeyman) who then ought to be that much more willing to train (aside from any personal reservations about adding to the number of potential competitors for scarce job opportunities). These arguments also lead to the conclusion that there ought to be a close correspondence between related instruction material and job assignments, both in terms of relevancy and timing.

A slightly more complex rationale for related instruction would add that the material it imparts serves as a stock of human capital that will help the apprentice and later the journeyman deal with unforeseen but inevitable complications, solve unusual problems, and be able to learn to use new techniques.

The reason for teaching "theory" in the classroom rather than on the shop floor is that explaining a complex matter is best (more effectively and more rapidly) done in a setting that permits a systematic, orderly presentation by someone skilled in teaching, and that it is less expensive to do this at one time for a larger number of apprentices.

In addition to the costs of providing related instruction, even when well implemented, it can have potential drawbacks. It can repell individuals with inadequate scholastic skills or a distaste for school and classroom learning, either causing them to drop out or not to apply initially. It can lengthen the duration of apprenticeship on the grounds that a necessary increase in the hours of related instruction requires increasing the apprenticeship term, presumably because of a limit on the number of hours of related instruction possible in a given school year. On the other hand, it can be argued that related instruction actually shortens training time (if not the formal apprenticeship term) by enhancing the capability of the apprentice to absorb and retain what he learns at work.

Objectives of the Study

The purpose of our study is to examine on a pilot basis the nature of related instruction and its contribution to apprenticeship training in three trades, two in construction and one in manufacturing. The two construction crafts are electrician and operating engineer; the manufacturing craft is all round machinist. Justification for this research is the few substantiated facts about the function of a key component of apprenticeship programs in the United States.

The choice of trades was dictated by the desire to be as diverse as possible despite the ability to study only a few crafts. Our criteria were: (1) more than one industry, (2) crafts differing in the nature and level of skill, and (3) strategic crafts for which apprenticeship was an important source of craftsmen. Limitation to three trades in the Boston area thus was a compromise between the ability to generalize and the expense of intensive field research. It is hoped, however, that our conclusions will be appropriate for other areas and trades.

Principal Hypothesis

Our guiding hypothesis is that related instruction has multiple roles which vary by trade and vary with the particular goals of different sponsors. Different trades have different task assignments executed under different technical constraints. Program objectives also can be multiple, either because a given program can have more than one goal, or because different programs are sponsored by different trades, industries, and/or employers motivated by different purposes and to differing degrees.

These multiple goals can include the need: (1) to refresh basic communication and calculating skills in order to improve the capacity to absorb training, (2) to provide theoretical or basic concepts so that the apprentice and later the journeyman can solve unpredictable problems, adjust to unusual conditions and to absorb new techniques, (3) to acquaint apprentices in advance with the fundamentals of a process or equipment, for the sake of more efficient learning, safety, or both, and (4) to substitute instruction in the classroom for instruction on the job because of economic or technical limitations inherent in the work process, such as a limited variety of assignments.

The increase in the amount of "free" public education undoubtedly is one reason why related instruction does not have to concentrate on general education, that is, on the fundamentals of reading, writing and arithmetic. However, there has been no comparable increase in the amount of "free" vocational or technical education. The reasons possibly are the priorities of an educational philosophy not especially sympathetic to vocational objectives, and the undesirability of making, or the inability to make, a permanent occupational choice at an early age.

The concentration on technical and hence more specialized subject matter has been accompanied by pressures to substitute instruction in the classroom for instruction on the job. In some instances these skills cannot be taught on the job. Two of these pressures are the cost advantages of task or work specialization and the comparatively high hourly cost of journeymen, and with them, apprentices. These motives for shifting what is taught on the job back to the classroom are reinforced by the lower per unit cost of classroom instruction. The increase in the expense and difficulty of training on the job and the comparatively lower unit cost of classroom instruction also encourage individual employers to shift the burden of training to the trade, industry or trainee. Individual employers try to avoid training costs when training teaches core material that is transferable to other firms.

In summary, the amount and nature of related instruction thus can be explained by the relative scarcity of alternative means for the individual to acquire the same knowledge and the expense of on-the-job training. The diverse objectives of related instruction also help explain the inclination of individual employers and industries and/or trades to meet their peculiar needs by developing their own differentiated program. In addition these differentiated programs aid employers in recapturing training costs by making employees less mobile.

Ancillary Issues

Although the chief issue, then, is the contribution of related instruction to apprenticeship training, there are many subsidiary issues which other individuals have raised. Some of these issues have already been mentioned. A more specific list follows:

(1) The currency and relevancy of course content (recognizing the diversity of goals).

(2) The integration of related instruction with training on the job.

(3) The repetition of earlier school work and work experience.

(4) Granting credit for prior courses and work.

(5) Related instruction as one reason for dropping out from apprenticeship or not applying for it (particularly in the case of the disadvantaged and minorities).

(6) The source, selection and effectiveness of related instruction teachers.

(7) The relationship between the scheduling of related instruction, teaching effectiveness and learning ability.

(8) Uniformity in the minimum number of hours of required related instruction, irrespective of trade.

(9) Related instruction as a factor in the duration of apprenticeship.

(10) The appropriate allocation of the costs of related instruction.

(11) Alternate payment mechanisms to increase the number and variety of related instruction suppliers.

The above include administrative, pedagogical, and economic matters. The strictly pedagogical are left to others to evaluate. Our research touches on many of the above, more in some cases than others, of course. Not all these topics are crucial or equally important, but each adds to a deeper understanding of the practice and performance of related instruction.

A Human Capital Explanation for Related Instruction

A current interpretation in the economic literature is that, from the point of view of the individual employer, training is an investment. The argument is that his return is higher the longer the trainee remains with him, the lower the employer's outlays on training, the quicker the trainee becomes self supporting, and the more steadily he improves his productivity.

An apprentice is likely to stay with his employer longer the better the pay and the employment conditions, and the lower his ability to change jobs without suffering a loss. The employer's direct (or out-of-pocket) training expenses will depend on the wage he pays his apprentice and his staff involved in training, and the time they must devote to it. How quickly a new employee becomes productive is related to the number and frequency of the tasks he can learn rapidly and can perform steadily.

One way of both maximizing the trainee's productivity and immobility is to teach him only tasks unique (or relatively unique) to the company and to have him specialize in them. The limits facing the employer are the nature of the production process, and the willingness and ability of the apprentice to change jobs. All things equal, however, the employer will be unlikely to provide general education or general training, that is, training that is transferable to other employers and that increases the potential mobility of the apprentice. The individual employer would thus prefer to produce more narrowly trained journeymen than all round journeyman.

The employer can reduce the burden of his training costs by passing all or part of them on to others. These others include society, other firms in the industry or trade, customers, suppliers, and individual workers. Society may provide "free" training in public schools, while the individual worker may attend private trade or technical schools. Any general education or general training needed by trainees can be presented in related instruction classes either conducted "free" by the public school system or conducted by the trade. The latter then assumes some portion of the costs of the individual firm by spreading them over all firms in the trade, particularly those who would do no training on their own. Related training allows the firm's own journeymen and supervisors to devote less time to trainees. If the firm sells in a product market in which sales are not highly responsive to reasonable price increases, training costs can be shifted forward that much more easily without a serious loss of volume. More on this later.

In an organized trade, where wages and other employment conditions are the same for all employers, the ability to minimize training expenses by paying lower wages to trainees is circumscribed.[1] In addition, a union is likely to resist task specialization. When apprentices become journeymen and earn the journeyman's scale, it is to the union's and the industry's interest, if not

1. However firms can differ in their efficiency and hence in their unit costs. The firm also can gain an advantage by hiring and retaining only the more productive members of the trade.

that of any one employer, to have craftsmen able to do as wide a variety of skilled tasks as possible.

Accordingly, the union is a pressure and mechanism for shifting training costs from the individual employer to the entire trade. The uniform union wage scale also reduces the risk of losing trained men to other employers in the trade or industry. The incentive for a firm to shift the cost of training is greater in industries with unstable product demand or with a casual or seasonal demand for labor. The latter means that men may work for many employers.

In contrast, an unorganized industry or branch of an industry has no ready mechanism by which to transfer training costs, barring the existence of an employers' association with strong powers to raise dues. The inclination of the employer will be to provide only specialized training and work assignments or to shift costs of general training to the individual worker either as lower wages or self-financed classroom instruction. The employer's interest in avoiding training costs is high when he is unlikely to retain an employee for a long period of time, and when considerable general training must be provided. Construction contractors face both conditions. Interestingly, the longer the apprenticeship term and the quicker the apprentice can perform journeymen tasks, the more the employer gains, since apprentice wages are below those of journeymen. It may be noted that a journeyman may regularly perform relatively simple tasks that can be quickly learned by an apprentice. A third or fourth year apprentice is likely to be able to do a large variety of journeyman's work.

The three trades studied were in industries or sectors of industries with much different market structures. As already noted, a firm's training costs can be passed forward by incorporating them in its product price, given a conducive market structure. The firms in our study sold in product markets with varying degrees of price competition. In construction in the Boston area, a large number of subcontractors bid against each other for contracts from a much smaller number of general contractors, a few of whom dominated the market.

Machinist apprentices, on the other hand, worked in firms in different industries with much different market structures. At one extreme were the job shops, which were in much the same relationship to their customers as the subcontractors in construction. At the other extreme was the captive shop of a large manufacturer without direct market competition for its product. Occupying positions in between were captive shops in three corporations with plants both here and abroad.

In addition to variations in product market structure, firms in the study faced different cyclical and seasonal patterns. Both were more serious in construction, where seasonal swings were especially severe for subcontractors that hired hoisting engineers. In addition, the latter were hard hit by a state-imposed moratorium on major highway construction in the Boston area. Cyclical movements also existed for the machining job shops, and during our study some were experiencing an upsurge in business and an increasingly critical shortage of skilled labor. One manufacturer had a diversified product line that mitigated its cyclical and seasonal patterns. Two other firms had relatively stable markets.

Company interest in training and in related instruction was influenced by these product market differences. The more protected the firm's market, the more inclined it was to concentrate on training and to provide its own related instruction. Similarly, firms with expanding markets also showed a revived interest in training, typically by expanding existing programs. Some of the latter also made their related instruction more specialized in order to reduce the risk of losing trained journeymen to other employers.

To generalize, individual employers will be less willing to train and hence to offer related instruction themselves: (1) the more general, that is, the more valuable, the skills being taught to other employers; (2) the greater the possibility of relatively cheaper alternatives (such as acquiring an experienced worker); (3) the more costly the training process itself; and (4) the lower the probability of recapturing such costs. The last factor is related to the first because it influences interemployer mobility of workers.

Legislative Inducements for Related Instruction

State and federal legislation penalize construction contractors if they do not incorporate related instruction in apprenticeship programs. The federal Davis-Bacon Act and the comparable state laws permit contractors on public works projects to pay apprentices less than the "prevailing" journeyman rate for the trade in the area, only if they are in "approved" or "registered" programs. Approval or registration (the terms are used interchangeably by the Massachusetts Division of Apprenticeship Training) requires among other things that apprentices attend a minimum of 150 hours of related instruction during each year of apprenticeship.

Another inducement for registration is veteran training allowances. Eligibility for these benefits requires that the trainee be in an officially certified program. In the apprenticeable trades, the state Division of Apprenticeship Training is the approving agency. Approval requires that apprenticeship programs include related instruction.

In construction, unlike manufacturing, firms have both reasons for registering programs. In the unorganized sector of construction, however, the typical practice apparently is to register programs only when bidding for public works contracts and to include in such programs only those apprentices who would be working on these projects. Registration was not maintained if the contract is lost, or after completion of a contract. The federal law applies to public works projects let by the federal government, and the state law to those let by state and local governments. Trainees and advanced trainees enrolled under the Boston Area Construction Plan, a "hometown" effort to employ minorities in the construction industry, also can be paid less than the journeyman scale.

Required Hours of Related Instruction

National apprenticeship standards require a minimum of 144 hours of supplemental class work during each year of a registered apprenticeship.

Massachusetts, however, in 1941, legislated approximately 150 hours, a requirement that is administered reasonably to accommodate the legitimate needs of the parties. For example, one of the specialty trades in construction in the state requires 182 hours and was well above that a few years ago. This flexibility allows related instruction hours to vary somewhat independently of the length of apprenticeship.

The local Operating Engineers we have studied require 144 hours, with more hours in the first term of each school year than the second. The local Electricians program studied contains a different number of hours each year, with only one year, the last, as low as 144.

The precise figure of 144 hours can be found in the 1917 Smith-Hughes Act, which, of course, deals with vocational education rather than apprenticeship as such. That legislation authorized Federal reimbursements to the states for vocational courses offered at least 144 hours in a year. The George-Dean amendments to Smith-Hughes later permitted reimbursement for shorter courses, but the Federal Bureau of Apprenticeship and Training adopted the original Smith-Hughes figure, largely because it was compatible with a 36-week school term, the most common in the country.[1] It was realized that apprentices would be attending class during the school year; 36 weeks multiplied by the customary four hours a week of class for apprentices came to 144.

The Organized and Unorganized Sectors of Construction

The organized contractors specialized in the construction of industrial plants, utility stations, high rise office buildings and apartment houses, and highways and bridges; the unorganized, in low rise multiple family housing and commercial buildings, although some also built industrial plants. Heavy construction, within the city of Boston and in immediately adjacent communities, particularly if publicly financed, belongs to the organized sector. The further the distance from Boston, the more likely construction is unorganized, particularly if privately financed and low rise.

In the organized sector, unions influenced access to the trade and industry and helped allocate apprentices and journeyman among firms. The IBEW, which had negotiated a hiring hall in 1963, played a greater role in the allocation of both apprentices and journeymen than the IUOE, which had no formal placement procedure. JATC's existed only in the union sector of construction. In the Boston area there was no comparable institution for admitting apprentices or allocating them in the nonunion sector. Although there are associations of unorganized contractors, they do not function in this capacity.

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1. Letter from Hugh C. Murphy, Administrator, Bureau of Apprenticeship and Training, May 25, 1973.

A crucial difference between these two sectors, then, was the way in which apprentices were recruited and the way they and journeymen were placed. In addition to administering the related instruction component of the apprenticeship program, the JATC coordinator in the electrical trade was responsible for placing apprentices. The coordinator for the hoisting engineers did not formally have this role; instead the local business manager informally helped apprentices find jobs. In both unions, of course, admission to apprenticeship was limited to certain times in the year and followed formal admission procedures, including the preliminary testing followed by interviews with three-member teams designated by the appropriate JATCs.

In the electrical trade, the coordinator's goal in placing apprentices was to maximize the continuity of employment, and given that goal, to provide work assignments that were as diverse as possible. Continuity of employment usually resulted in apprentices remaining with one employer for long periods of time. In making placements, the coordinator considered such factors as gaps in apprentices' work experiences, the variety of tasks on projects, their duration, the attitude towards training of different contractors, the length of time between jobs, and personal idiosyncrasies of the people involved. In practice, the nature of existing employment opportunities was a serious obstacle, but within that limit, the coordinator pursued the two goals noted above. The informal placement efforts of the IUOE took into account similar factors and other ones as well. Hoisting engineer apprentices thus were more likely than the electrical apprentices to rely on informal sources, although the latter now included the unofficial help of the business manager, as well as that of the apprentice coordinator.

In the unorganized sector there is no institution to help place apprentices. It was the responsibility of the apprentice to seek out jobs and maximize the amount and variety of his assignments when laid off. However, there was a tendency for apprentices to remain with the same contractor as long as work was available. The apprentice's sources of information were the traditional ones in manual-worker labor markets: friends and relatives, and his own personal employment experiences. Here informal job sources predominated, including direct application. All things equal, the nonunion apprentice probably was less able than his union counterpart to maximize hours of work and variety of assignments. The consequences for training of this less structured labor market can be hypothesized but not easily quantified. The limited evidence we have, namely the hours worked reported by journeymen with different training backgrounds, suggests that the effects might be small.

Methodology

For regression analysis, it is desirable to have a sample large enough to have a small "t" statistic, which is the coefficient of an independent (or predicting) variable divided by its standard error. The "t" statistic provides a test of significance for deciding whether the coefficient, and hence the variable, is significantly different from zero. Sample sizes of 60 to 70 are sufficient to have a reasonably small "t" statistic. Larger samples reduce the latter only slightly. In regression analysis, the absolute size of the sample, not the proportion of the population sampled, is the critical factor.[1] This, of course, assumes a random sample.

Journeymen machinists and apprentice machinists included in the study were randomly selected from 18 establishments in the Greater Boston area employing a total of 140 apprentices and approximately 1,200 machinists. A number of employers had long histories of well regarded training in the apprenticeable trades. Only two of the 18 sampled employers had unions, and neither had the equivalent of the JATC in construction. The unions were industrial in structure and did not participate in the administration of apprenticeship. Fifteen of the 18 employers were drawn randomly from 38 listed by the state Division of Apprentice Training as having apprentices in registered machinist programs as of mid-1971. (When contacted, one was found to have no apprentices.) The remaining three firms of the 18 were randomly drawn from metal working and metal fabricating establishments listed in the Massachusetts Industrial Directory 1971[2] that had been identified by apprenticeship officials and others familiar with training in the area as having either formal but unregistered training programs for machinists or a reputation for effective training. Companies with unregistered programs were deliberately included in order to compare their programs with the registered ones of the remainder of the sample. (Again, when contacted, one was found to have no machinists in training.)

Although the intent was to distribute questionnaires to machinists in the same employing units from which we drew the apprentices, two of the sampled firms had no machinist apprentices or trainees. In addition, one firm felt it could not permit interviews or the distribution of questionnaires because of ensuing litigation and because of imminent collective bargaining negotiations. Another firm with both journeymen and apprentices allowed us to distribute only questionnaires to both groups but not to interview apprentices. Long standing corporate policy prohibited outside contacts with employees while working or the divulging of their addresses and phone numbers. Permitting the distribution of

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1. For example, the "t" statistic at the .95 confidence level for samples of different absolute sizes are:

Sample Size	"t" statistic	Change in "t-statistic"
2	2.920	--
10	1.812	.108
20	1.725	.087
30	1.697	.028
40	1.684	.013
60	1.671	.013
120	1.658	.013
∞	1.645	.013

2. Commonwealth of Massachusetts, Department of Commerce and Development, Boston, Mass., 1971.

questionnaires was a radical departure from past practice. Both these firms made available detailed data about their training programs, their apprentices, and the current positions with the firm of their former apprentices.

Ten of the employing units were job shops ranging in size from fewer than five employees to nearly 70. One of the ten also produced specialized industrial equipment. Twenty-five of the apprentice interviews and 15 of the journeymen questionnaires came from these job shops. All but one of the remaining eight units were captive shops of major corporations employing well over 1,000 workers each. Thirty-eight of the apprentice interviews and 92 of the journeyman questionnaires came from the captive shops. A variety of metal using and metal fabricating industries was represented: aircraft engines and parts; ship building and repairing; measuring, analyzing and controlling instruments; electrical machinery; cutlery; communication equipment; and photographic, medical and optical goods.

In all, then, interviews were conducted with 63 machinist apprentices working in 14 units employing 140 apprentices, and 107 journeyman questionnaires were returned from 18 units employing about 1,200 machinists. Questionnaires also were distributed to journeymen machinists in two more employing units that had no apprentices or trainees, and mail questionnaires to both journeymen and apprentices in another unit.

The 107 returns represented 20.0 percent of those distributed. The questionnaires were distributed to 7.0 percent of the journeymen machinists in the Boston SMSA. The U.S. Census of Population reports that 7,568 machinists lived there in 1970.[1] Not all may have worked in the area, however, nor is it known how many could be legitimately considered all round craftsmen.

Fifty-three of the 63 apprentices were in registered programs. The 53 represented over 10 percent of the registered machinist apprentices in the entire state, which had only 454 at the end of June 1971.

The machinist data were supplemented by information about related courses taken by 331 tool and die makers employed in metal working or metal fabricating firms in the Boston area in 1966. The men had been interviewed for a study of how tool and die makers were trained.[2] Of particular value were two performance (or skill) ratings given for each man by his immediate supervisor or foreman. One was a measure of the man's overall performance; the other, of the range or breadth of work he could do. In addition to these measures, detailed information had been gathered about each man's training path, education, years in training, and the number of years before he had been classified or paid as a tool or die maker, and before he considered himself a competent, all round craftsman.

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1. U.S. Bureau of the Census, Census of Population: 1970, Detailed Characteristics, Final Report PC(1)-D23, Massachusetts, U.S. Government Printing Office, Washington, D.C., 1972. Tables 170 and 171.

2. M.A. Horowitz and I.L. Herrnstadt, A Study of the Training of Tool and Diemakers, Northeastern University, Boston, Mass., 1969.

Nearly all the tool and die makers originally had been trained as machinists and had worked as such before becoming tool makers, die makers, or tool and die makers. Machinists and tool and/or die makers are closely related crafts. They operate the same metal working machines and devote a major part of their working time machining metal parts to close tolerances. The major difference between the two crafts is that the tool and die maker machines parts for a tool or a die, and often will be responsible for its assembly and proper functioning. In contrast, the machinist makes parts that enter into a wide range of metal products, and he usually is not responsible for assembly.

The electrician apprentices and the hoisting engineer apprentices were chosen from members of two local trade unions in the Boston area. In each case the population of apprentices was stratified to obtain an equal percentage of the participants from each year of apprenticeship. A random stratified sample of 73 IBEW apprentices thus was drawn from the apprentices indentured to the electricians JATC; a random stratified sample of 74 apprentices was drawn from the apprentices indentured to the operating engineers JATC.

The 73 apprentice electricians constituted 16.4 percent of their group; the apprentice hoisting engineers, 53.6 percent. Most of the apprentice engineers were in their third or fourth years. No new apprentices had been admitted into the program in 1971-72 or 1972-73, because a drop in job opportunities had left a high proportion of journeymen idle and had severely curtailed training opportunities. The second year apprentices were individuals who either had returned after entering military service at the end of their first year, or were repeating their second year because of injury or illness, or poor grades or attendance in related instruction. In contrast, the electricians had not experienced the same lack of work, although by 1973 a drop in construction activity by union contractors was beginning to hurt them also.

The following table gives the distribution of the apprentices populations and samples by year of apprenticeship.

Apprenticeship Year	Electrician Apprentices			Hoisting Engineer Apprentices		
	Total Class	Number Interviewed	Percent of Class	Total Class	Number Interviewed	Percent of Class
1st	116	17	14.6	0	0	--
2nd	120	20	16.7	12	9	75.0
3rd	133	20	15.0	64	32	50.0
4th	76	16	21.1	62	33	51.6
TOTAL	445	73	16.4	138	74	53.6

The IBEW local deals with approximately 125 employers, and its apprentices constituted nearly all the registered electrical apprentices in construction in the area. According to the records of the DAT there were only 62 additional apprentices employed by 14 Boston area contractors in registered programs independent of the JATC.[1]

Questionnaires were mailed to 870 journeymen electricians drawn randomly from those with addresses in the Boston area in the 1972 List of Licensed Electricians issued by the Massachusetts State Examiners of Electricians. Since union affiliation of electricians on the List is not given, it was impossible to stratify the sample on this basis. A total of 196, or 24 percent of the 800 deliverable questionnaires were returned.[2]

The original intent had been to mail the questionnaires to journeymen in the same IBEW local to which the apprentices belonged. However, the union officers, newly elected in 1972, felt it would violate the union constitution to divulge the name and addresses of the membership to nonmembers. One reason for the refusal to release the list was the irritation of the rank and file over unsolicited mail received by them, which they considered an invasion of privacy. In addition, the local was still smarting over what it felt was a misuse of background information disclosed in confidence to a local journalist. The local's sensitivity led us not to enquire about union membership in the electrician's mail questionnaire.

A total of 752 mail questionnaires, amounting to 20.7 percent of the journeymen population, were sent to two different groups of journeymen hoisting engineers in the IUOE local associated with the engineers JATC. A sample of 584 journeymen who had not been apprenticed was drawn randomly from the 2,500 members of the local. The other group consisted of all 168 journeymen trained as apprentices since the program began in 1963. The return rates from the non-apprenticed engineers and the apprenticed ones were about the same: 23.1 percent for the first, and 22.6 percent for the second. In all, 173 questionnaires, or 23.0 percent of those mailed, answered. The nearly identical returns from the two groups suggests comparable attitudes towards the study and perhaps towards training as well.

The number of journeymen electricians and the number of journeymen engineers in the sample who returned questionnaires represented about 8.0 percent and 7.0 percent, respectively, of those reported by the 1970 U.S. Census of Population as residing in the Boston area and employed in construction.[3] Since only employed workers are included, the figures might understate the actual numbers in each trade. The difference probably is small for electricians, for whom job opportunities in construction were plentiful at the time but may not be for the hoisting engineers for whom work in construction already was slack.

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1. There also were 82 with three large industrial establishments.

2. Seventy of the 870 were returned as undeliverable.

3. U.S. Bureau of the Census, Census of Population: 1970, Detailed Characteristics, op cit., Tables 170, 171 and 180. There were 2,899 electricians; 429 cranemen, derrickmen and hoistmen; and 1,369 excavating, grading and road machine operators, excluding bulldozer operators, employed in construction in 1970. Another 397 bulldozer operators also are listed but ot distributed by industry.

In summary it should be noted that our analysis and conclusions are based upon personal interviews with a random sample of apprentices and with apprentice coordinators and instructors. The data gathered from the mail questionnaires sent to journeymen were used to substantiate the conclusions drawn from the personal interviews. It should be noted that the question of randomness only arises with respect to the construction trades. There were over 300 personal interviews with journeymen machinists. In addition we attempted to check the randomness of the respondents in the construction mail questionnaire by comparing their characteristics with the characteristics of apprentices. (See Appendix for the characteristics of the two groups.)

Data and Information Sources

The study relied on a variety of information and data sources. These included personal interviews, mail questionnaires, company personnel records, company training records, and the records of Joint Apprenticeship and Training Committees (JATC's). Background data on wages, employment, hours worked, and the market structures of the industries or trades studied came from published and unpublished material of municipal, state and federal governments, as well as the data banks of the National Bureau of Economic Research, and the New England Economic Project.

Detailed, semi-structured personal interviews were conducted with the following groups: representative samples of active apprentices during 1971 and 1972 in each of the three trades; local and international officers and staff of the International Brotherhood of Electrical Workers (IBEW), the International Union of Operating Engineers (IUOE) and the International Association of Machinists (IAM);[1] line and staff officials, including training directors, of the firms employing machinist apprentices; a selective list of general contractors and subcontractors including both union and non-union; directors and other representatives of employer associations in the three trades: JATC coordinators and members; state education officials and city school administrators; administrators of private technical schools; teachers of related instruction classes; and finally, representatives of the federal Bureau of Apprenticeship and Training (BAT) and of its state counterpart, the Division of Apprentice Training (DAT), part of the Massachusetts Department of Labor and Industries. It should be noted that the BAT and the DAT share responsibilities for different apprenticeable trades and areas to avoid duplication of effort. Schematically, the interviews can be classified as follows:

1. Supply side of the labor market

   a. Workers

      (1) Active apprentices in the machinist, electrical and operating[2] engineering trades

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1. Officers of unions other than these three also were contacted, although their programs were not systematically studied.

2. The terms operating engineers and hoisting engineers are used nonmously.

(2) Journeymen machinists, electricians and operating engineers

(3) Apprentice drop-outs from the same trades

b. Trade unions

(1) Business agents (or managers) of local IBEW and IUOE local unions in Boston area

(2) National staff of the IAM, IBEW and IUOE

c. Training organizations

(1) Schools

(a) Vocational education officials of the state school systems and of local schools conducting related instruction classes

(b) Administrators of private trade/technical schools

(c) Related instruction teachers

(2) (a) JATC coordinators, staff and members of the electrical and the operating engineers trades

(b) National training directors of the IAM, IBEW, and IUOE

2. Demand side of the labor market

a. Individual employers

(1) Personnel officers, training directors,[1] selected supervisors of firms and establishments employing machinist apprentices

(2) Proprietors and managers of selected general contractors and specialty trade contractors, union and nonunion

b. Officers of employer associations

(1) General contractors and specialty contractors, union and nonunion construction

(2) Metal machining

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1. These could be classified on the supply side as well.

The interviews with the contractors and their associations were semi-structured and sought two kinds of information. The first dealt with the structure and the economics of the industry or a specific sector, such as general contracting, commercial and low rise residential construction. The second dealt specifically with the skills expected of electricians and operating engineers, training policies, training practices, labor recruitment and retention. Unorganized contractors were specifically sought out to see what difference the absence of a union meant for training and recruiting.

Nature of Information Sought

From educators, coordinators, and training directors, we sought information about their role in the administration and financing of related instruction. Of particular interest was the extent to which they influenced curricula, course content, choice of instructors, and teaching methods, as well as their ability to keep up with advances in the trade and in teaching.

From the apprentice interviews we obtained information about their education, reasons for choosing their trade, and their training experiences at work and in related instruction. We also obtained information about the coordination of related instruction and on-the-job training, the repetition in related instruction of prior courses, and their evaluation of related instruction.

From the journeymen we obtained information and their education, training and related instruction, and their evaluations of the latter. The mail questionnaires, of course, afforded no opportunity to explore motives and subjective evaluations.

The collection of information from journeymen proved vexing. First, we had the difficult task of severely limiting our questions in order to minimize the risk of not having the questionnaires returned. Still, about one fifth of all those mailed or distributed were returned usable, a return rate well within the range of most mail questionnaires. Second, our follow-up efforts were blocked by our desire to maintain the anonymity of the respondents, hoping that anonymity also would encourage returns. Third, our plans had called for obtaining names and addresses of journeymen from the two unions in the construction industry. One of the unions, however, felt unable to furnish mailing lists because of sensitive internal considerations. Although we substituted the public List of Licensed Electricians, our initial mailing could not distinguish between union and nonunion members, or construction and maintenance electricians. Moreover, addresses on the list were not always current. Fourth, since the machinists had to be located by first selecting a company, we hoped to have supervisors distribute them. However, two employers would not allow us to contact or send questionnaires to their employees. Where supervisors distributed questionnaires to journeymen, there was reluctance in some job shops to irritate the men by reminding them to return overdue questionnaires.

Finally and probably most important, we had to contend at best with impatience and at the worst with an unanticipated amount of distrust and hostility towards requests for personal information. There are a number of possible explanations for these negative attitudes: frequent official and private requests for data about union or company activities, a deluge of unsolicitated "junk mail," the "invasion of privacy" represented by divulging names and addresses of members or employees to outsiders, the failure of researchers and other information seekers to send their findings to those who had cooperated in producing them, and the underlying suspicion that any information provided could be used for private gain or as a weapon against the contributors. As already noted, at least one of the unions had felt victimized by the misuse of information given in privacy. The building trades in particular were wary of this possibility.

In the background there were such forewarnings as the public clamor about some of the questions being asked in the 1970 U.S. Census, and where the trade unions were concerned, such irritants as the open hostility of some groups towards "high union wages" or "restrictions on entry." Locally, charges of racial discrimination in membership practices had been made by official bodies, state officials, and certain minority spokesmen, despite the existence of an active "hometown" plan to recruit and train minorities for skilled construction jobs. Simmering beneath the surface were persistent suggestions of nepotism in the admission policies of certain unions. These factors aroused misgivings about the eventual use of information given in good faith.

Nonetheless, with only one or two exceptions, all the union officers, training directors, company officials, and association executives were cooperative and candid. The apprentice coordinators could not have been more helpful.

The two JATC's and the two firms that would not allow their employees to be contacted made available detailed data that could be used to rigorously test major hypotheses about related instruction or apprenticeship.

Data from the JATC's included the related instruction grades for each apprentice, his attendance, and the number of hours worked. The hourly data from the electrician's JATC covered a twelve-month period in 1971 and 1972. The grades were the overall averages for each semester. The electrician's data also included for each apprentice the number of hours spent during the year on particular tasks and the number of employers for whom he worked. The hoisting engineer's hourly data covered five months, beginning with October 1971. Here the grades were those for each course, for conduct and for effort. There also was a grade for on-the-job performance given by the journeymen with whom the apprentice worked.

The two firms provided us with demographic characteristics of their machinist apprentices, their educations, grades in related instruction, and course attendance. One of the two also made available the current position with the company of apprentice graduates of the last five years.

Questionnaires to Apprentice Drop-outs

The least successful of our efforts was the attempt to contact apprentices who had prematurely left the apprenticeship programs included in our study. Names and mailing addresses were obtained from records of the state DAT, and from one JATC. It was decided not to go further back in time than five years. The original mailing went to 302 former apprentices who had not completed registered electrician, hoisting engineer, or machinist programs since 1966. Only 231 of the 302 had addresses to which mail could be delivered. The return rate from the 231 was just 10.4 percent. Eleven former machinist apprentices and 13 former electrician apprentices responded; none of the hoisting engineers did.[1]

The principal reasons for contacting apprentice drop-outs was to learn if their aborted training had nonetheless proven valuable in terms of their later labor market experiences, and whether related instruction had contributed to their failure to finish training. One hypothesis is that apprentices drop out when the labor market is tight because they then can command journeyman's pay. Another is that related instruction discourages otherwise capable people with inadequate education or with a dislike of formal schooling. Not all was lost, however. One of the questions asked the sample of apprentices was whether they knew of any apprentice contemporaries who had left the program because of an inability to cope with related course work.

Organization of the Study

The next chapter introduces labor market information for each trade, contrasting the casual occupational or horizontal labor market in construction with the vertical employer or establishment oriented labor market in metal working. Included are employment trends in the industries or industrial sectors employing the three skills, and where possible, wages and earnings. Except for the decennial census, there are no continuing employment or earnings series for any of these critical trades.

The next three chapters describe and analyze related instruction in each trade in turn. Chapter 3 treats the operating engineering trade; Chapter 4, the electrical; and Chapter 5, the machinist. Each of these chapters contains three distinct sections. The first describes the nature of related instruction in the trade; the second discusses the major findings of the apprentice interviews; and the last uses multiple regression techniques to test the effect of related instruction on apprentice performance. In the two building trades, the measure of performance used is hours of work, on the realistic assumption that contractors will tend to retain longer only their more capable men. In the machinist trade, in a much differently structured labor market, the same measure has less validity, and is buttressed by the ratings collected in an earlier study of the training of tool and die makers.

Chapter 6 compares the role of related instruction in each trade. This chapter also compares and analyzes the findings from the written questionnaires distributed to journeymen and discusses the costs of related instruction. The

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1. We did not attempt to draw any inferences based upon the drop-out questionnaire.

final chapter of the study presents our major conclusions and the policy recommendations they support.

CHAPTER 2

STRUCTURE OF THE INDUSTRIES

This chapter describes the nature of construction and metal working industries in the Boston Area and explains the reasons for the individual analysis of each trade. The first part of the chapter discusses these reasons, while the rest of the chapter provides background information about the trades and industries.

Rationale for Separate Treatment of the Three Trades

The three trades selected for analysis in this study differ substantially in terms of both labor and product markets, and the nature of the work. The greatest differences are between the labor and product markets of manufacturing industries (which employ the machinists) and of the construction industry (which employs the electricians and the operating engineers).

While there are differences in the operation of labor markets among the various manufacturing industries, these differences are minor compared with the differences between manufacturing and construction. In most manufacturing industries firms are free to hire any job applicant and they then can decide whether or not he is to be trained for a specific job. Upgrading of workers is a relatively common phenomenon and an internal labor market, operating within the plant, governs the pricing and allocation of labor. An employee hired by a manufacturing firm generally works in a specific work site and knows what his specific work assignment is, and what his prospects are for regular, steady employment. Thus, a machine operator may be hired to operate a lathe, and then trained through upgrading to be a machinist; or a machinist may be hired and trained to be a toolmaker or diemaker. In either case, the employee knows where he is to work, what his job is and whether he has a regular job with the employer.

The operation of the labor market in the organized sector of the construction industry is generally dependent upon the forces of an individual craft union and a contracting firm that may be dealing only with the craft union. An employee is likely to find out about an employment opportunity through his union, and the union business agent may actually refer a specific union member to the job. This tie between union and contractor need not be very close, and craftsmen may locate their own jobs, as they do in the unorganized sector. Unlike the situation in manufacturing, where an employee is attached to an employer, in construction a worker is attached to the industry, but not necessarily to a single employer. The attachment of the worker to the firm in manufacturing is reinforced by recall rights. When employed by a construction contractor, the worker is aware that the duration of his employment (and therefore his attachment to the firm) can depend upon the need for his craft at the construction site. When the specific work is done, the worker's job may be over. If the contractor has other work it is possible he may employ the worker at the other job site; if no other work is available the worker may have to seek work elsewhere.

While a manufacturing firm may engage in any number of types of training of its employees (or perhaps none at all), the contractor in the construction industry is generally limited to the choice of no training or apprenticeship training. The decision as to number of apprentices and their selection is negotiated by the union and the employer association. Whether an individual

firm takes any apprentices is decided by the firm, subject to union pressure. The individual employer desires more journeymen in the trade, but is reluctant to bear the costs of training.

There are labor market differences between different crafts in the construction industry.[1] Electricians require a different kind of training than the operating engineers; the former require more nonmanual skills such as electrical theory, mathematics and blueprint reading. Also, while the electrician may specialize, it is not too common for him to do so; the training of electrician is sufficiently broad to cover most aspects of the craft. The work of the operating engineer is such that many do specialize, and the training can be designed to turn out journeymen who are capable of performing limited work of the craft. Thus, an operating engineer may specialize in blade equipment and would not be qualified to operate a crane. The reverse may also be true.

The products of the three trades under consideration are sufficiently different to underline the need to treat each of the trades separately. The machinists normally work in manufacturing industries whose final product is a physical commodity that is either sold to other firms or used internally by the firm that produced the product. The electrician in the construction industry sells a service, i.e., the installation of wiring and electrical equipment in a structure. Thus, the electrician performs a direct service for the structure that is being built. The operating engineer, on the other hand, is frequently performing an indirect service for the construction of a structure. The work performed by operating engineers in building construction generally is a service to other crafts, that is, hoisting equipment or material needed by workers in other crafts who are performing a direct service in the construction. The pace of work is therefore dependent upon the work performance and needs of other crafts. In highway construction, operating engineers are the major craft on the project.

Just as the difference in product and labor market differentiate the basic aspects of the three trades under consideration, these differences also have an impact on their apprenticeship programs. While apprenticeship normally serves the same function, i.e., the training of a craftsmen, there are differences among programs for different crafts. At a minimum all apprentice programs are geared to imparting the broadly defined skills of a craft. However, an apprenticeship program may also offer training in supervisory skills and in skills that are needed by an independent contractor. While such skills may not be part of the trade, they do make upward mobility considerably easier. An apprenticeship program may also serve an important socializing purpose,

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1. Strauss points out that within construction itself there are differences between crafts in the degree to which an employer is willing to retain a craftsman on a permanent basis. This leads to different attitudes in the willingness to train. See George Strauss, "Apprenticeship: An Evaluation of the Need," Essays on Apprenticeship, Norman F. Duffy, ed. (Center for Studies in Vocational and Technical Education, University of Wisconsin, 1967)pp. 12-14.

which serves the very important function of having the graduate apprentice accepted as an equal by his peer group.

The administration and structure of the training may also vary among programs. The variance may include such factors as formality, the logical progression of assignments, the ability to coordinate on-the-job training and related instruction, and emphasis on practical experience as distinct from didactic materials. Within this framework the role of related instruction may differ substantially from one apprentice program to another.

The role of related instruction in the apprenticeship of machinists is fairly clear, largely because the programs are sponsored by individual companies. Where a company offers the related instruction aspect of its apprenticeship program, it can tailor the class work to its own specific needs. Leadership qualities may be taught, as well as the formal classroom needs of learning the trade. Greater coordination can also be obtained between classroom instruction and on-the-job training because of the closer control the firm has over both parts of the apprenticeship program.

The related instruction part of the electrician apprenticeship program also contains aspects of leadership and supervisory training. Here, however, the apprentices are also exposed to materials that are needed to become an independent contractor. Since electricians are licensed by the state, safety rules and regulations (the electrical code), are also taught in the classroom. While some coordination between related instruction and on-the-job training is possible, not too much actually occurs. The training on the job is determined by the nature of the work at the construction site, and the sequential order of training from the least difficult to the most difficult may not be possible.

The classroom aspect of the apprenticeship for operating engineers (especially for hoisting and digging equipment) differs significantly from that of other apprenticeship programs. There is very little of the duties and functions of an operating engineer that can be taught in a classroom. However, some of the knowledge learned in the classroom also is needed as a journeyman, e.g., in supervising his own apprentices. The training for operating engineer is basically experience on the machinery to be used. Apprentices function on the job as oilers in the Boston area.[1] In this capacity they perform routine preventative maintenance, simple repairs, and act as signalman. Classroom instruction is geared in part to teach these skills, but clearly, after the first year the overall intent is on training journeymen operators. This dichotomy between classroom objectives and the work performed on the job by the apprentice distinguishes this trade from the other two.

Examining these three trades from the view of the labor market, the product market, their apprentice programs and the role of related instruction, their differences become clear. Apprenticeship programs and the related

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1. In some jurisdictions, third and fourth year apprentices actually operate blade equipment by themselves.

instruction that go with them are not a homogeneous product. The variations are substantial, and any in-depth analysis of related instruction requires that each trade be handled separately.

Nature of Employment in the Industries

All types of worker training, including apprenticeship, occur within the milieu of the labor market. In order to have a better understanding of specific apprenticeship programs, it is necessary to have some data on employment and earnings in the industries and the occupations with which we are concerned. Employment data by occupation is not generally available but changes can be estimated, based upon some industry data.

While employment in the service sector of Massachusetts and in Boston has continued to rise, the manufacturing sector has declined in both relative and absolute terms over the past decade. Manufacturing employment in the state was 698,000 in 1960, but by 1971 the figure was 604,000, a decline of over 13 percent. The drop was not steady from year to year. From 1960 through 1964 the figures declined; then increases occurred in the next three years recouping the total previous loss. (Employment in 1967 exceeded that of 1960 by close to 2,000 workers). The employment drop from 1967 to 1971 was very sharp.

Construction in Massachusetts has continued to grow over the decade. From about 78,000 construction employees in 1960 the industry expanded fairly regularly to reach 100,300 in 1971, an increase of 28.3 percent.

Employment in the Boston SMSA represents well over one-third the total employment in the state, and over 50 percent of construction employment in the state. Because of the industrial structure of the Boston SMSA, manufacturing employment in the area showed a larger decline than in the state. The cyclical pattern was the same for the Boston area, with manufacturing employment at 303,800 in 1960; 275,500 in 1964; 305,000 in 1969; and 259,400 in 1971. The decline over the decade was 14.6 percent for Boston SMSA, compared to 12.5 percent for the rest of the state.

Construction employment in the Boston SMSA rose during the past decade by 16 percent, less than 28.3 percent for the state as a whole, and considerably less than the 46.2 percent for construction employment in the rest of the state, excluding the Boston SMSA. In the Boston area, construction employment was 46,800 in 1960, and it rose rather steadily to a peak of 57,000 in 1969. In 1970 and 1971 employment fell, dropping to 54,400 in the latter year.

Average annual employment by construction trade is not available. However, as an indication of the significance of the trades, employment by relevant industry grouping is presented. It may be noted that these industry employment figures include not only the craftsmen but also all other employees in the industry. Table 1 shows for the Boston SMSA and for Massachusetts average annual employment from 1960 through 1971 for contract construction, electrical contractors (SIC code 173) and for contractors employing operating engineers (SIC codes 161 and 179). Employment in the electrical contracting industry rose steadily over the past decade in the Boston SMSA, increasing from 3,200 in 1960 to over 5,000 in 1971, a jump of about 60 percent. Employment by electrical contractors in the state also rose significantly over the decade, with a rise in excess of 60 percent. Contractors employing operating engineers showed a substantial employment drop in 1961, but ever since then employment has been climbing rather steadily. In the Boston SMSA the rise since 1961 was about 18 percent; in the state as a whole the rise was about 36 percent, double that of the Boston area.

Estimates of employment and manpower requirements for construction craftsmen in Massachusetts, 1968-1975 have been made by the Massachusetts Division of Employment Security.[1] The following shows the relevant information:

TABLE 1

AVERAGE ANNUAL EMPLOYMENT IN CONTRACT CONSTRUCTION, MASSACHUSETTS AND BOSTON SMSA, 1960 - 1970

	BOSTON			MASSACHUSETTS		
	Contract Construction	Electrical Contractors SIC 173	Contractors Employing Operating Engineers SIC 161 and 179	Contract Construction	Electrical Contractors SIC 173	Contractors Employing Operating Engineers SIC 161 and 179
1960	46,760	3,200	9,415	78,183	5,677	14,025
1961	45,541	3,458	8,351	77,658	5,798	13,806
1962	47,233	3,611	8,361	79,700	6,205	13,711
1963	48,350	3,479	8,609	81,416	6,045	14,283
1964	50,316	3,657	8,741	86,900	6,318	15,470
1965	50,533	3,961	8,502	87,616	6,761	15,623
1966	50,258	4,133	8,817	88,583	7,230	15,992
1967	50,275	4,174	8,744	88,850	7,523	16,212
1968	53,083	4,335	9,232	93,600	7,898	17,219
1969	57,033	4,822	9,738	99,608	8,748	17,839
1970	56,458	5,171	9,877	100,050	9,279	18,888
1971	54,400	5,496	9,950	100,300	9,755	19,179

Source: Massachusetts Division of Employment Security

1. Massachusetts Division of Employment Security, Occupational Research Department, Construction Industry in Massachusetts, Employment and Unemployment. August 1971, p. 5.

While employment of all construction craftsmen is expected to rise by about 7.8 percent from 1968 to 1975, the number of new people needed for growth, and deaths and retirements amounts to about 23 percent. The expected needs due to growth (9 percent) and the total needs (22 percent) for excavating, grading machine operators are quite similar to those of the total craftsmen group. Electricians, on the other hand, are expected to grow at a much slower rate. Employment of electricians is expected to rise by only 2.1 percent over the seven-year period, 1968-1975; and the total job openings for this craft are expected to rise by only 13 percent. (See Table 2.)

TABLE 2

FORECAST OF MANPOWER REQUIREMENTS IN CONSTRUCTION FOR MASSACHUSETTS, BETWEEN 1968 AND 1975

Trade	Employment			Job Openings 1968 - 1975		
	1968	1975	Difference	Total	Due to Growth	Due to Deaths-Retirements
All Construction Craftsmen	79,095	85,326	6,231	17,800	6,231	11,569
Electricians	11,886	12,136	250	1,580	250	1,330
Excavating, Grading Machine Operators	4,393	4,805	414	969	413	556

Annual employment data in the third trade under study, machinist, are not readily available for Massachusetts or for the Boston area. As an indication of employment trend, employment in industries that employ large numbers of machinists are presented in Table 3. It should be noted that in most companies in such industries, machinists represent a small percentage of total employment. Total employment of the five industries selected in the Boston SMSA showed a decline of 6.4 percent from 1960 to 1971, although there is considerable differences among the industries. Fabricated metals and electrical machinery showed substantial employment declines (10 percent and 26 percent respectively) over the eleven year period. While employment in transportation equipment fluctuated widely over the decade, it ended up at more or less the same level as in 1960. Machinery (except electrical) and instruments both showed substantial employment increases, with employment in the former rising by about 15 percent, and in the latter by about 32 percent.

While employment in the machinist trade undoubtedly shows a cyclical movement, seasonal variations are not serious in those industries that commonly employ machinists. In construction, however, the weather and the elements do have an effect upon the scale of operation, especially in those

TABLE 3
EMPLOYMENT IN INDUSTRIES EMPLOYING LARGE NUMBERS OF MACHINISTS,
BOSTON, SMSA, 1960-1971
(in thousands)

	Fabricated Metals SIC-34	Machinery (Except Electrical) SIC-35	Electrical Machinery SIC-36	Transportation Equipment SIC-37	Instruments SIC-38	Total
1960	16.5	28.2	61.9	18.4	14.5	139.5
1961	16.7	28.2	59.7	21.9	13.5	140.5
1962	17.3	28.7	57.7	17.7	14.7	136.3
1963	16.6	29.9	51.6	15.8	16.2	130.1
1964	16.5	31.3	46.2	14.6	15.8	124.4
1965	17.0	33.2	47.9	18.8	16.3	133.2
1966	18.0	35.8	54.2	21.5	17.8	147.3
1967	18.1	35.5	57.4	23.8	19.0	153.8
1968	17.1	34.3	57.5	21.9	18.5	149.3
1969	16.8	34.3	55.5	21.2	19.7	147.5
1970	15.9	34.6	51.3	20.2	19.8	141.8
1971	14.9	32.3	45.8	18.5	19.1	130.6

Source: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, 1939-1971.

areas where winter weather is severe. The New England climate does have a significant impact upon construction during the winter months, and as a result the industry shows a marked seasonal pattern. Employment in contract construction, as well as electrical contractors (SIC 173) and contractors employing operating engineers (SIC 161 and 179) shows a high during the summer months and a low during the winter months.

An examination of the monthly employment figures for contract construction, electricians (SIC 173) and operating engineers (SIC 161 and 179)[1] shows that the amplitude of the seasonality has been declining over the past decade. The percentage variation from peak to trough and from trough to peak has gradually declined from 1960 to 1971, indicating a lessening of the seasonal factor. To some degree this may be the result of technological changes that make it possible to engage in more construction activity during the winter months. The greatest degree of seasonality was shown by the operating engineers where employment varied from trough to peak by more than 50 percent in the early years of the decade and by slightly less than 50 percent in 1970. The electricians showed considerably less seasonality, with employment varying from trough to peak by about 15 to 20 percent in the early 1960's and only 11 percent in 1970. The figures cited above are for the Boston SMSA. In almost all cases the seasonality for the construction industry for the state as a whole was greater than for Boston SMSA.

Industry Structure

The general building construction industry (SIC 151) in the Boston SMSA has been growing during the past few years, even though the number of firms in the industry has dropped slightly. In the two-year period, September 1968 to September 1970 the number of firms declined from 1,756 to 1,649, a drop of about 6 percent, while employment and the total wage bill increased substantially. As shown on Table 4, the general building construction industry is highly concentrated. In September 1968 the ten largest firms represented 0.6 percent of all firms in the industry in the Boston SMSA, but employment of these big ten represented 24.5 percent of total employment and their quarterly wages represented 28.7 percent of the industry's quarterly wages. These ten firms employed an average of 513 workers, with an average quarterly wage bill of $1,285,400; the remaining firms in the industry employed an average of 9 workers with an average quarterly wage bill of $18,000.

By September 1970 the number of firms in the industry declined by 107, while the 10 largest firms grew even larger than they were in 1968. Employment in the 10 largest firms represented 31 percent of total industry employment, and the quarterly wage bill of these 10 firms represented 35 percent of quarterly wages of the whole industry. These large firms employed an average of 709 workers, with an average quarterly wage bill of $2,087,200, while the remaining firms in the industry employed an average of 9.6 workers, with an average quarterly wage bill of $23,000.

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1. Raw data obtained from Massachusetts Division of Employment Security.

TABLE 4

EMPLOYMENT AND WAGES OF TEN LARGEST FIRMS AND ALL FIRMS IN GENERAL BUILDING CONSTRUCTION IN THE BOSTON SMSA, 1968 AND 1970

	September 1968			September 1970		
	Ten Largest Firms in Boston SMSA	Total Firms in Boston SMSA	Percent of ten Largest Firms to Total	Ten Largest Firms in Boston SMSA	Total Firms in Boston SMSA	Percent of ten Largest Firms to Total
Total of Units	10	1,756	0.6	10	1,649	0.6
Total Employment	5,131	20,893	24.5	7,090	22,784	31.1
Quarterly Total Wages (000)	$12,854	44,777	28.7	20,872	59,448	35.1
Quarterly Taxable Wages (000)	$ 3,974	18,668	21.3	5,430	20,820	26.1

Source: Computed from data of the Massachusetts Division of Employment Security.

It may be noted that the data cited above and on Table 4 were for the month of September, not a peak month for construction activity but also not a very slow month. Normally construction hits a low in the winter months of January, February, or March, when activity could decline by as much as 50 percent. During such slow months some small firms may have no work at all, while the others may show a decline in employment to below an average of nine workers.

According to Dunn and Bradstreet information for Massachusetts, there were 8,441 firms in the construction industry, of which 2,188 were general building contractors, 1,544 were plumbing, heating and air conditioning contractors, 866 were electrical contractors, 581 were painting, paperhanging and decorating contractors, and 538 were excavating and foundation work contractors. Information on size of firm was available for 7000 companies, and of these 76 percent had under 10 employees; 13 percent had between 10 and 19 employees and 8 percent had between 20 and 49 employees. A distribution of the firms by volume of sales shows that slightly more than 50 percent had sales of under $100,000; 6 percent had sales of between one million and 10 million dollars, and only 0.3 percent had over 10 million dollars.

Wages and Earnings

Earnings data by occupation are not readily available, but numerous clues can be put together to approximate the relative levels of occupational earnings, if not the absolute levels. It is conventional wisdom that construction workers receive very high wages, compared to workers in other industries. Because of seasonality, however, average annual earnings of workers in the construction industry are not substantially different than the earnings in many other industries.

An examination of Table 5 shows that in 1960 the average annual earnings in industries such as machinery, except electrical, and transportation equipment exceeded those in contract construction by substantial amounts. Other metal working industries showed lower earnings, but the differences were not large. From 1960 to 1970 earnings in contract construction rose much more rapidly than in other industries, and the level in 1970 exceeded the earnings in all the metal working industries. Again the differences were not overwhelming.

It should be noted that because of the seasonality in the construction industry the construction worker is probably earning a higher annual income while working fewer days during the year. It is not possible to determine what other earnings opportunities seasonally unemployed construction workers do have. Undoubtedly some may have opportunities to engage in part-time economic activity, while others may not. The amount of other income earned is not possible to determine.

The metal working industries cited on Table 5 are those industries which employ large numbers of machinists. In the manufacturing sector of the economy these industries are relatively high-paying, although there is considerable variation among them.

TABLE 5

AVERAGE ANNUAL EARNINGS IN SELECTED INDUSTRIES,
BOSTON SMSA, 1960 and 1970

INDUSTRY	Average Annual Earnings		
	1960	1970	Percent Change
Contract Construction (SIC 15-17)	$5,814	$10,542	81.3
Fabricated Metal Industries (SIC 34)	5,445	8,754	60.8
Machinery, except Electrical (SIC 35)	6,034	9,936	64.7
Electrical Machinery (SIC 36)	5,366	9,165	70.8
Transportation Equipment (SIC 37)	6,890	9,773	41.8
Instruments (SIC 38)	5,700	10,013	75.7
All Manufacturing (SIC 19-39)	5,289	8,673	64.0

Source: Massachusetts Division of Employment Security, <u>Employment and Wages in Massachusetts, 1958-70</u>.

The specific earnings of craftsmen depend upon the wage rate for the craft. In the construction industry, the union wage scale sets the rate for all craftsmen employed by a union contractor. The craft union negotiates a wage contract with the association of contractors in the geographical jurisdiction of the union, and a wage rate is established for all union work in the area. This is the situation for both the electricians and the operating engineers, although in the case of the latter different rates are set for different types of equipment.

In the case of the machinists, who are normally employed by firms in manufacturing industries, there is no single union wage schedule, nor for that matter, is there a single craft union that represents all machinists. In small machine job shops, if the machinists happen to be organized, the union is likely to be the International Association of Machinists; in the New England area most such job shops are unorganized, and all of the shops we interviewed in the Boston area were not unionized. In the larger metal fabricating firms that are organized, the machinists are generally part of the production workers bargaining unit, and are likely to be organized by an industrial union, such as the International Union of Electrical Workers, the United Electrical Workers, or the United Automobile Workers. In such cases the wage level of the firm may vary within an industry and among industries, depending upon factors unique to the particular industry and union. For these reasons there is not likely to be a uniform wage schedule for machinists in an area.

In the Boston area the union wage scale for construction electricians was $3.90 per hour in 1960; by mid-1972 the rate had increased to $8.50, a rise of close to 120 percent. Fringe benefits for the electricians have also risen, and it is estimated that the current cost of fringes per employee per hour is approximately $1.50.

The operating engineers have a schedule of rates, with wages varying by type and size of machinery operated. The standard rate normally quoted is the Group I rate covering heavy equipment. In the Boston area the Group I rate rose from $3.95 in 1960 to $9.31 in 1972, a rise of 136 percent; the lowest standard rate Group IV (operators of pumps, compressor and welding machines) rose from $3.50 in 1960 to $7.67 in 1972, an increase of approximately 120 percent. Just as the electricians, the operating engineers have also had gains in fringe benefits and it has been estimated that these benefits would increase the workers' benefits by $1.50 per hour.

Thus, in the Boston area, an electrician or an operating engineer who obtains employment with a unionized contractor knows what his wage rate will be. The union wage schedule is recognized by all organized employers. For the machinist there is no such uniform wage. Firms employing large numbers of machinists are not necessarily in the same industry, and their wage structures may differ substantially. The machinist wage rate is normally part of the firm's wage structure, and the difference from firm to firm may be great. Some firms are organized and others are not, but the level is determined by more than unionization.

According to a 1972 area wage survey in Boston by the U.S. Bureau of Labor Statistics, the mean hourly earnings of maintenance machinists were $4.73, with a range from a low of $3.00 to a high of over $6.00 per hour. In our sample we found firms paying machinists as high as $5.00 per hour, while other firms were paying as high as $7.00 per hour. Many of these firms maintained wage ranges for machinists, with some journeymen being hired in at rates as low as $3.50 per hour.

On the whole, in job shops, even when unorganized, machinists were earning about $1.00 per hour more than in the larger captive shops. This differential may be explained, at least in part, by the fact that few of the small job shops had much of a fringe benefit plan, and the higher wage rate was to offset the fringe benefits offered by the larger companies.

Skills and Training Required

In almost all apprenticeship programs the emphasis is on the training of an all-round craftsman who can handle, with little or no additional training, any and all aspects of the trade. While a journeyman working at this trade is likely to have a job where considerable specialization occurs, broad knowledge of his craft gives him considerable mobility, both laterally and upward. Thus, from the view of the worker himself and of the industry in which an apprentice is being trained, the broad training offered by apprenticeship has great benefits.[1]

1. Electrician

A complete description of the work that can be required of an electrician covers duties and functions of the craftsman working in any industry. Such functions clearly include many which are rarely if ever called for in the construction industry. The following is the Dictionary of Occupational Titles job description of electrician (any ind.) 824.281:[2]

> Plans layout and installs and repairs wiring, electrical fixtures, apparatus, and control equipment: Plans new or modified installations to minimize waste of materials, provide access for future maintenance, and avoid unsightly, hazardous, and unreliable wiring, consistent with specifications and local electrical code. Prepares sketches showing location of all wiring and equipment or follows diagrams or blueprints prepared by others, insuring that concealed wiring is installed before completion of future walls, ceilings, and flooring. Measures, cuts,

1. Apprenticeship usually includes both OJT and related instruction. The purpose of this study is to examine the independent contribution of related instruction.

2. U.S. Department of Labor, Manpower Administration, Dictionary of Occupational Titles, 1965, Vol. 1.

> bends, threads, assembles, and installs electrical conduit, using such tools as hacksaw, pipe threader, and conduit bender. Pulls wiring through conduit, assisted by ELECTRICIAN HELPER. Splices wires by stripping insulation from terminal leads with knife or pliers, twisting or soldering wires together, and applying tape or terminal caps. Connects wiring to lighting fixtures and power equipment using handtools. Installs control and distribution apparatus, such as switches, relays, and circuitbreaker panels, fastening them in place with screws or bolts, using drills, masonry chisels, hammer, anchor bolts, and wrench. Connects power cables to equipment, such as electric range or motor, and installs grounding leads. Tests continuity of circuit to insure electrical compatibility and safety of all components, using standard instruments, such as ohmmeter, battery, and buzzer and oscilloscope. Observes functioning of installed equipment or system to detect hazards and need for adjustments, relocation, or replacement. May repair faulty equipment or systems (ELECTRICAL REPAIRMAN). May be required to hold license. May cut and weld steel structural members, using flame-cutting and welding equipment.

The duties and responsibilities of an electrician placed this craft in the category of highly skilled, with special requirements for manual dexterity, blueprint reading and knowledge of electrical theory and circuitry. While much of the skill must be acquired on the job, there is considerable theory and didactic materials that are better taught in the classroom. Inasmuch as an electrician in construction may often work in isolation from other electricians he must be able to handle most types of electrical work and problems that arise, and must have full knowledge of building codes and safety regulations.

Over a number of years the types of electrical work an electrician may encounter in construction are numerous, but on any single project the work may be rather narrow and repetitive. An apprentice electrician generally receives his on-the-job training by working along side a journeyman, and the apprentice's training is limited by the work assigned to the journeyman on that job. If the work is repetitive, and the skills required are narrow, the apprentice's training during the time on that job is narrow. Because the kind of work available is limited at any one time, the training of apprentices may also be limited. Over a period of time an apprentice may have a number of job assignments, and therefore is likely to be exposed to a variety of types of work. His experience will then be quite varied, but haphazard, at best. Hopefully over the four-year period of an apprenticeship the apprentice is exposed to work that covers the basics of the trade, but it is very unlikely that the sequence of work assignments will be in any logical order of simplest to most difficult work tasks.

2. Operating Engineer

A journeyman operating engineer must be adroit in the operation of a wide range of machines that may be used in all types of construction. The equipment will differ according to the work to be performed, but the equipment may also differ because of the age of the machine and its maintenance, or because of different equipment manufacturers. Because of the nature of the work, especially in the use of large heavy equipment, safety is a crucial factor. Operating engineers are responsible for the maintenance and adjustment of their equipment, and are expected to do minor repairs on machines.

The International Union of Operating Engineers defines the trade as follows:[1]

> Operating engineers are required to operate, maintain and repair a large variety of types of powerdriven machinery including power shovels, cranes, derricks, hoists, pile drivers, bull-dozers truck-excavators, tractors, scrapers, graders, concrete mixers, paving machines, pumps and compressors.

In the Boston area the work of the operating engineer or hoisting engineer is described in detail in the Dictionary of Occupational Titles. The job description of hoisting engineer (any ind.) 921.883 is as follows:

> Operates compressed air, diesel, electric, gasoline, or steam drum hoists to control movement of cableways, cages, derricks, draglines, loaders, rail cars, or skips to move men and materials for construction, logging, mining, sawmill, and other industrial operations. Starts hoist engine and moves hand and foot levers to wind or unwind cable on drum. Moves brake level and throttle to stop, start, and regulate speed of drum in response to hand, bell, telephone, loudspeaker, or whistle signals or by observing dial indicator or marks on cable. May fire boiler on steam hoist. May operate hoist with more than one drum. May repair, maintain, and adjust equipment.

There is tremendous variation in the size, complexity, and skill required on the various types of equipment. Some of the equipment is relatively simple and requires only one man to operate. The high-rise equipment, such as cranes, derricks and hoists, are two-men machines, requiring a journeyman to operate the machine and an apprentice (oiler) to perform routine daily machine lubrication as well as act as safety and signal man to the operator of the machine. It is only on these latter machines that apprentices are employed.

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1. Apprenticeship Standards for International Union of Operating Engineers, Local 4, I.U.O.E., p. i.

The on-the-job training of the operating engineer apprentice is relatively unique in that the primary role of the apprentice is to lubricate and maintain the machine rather than learn to operate the machine, which is the journeyman's principal function. The journeyman and the apprentices have different job descriptions and responsibilities, and the work the apprentice does on the job is distinct from the type of work he will be required to perform as a journeyman. Whatever experience the apprentice may acquire on the machines is the result of a personal relationship with the journeyman, who may permit the apprentice to operate the machine during lunch hour and other odd times.

3. Machinist

A machinist is a highly skilled shop worker who is employed in a wide range of industries. While many machinists are employed in independent machine shops, many others work in the machine shop of industrial plants, as auxiliary to the production line. Unlike a construction trade where the industry sets the general standards of the craft, machinists have varying skill requirements and perform different assignments, depending upon the firm or industry in which they are employed.

The following is a general description, from the Dictionary of Occupational Titles, of machinist (machine shop) I, 600.280:

> Sets up and operates machine tools, and fits and assembles parts to make or repair metal parts, mechanisms, tools, or machines, applying knowledge of mechanics, shop mathematics, metal properties, and layout machining procedures: Studies specifications, such as blueprint, sketch, or description of part to be replaced, and plans sequence of operations. Measures, marks and scribes dimensions and reference points to lay out stock for machining (LAY-OUT MAN). Sets up and operates lathe, milling machine, shaper, or grinder to machine parts to specifications, and verifies conformance of part of specifications, using measuring instruments (TOOL-MACHINE SET-UP OPERATOR). Positions and secures parts on surface plate or worktable with such devices as vises, V-blocks, and angle plates, and uses handtools, such as files, scrapers, and wrenches, to fit and assemble parts to assemblies or mechanisms. Verifies dimensions and alinement with measuring instruments, such as micrometers, height gages, and gage blocks. May operate mechanism or machine, observe operation, or test it with inspection equipment to diagnose malfunction of machine or to test repaired machine. May develop specifications from general description and draw or sketch product to be made. May be required to have experience with particular products, machines, or function as construction or repair, and be designated accordingly.

The type of on-the-job training that a machinist apprentice receives varies considerably depending on the work being done by the employing firms, and whether the firm runs its apprenticeship jointly with a union. Depending upon the long-run interests of the firm the apprentice may be given intensive and broad experiences, or he may be narrowly trained to meet a single need of the employing firm. In a larger company an apprentice may be carefully selected, and then exposed to a rather formal training program where the apprentice is assigned to work with a specific journeyman. Beginning with simple tasks assigned by the journeyman, the apprentice progresses to more sophisticated tasks as his proficiency increases.

In another type of situation, whether in a large or small firm, the employer's needs are very narrow, and the apprentice's experiences are also very narrow; he could be assigned to certain simple types of production work and never be exposed to some of the more complex aspects of the trade. When only such simple type of work is available in the shop, there is no opportunity for the apprentice to obtain experience in other types of work. Only if such an apprentice is prepared to shift to a number of firms will he get a wider range of experience.

CHAPTER 3

RELATED INSTRUCTION IN THE OPERATING ENGINEERS TRADE

Definition of the Trade

"Operating engineers are required to operate, maintain and repair a large variety of types of power-driven machinery including power shovels, cranes, derricks, hoists, pile drivers, bulldozers, truck-excavators, tractors, scrapers, graders, concrete mixers, paving machines, pumps and compressors."[1]

Versatility in the variety of equipment a journeyman is qualified to operate increases the journeyman's chances for steady employment.

The journeyman operator is found on all construction projects large enough to require power excavation, hoisting or pumping equipment.

Evolution of Training

The apprentice program in Boston began in 1963 through the local efforts of the International Union of Operating Engineers in conjunction with Boston area contractors, and led to the establishments of the Joint Apprenticeship and Training Committee for operating engineers. Before 1963, training had occurred mostly on the job. The trainee served for three years as an oiler under the supervision of a journeyman. This form of training existed only in the hoisting equipment classification and on certain other machines which required two men; there was no formal training, and still is none, for scraping and paving equipment because these machines require only one man.

The oiler classification served two functions. One was to lubricate and perform routine maintenance on the equipment and to act as a signalman; the other was to learn to operate the machine.

While the oiler classification carried out its first function, it failed as a source of future operators. Oilers were remaining oilers much longer than three years before tranferring to the operator classification; moreover, some oilers never intended to transfer but remain "professional" oilers.

The oiler classification thus was not providing skilled operators. Just as important, oilers were occupying positions needed for trainees who did want to become operators.

In addition, operators were too busy to train on the job, and oilers often did not receive enough operating experience to develop the skills required. It was hoped that a formal training position would correct this. With the substitution of the apprentice for the oiler at the entry-level, the latter classification is now closed to new entrants and will eventually be depleted by attrition. Newly hired workers now enter as apprentices.

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1. I.U.O.E., Local 4, Apprenticeship Standards for International Union of Operating Engineers, p. 1.

Entrance Qualifications for IUOE Apprenticeship

The apprentice applicants must meet five requirements. He must be between 18 and 25 years of age;[1] physically capable of performing work in the trade; and have a high school education or its equivalent. The latter requirement may be met by a GED or nine years of schooling and military service. In addition, the applicant must pass an aptitude test and be a United States citizen or have filed for citizenship.

Once the above basic qualifications are met, the JATC interviews all applicants and ranks them according to the following criteria:

	Maximum Score
High School Education or Equivalent	10
Mechanical: Technical Subjects	5
JATC Evaluation of Physical Ability	10
Previous Work Experience	10
Motivation and Attitude	15
Military Service	10
Satisfactory Verification of Character and Work History	10
Pass Aptitude Test[2]	15
Appearance and Character	15

Applicants must score 70 or better out of a maximum of 100 to be placed on the eligibility list and are ranked by score. As employment opportunities become available, highest ranking applicants are called to sign indenture papers and are enrolled in the program. Applicants receiving a score of 70 or above, but who are not called for indenture, must reapply to be considered for the next year's class.

Apprenticeship Standards

The apprenticeship program requires four years of training, each comprising 2,000 hours of work experience and 144 hours of related instruction. There is a probationary period of 1,000 hours of six months during the first year of employment, when the indentureship can be dissolved by either the JATC or the apprentice.[3] Individuals with previous experience in the trade can

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1. Except for persons with military service, for whom years of service up to four years are added to the age.

2. As of time of this study, the aptitude test used was the GATB.

3. The ratio of apprentices to journeymen is one to five.

receive advanced credit from the JATC.

The apprentice is not guaranteed continuous employment. If laid off because of business conditions, the apprentice is reemployed before new apprentices are hired.

Details of the Related Instruction Program

As stated earlier, apprentices are required to attend 144 hours of related instruction classes each year. Classes are held at four locations, two at regional vocational-technical high schools in the area, one at a high school in Boston, and the fourth at the shop of the local union, also in Boston. Apprentices must attend classes two evenings each week for three hours each from October to April. Apprentices are not paid for the class time. Apprentices must buy their own texts.

The instructors are union journeymen certified to teach by the Commonwealth. All students are union apprentices because only the JATC trains for the trade.

Attendance at related instruction classes is required. The only acceptable excuses for absences are military obligations, sickness, and out-of-town work. Even for legitimate absences, apprentices are responsible for keeping up with classroom work. Apprentices may be held back or cancelled from the program for excessive absences or for failing their coursework.

A minimum grade average of 60 percent must be made to be promoted. The grade includes one given by the journeyman with whom the apprentice works. Because all apprentices are paid the same rate, wage increments are not contingent upon related instruction grades or attendance. However, remaining in the program is contingent upon satisfactory performance in related instruction.

The initial course outlines were developed by the I.O.U.E. National Joint Apprenticeship Committee. The curriculum was developed by the local apprentice coordinator and the National Committee to correct weak points in training. It has been revised yearly by instructors; a standardized curriculum is presently being prepared by the National JATC on the basis of this local's program. Even with adoption of a national curriculum, local JATCs will retain the right to accept specific courses based on relevancy to their areas.

The 1972-73 curriculum follows:

Year	Term	Course Titles	Hours	
1	1	Indoctrination	3	
		Introduction	3	
		Lubrication	24	
		Introduction to Power	39	
		Review and Test	6	75

Year	Term	Course Titles	Hours	
	2	Introduction to Power Trains	30	
		Hydraulics	6	
		Review, Tests and Awards	6	42
				144
2	1	Indoctrination	3	
		Language of Electricity	3	
		Batteries and Cranking Circuits	12	
		Cranking Motors and Generators	27	
		Symbols and Diagrams	9	
		Regulators	15	
		Review and Test	6	75
	2	Fuel and Ignition Systems (gasoline)	27	
		Trouble Shooting	21	
		Miscellaneous	15	
		Review, Test and Awards	6	69
				144
3	1	Indoctrination	3	
		Electric Motors and Controls	54	
		Electrical Safety	12	
		Review and Test	6	75
	2	Rigging and Reeving	63	
		Review, Test and Awards	6	69
				144
4	1	Indoctrination	3	
		Review First Year	12	
		Review Second Year	15	
		Review Third Year	15	
		Introduction to Hoist and Drill Rigs	15	
		Preparation for Hoisting License	9	
		Review and Test	6	75
	2	Grades and Plans for Operating Engineers	45	
		Apprentices' Night[1]	18	
		Review, test and Awards	6	69
				144

For the most part, related instruction consists of courses which are intended to give the apprentice a working knowledge of engines, power sources, generators, etc. This knowledge will enable him, as an operator, to understand the workings of the equipment, to aid him in the proper operation of the equipment, and to provide him with the skills necessary to perform the minor equipment repairs which will be required of him as an operator. While undue amounts of time seem to be spent on the mechanical aspects of the trade, the instructor's manual emphasizes the fact that the apprentice is being trained to be an operator, not a heavy duty mechanic. According to a manual issued by the local

1. Each apprentice prepares a 10-minute talk on the machine he is currently operating.

union:[1]

> The point of this program is to train operators, not mechanics. The Administration and Trustees want the apprentices to become journeymen equipment operators who are able to operate efficiently and who are able to make all minor repairs and adjustments on their machines. The instructors should keep these goals in mind when presenting these subjects. Keep it general.

Coordination

Since the local union's jurisdiction covers a broad geographical area, apprentices attending the same related classes typically are assigned to entirely different projects at different stages of completion. Therefore, while it is possible to control what an apprentice learns in the classroom, the job-site training is highly variable as to relevance and quality. The problem is compounded by the numerous types, makes, and ages of equipment with which an apprentice must become familiar.

The difficulties of coordination are compounded by the dual role in which the apprentice is placed. The major classroom objective is to train journeymen, while the job-site duties of the apprentice are those of the traditional oiler. Among the first courses an apprentice takes in related instruction is "Lubrication," a subject which finds immediate application on the job but in a field somewhat removed from the apprentice's ultimate objective of operation. Having acquired classroom knowledge of lubrication, the oiler portion of the apprentice's dual role is reinforced by task assignments.

The amount of "seat time"[2] an apprentice is supposed to receive on the job is indicative of the problems created by the apprentices' dual role. Apprentices are supposed to receive two hours per week of seat time. Even if the apprentice is employed 52 weeks a year for four years, he is supposed to spend only 416 hours out of a total of 8,000 hours (or 5.2 percent of his apprenticeship) learning to operate equipment. From apprentice interviews it is evident that there is considerable variation in the actual number of hours in the seat an apprentice gets. The number of hours appears to be some function of the apprentice's relationship to his operator, the operator's sense of security in his job, the type of job they are working on, and the type and condition of their machine.

The most obvious solution to the problem of coordinating is to change the role of the apprentice on-the-job. However, in view of safety and contractor's cost, changing the apprentice's role on the job may prove difficult. Ideally, apprentices should have the opportunity to run equipment

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1. Beurman, D.F., Grande, J.B., Instructors' Guidelines, July 1971, p. 10.

2. Seat time is the amount of time the apprentice is actually operating the machine.

in a training site.[1] Safety factors are more easily controlled at a training site, and apprentices would receive valuable operating experience which they are not receiving on the job. A training site would also give apprentices the opportunity to learn to operate a wider range of equipment. It is conceivable that training time could be reduced by requiring apprentices to attend training sites on weekends or during periods of unemployment for the first two years of their apprenticeship. Related instruction classes could be given at the same time at the training site so there would be immediate reinforcement of class and on-the-job work.

After the first two years of his apprenticeship, with two years of operating experience and related instruction at a training site, the apprentice would be more capable of operating equipment at a real job site. In addition, a journeyman may have more confidence in the apprentice's ability and be more willing to let him operate.

From Apprentice to Journeyman

It is correct to say that the general goals of the local's apprenticeship program are first to train better journeymen as evidenced by their versatility (i.e., the number of machines they are qualified to operate), and second, to train journeymen in a shorter period of time than in the past. The training through the oiler classification was of three years duration versus four years for apprentices. However, as stated earlier, the oiler classification included many with no pretensions to become journeymen while those motivated to become operators often took much longer than three years to accomplish this.

Apprenticeship was an attempt to systematize the training standards and processes and hence the supply of well qualified journeymen. A comparison of training time of oilers and apprentices can not be made at this time. The first class did not graduate until 1967. Furthermore, there has been a moratorium on highway construction within the Boston metropolitan area which has seriously affected employment in the trade. The moratorium has caused men in highway construction to seek work on other construction projects. These are men who are qualified to operate hoisting equipment.

To earn journeyman status an apprentice must work as an operator for six months after completing the four-year apprenticeship. He must bring his pay stubs to the union to prove he has satisfied the employer(s) for the six-month probationary period.[2] Under normal employment conditions, the transfer time (the elapsed time between completion of apprenticeship and acceptance as journeyman) would be a good indicator of the success of the apprenticeship program. However, given the adverse employment conditions, apprentices are not being offered machines to operate because there are experienced journeymen out of work. Furthermore, the union has not accepted any new apprentices for the last two years. Since the supply of apprentices has been temporarily

1. The local union currently is in the process of acquiring such a site.

2. An apprentice is admitted to the parent body only after a vote of the members.

cut off, it is easier for apprentices to find jobs as apprentices (i.e., as oilers) than as operators.

Data Sources

This analysis of the related instruction program in the operating engineer's trade draws on data from personal interviews with 74 operating engineer apprentices, randomly selected from among years two through four of the current class of apprentices,[1] union records of 149 active apprentices and a mail questionnaire sent to 500 journeymen, which included ones trained with and without formal apprenticeship.

Findings of Apprentice Interviews

The operating engineer apprentices had an average of slightly under 12 years of formal education. With few exceptions they all had completed high school.

Apprentices are recruited from a variety of high school backgrounds; 41.9 percent graduated from general education programs; 25.7 percent from college prep programs; 24.3 percent from vocational educational programs and 8.1 percent from co-op programs.[2] While the greatest number of apprentices come from general education programs, the distribution would not seem to indicate a strong bias in favor of any one type of background. It would seem to indicate that prior education in some form of manual arts is not essential training. No Boston area school offers a high school program in this trade, and no apprentice has such training. The average age of the apprentice in the sample was relatively high, (25.1 years), and 36.5 percent had fathers who were in the trade. The fathers averaged 10.2 years of formal education.

The mean age at which the apprentices decided to become operating engineers was 20.4 years. Therefore, on average, they had finished high school and had been out working, in military service or in post high school training for about two years before deciding to enter the trade. Only 18.9 percent decided to enter apprenticeship before they had completed high school. Only 5.4 percent had post high school training in the same or closely related trades.[3]

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1. Year one was eliminated since there was only one first-year apprentice. The stratified sample represents 33 percent of the apprentices in each of the three years.

2. In co-op programs students alternate every other week between school and work. The week that would otherwise be spent in shop class instead is spent on a related job.

3. The only trade considered closely related was auto or diesel mechanics which provides the necessary mechanical background and skills to perform as an operating engineer.

The mean number of years of post high school training in a trade or technical school for all apprentices was less than three months. This indicates that the two-year gap between high school graduation and the decision to enter the trade was typically not spent in post high school education.

Of the apprentices sampled, 14.9 percent received some credit towards their apprenticeship for previous work experience or previous education. Credit in this case may mean a reduction in the term of apprenticeship, elimination of some classes or credit towards entering the program (i.e., given preference for admission).

Individuals entering this apprenticeship program seem to have had diverse labor market experience and most of them have had at least some work experience prior to entering apprenticeship. Most (96 percent) had full time jobs before entering the trade and 77 percent had full time related jobs. In general, one would conclude that the apprentices have had a chance to look around and gain some knowledge of the "world of work." It is also reasonable to conclude that the apprentice has made a late career choice because he had inadequate knowledge of the trade.

The most important influences in the choice of trade were relatives and friends. See the following:

Parent or relative	35.1%
Friend	17.6
Advice or training from vocational high school	0.0
Advice from academic high school	0.0
Advice from co-op high school	0.0
Advice from State Employment Service	1.4
Self and other	46.0

We could conclude from this that information about the trade is disseminated in a rather imperfect way. Nearly half of the apprentices could identify no specific outside influence. The other two significant influences are parents and relatives (35 percent) and friends (18 percent). These responses also indicate that the high schools and public employment service had little if any influence in career decisions in this trade.

The majority of apprentices, 58.1 percent, had learned about the apprenticeship program from a parent or relative in the trade, while 27.3 percent learned about the program from a friend. Only 2.7 percent learned about the apprenticeship program from the public employment service and 12.2 percent from other sources. This indicates a rather imperfect system for disseminating information. Although family ties play a role, it is our opinion that the lack of information is the more critical factor; it is also the one most easily corrected.

In an attempt to assess the value of related instruction and its role in apprenticeship, we asked a series of questions which were subjective in nature. Since each apprentice is required to attend related instruction, we asked (a) if a penalty[1] was an important reason for attending, and (b) if they would

1. The penalty can range from a reprimand to dismissal from the program.

attend if there were no penalty. About two-thirds stated that the penalty was an important reason for attending class, but three-quarters also said they would attend even if there were no penalty. The explanation of this apparent contradiction is that the apprentices said that they would not attend as regularly as they now do. This indicates that apprentices believe that related instruction does have some value to them. When asked if they could be as good a tradesman without related instruction, 70.3 percent believed they needed related instruction to be as good a journeyman. Among those answering yes (29.7 percent), many qualified their answer by saying that it would take longer to become a journeyman.

We asked apprentices to rank the value of related instruction from one to four, one being not valuable at all and four being very valuable. Most ranked related instruction very valuable for learning the trade, while another 10 percent ranked it valuable.

The quality of instruction appears to be high. We asked if, on average, instructors are well-prepared and 91.9 percent answered yes. Almost all (98.6 percent) stated that instructors were up-to-date with current technology in the trade and 89.2 percent that instructors explained the material clearly. Some individuals did say that certain instructors were not of high caliber but the overall comments do indicate a high degree of satisfaction with the quality of instruction.

Apprentices view some portion of related-instruction course material as not "trade specific." Four-fifths (82.4 percent) stated that they believed related instruction would be useful to them if they ever decided to leave the trade. This indicates that they believe that some of the material is transferable to other occupations. The mechanical repair skills learned in related instruction were most often mentioned in this regard.

In attempting to determine how related instruction complements on-the-job training we asked whether there was systematic training on the job. We explained that systematic training meant apprentices were given simple tasks at first and gradually worked up to more difficult ones in some logical manner. Only one-third (35.1 percent) of the apprentices believed that their on-the-job training was systematic. To probe this issue further, we asked whether they were kept on some types of work longer or shorter than it took them to learn how to perform the task. The response showed that 69.9 percent were kept on some types of work assignments too long, and 58.9 percent were moved from some types of work too quickly.

As previously noted, apprentices perform on the job as oilers while they are learning the trade. As oilers they act as signal men and perform routine maintenance, and they do not actually operate equipment except when the journeymen allow them. Thus, those aspects of related instruction which are designed to teach apprentices to be operators are not necessarily used on the job when they are functioning as oilers.

The number of hours per week of operating time which an apprentice receives varies widely among different years and within each year. The following shows the means, ranges, and standard deviations for years one through four of apprenticeship:[1]

Years of Apprenticeship	Mean	Range	Standard Deviation
First	3.6	0 to 20	4.95
Second	6.6	0 to 25	6.52
Third	9.8	0 to 30	8.13
Fourth	11.6	0 to 35	8.79

The difference of the means of any two years is less than twice the standard deviation of either of these two years. For example, the difference between the mean of years one and four is only 8.0, which is less than two standard deviations from either the mean of the first or the fourth year. We would have to reject at the 95 percent confidence level, the hypothesis that there is a significant difference between the two means. As one would expect the average amount of time operating equipment increases with each year of apprenticeship; however, the difference between any two years is not statistically significant. If apprentices work a 40-hour week, a small portion of their time is devoted to operating, regardless of year.

Findings from Union Apprenticeship Records

The data presented in this section were gathered from union apprenticeship records for an IUOE local in the Boston area. The universe was all current apprentices in years two through four of apprenticeship, and we collected data on each of the 149 apprentices in the universe. The first year was omitted because there was only one first-year apprentice in the local. Because of the slowdown in highway construction, unemployment rates among journeymen were relatively high, and the number of apprentices indentured each year had declined. Given the manipulations which we have performed on this data (presented in this section) the exclusion of first-year apprentices is not critical. In fact, we would have eliminated them anyway. Our reasons will become apparent as this section proceeds.

The data include: grades given in related instruction classes; the "grade" given to the apprentice by the journeyman for whom he worked; the number of absences from related instruction classes; a grade for conduct in related classes; a grade for effort in related classes, and the number of days worked during the period from November 1971 through March 1972. The course grade is based primarily upon quiz scores. Conduct and effort are probably subjective, reflecting the instructor's personal opinion of the apprentice. The grade given by the journeyman should reflect the apprentices' performance on the job. There is a formal reporting system under which the journeyman fills out a form which is then given to the apprentice coordinator.

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1. We asked each apprentice how many hours per week on average he operated in each of the years of his apprenticeship.

The conduct and effort grades as well as the number of absences probably measure the apprentices' attitudes toward related classes. We thus believe we have a measure of ability (course grades) and measures of attitude (effort, conduct and absences).

The hours worked cover the winter months of 1971-1972 which comprise the off-season for operating engineers. In addition unemployment among journeymen and apprentices was high because of a local slowdown in construction, given this loose labor market, differences in ability would be expected to be positively related to the number of hours worked by individuals. For these reasons, this may be a more desirable period in which to test the differences in productivity among apprentices. During the summer months it is likely that all apprentices will be fully employed or at least there will be less variation among them in employment. In periods where there are high levels of unemployment rational employers will retain the most productive workers and lay off or refuse to hire the less productive.

We are, in this section, assuming that employers are rational. They are capable of determining the relative productivity of different workers and once having done this, base their employment decisions upon productivity. Granting these assumptions, hours worked should be a measure of productivity (i.e., the quality of a worker's performance on the job). This is no more than the usual assumption in economics. Since we cannot measure ability directly, we are using hours worked as a proxy for it, and then using performance in related instruction as a determinant of hours worked. Using hours worked as a measure of relative productivity is more appropriate in construction, where there is no seniority system than in some other industries. Contractors have the right to lay off or refuse to hire any apprentice or journeyman.[1]

There was a substantial difference in the hours worked by the 149 apprentices during the five months. The range was from 0 to 1122 hours. The standard deviation equaled 243.8 hours and the mean equaled 708.6 hours. Similarly, there was a large diversity in course grades, with a median of 84.8, standard deviation of 8.36 and range from 53.2 to 100. The other variables also showed a wide range of values.

Assuming that hours worked measures differences in performance among apprentices, we estimated the following model:

$$Z = k + a(A) + b(C) + c(F) + d(Q) + e(B)$$

Where

Z = hours worked

A = "grade" given by journeyman

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1. It should be noted that there is no union hiring hall in the IUOE local we studied.

C = conduct

F = effort

Q = course grade average

B = number of absences from related instruction courses

The following results were obtained:

Coefficients	Value of Coefficient	t-Stat
a (grade by journeyman)	3.821	2.614
b (conduct)	-3.073	-0.859
c (effort)	0.076	0.017
d (course grades)	-3.215	-0.885
e (absences)	-1.571	-0.287
k (constant)	920.259	2.738

Overall F ratio = 2.171 (5/143)
Corrected R^2 = .032
Sample size =149

We would hypothesize that the signs of all coefficients except for absences (e) should be positive. The results indicate that the model in total has little explanatory power. The low R^2 of .032 and low F ratio clearly demonstrate this. In fact, we observe that d, which is the coefficient for course grade, and b which is coefficient for conduct in class are negative, indicating an inverse relationship between grade and job performance, and between effort and job performance. At any rate, the t statistics indicate that these two variables are not significant at even the lowest level (i.e., 0.1).

The only explanatory variable which is significant (at the .05 level) is the grade given by the journeyman, (A). There is a positive relationship between grade and hours worked. If this grade reflects the apprentice's true ability, then the fact that it is significant lends some support to our earlier assumption that hours worked does reflect ability. However, the model has a very low R^2, indicating that the independent variables explain very little of the differences in hours worked.

This indicates that employment is related to a variety of other factors. There are other possible explanations for the low R^2. First, a different form of the model may improve both the overall explanatory power of the model and the t statistic for course grade. Secondly, we may have selected an unusual period when employers were about to hire, but had not yet adjusted by hiring, unemployed but more productive apprentices. And third there may be noneconomic and noneducational variables which explain the variations in employment.

We attempted a number of other forms of the model. These included: (a) testing for some threshold effect of grades, (b) eliminating some of the variables which were slightly colinear, (c) allowing for a slope change in the effect of grades, and (d) allowing for a non-linear relationship between grades and hours worked.

The following additional equations were estimated:

$$Z = k_1 + a(A) + b(C) + c(F) + d(B) + n(D) \quad (1)$$

$$Z = k_2 + a(A) + b(C) + e(Q) \quad (2)$$

$$Z = k_3 + a(A) + c(F) + e(Q) \quad (3)$$

$$Z = k_4 + a(A) + d(B) + e(Q) \quad (4)$$

$$Z = k_5 + a(A) + b(C) + c(F) + d(B) + l(DQ) \quad (5)$$

$$Z = k_6 + a(A) = b(C) + c(F) + d(B) + e(Q) + f(Q^2) \quad (6)$$

Where:

Z = hours worked

A = "grade" given by journeyman

D = conduct grade

F = effort grade

Q = course grade average

B = number of absences from related instruction class

D = dummy variable (0 or 1) depending upon value of Q

Equation 1 replaces the quiz grade in the original equation and substitutes in its place a dummy variable (D) whose value is zero or one depending upon the value of course grade (Q). We altered the value of Q at which D = 1 in an attempt to find the optimal threshold. Beginning with D = 1 if $Q \geq 40$ (otherwise D = 0) we increased the value of Q at which D = 1 in five unit increments up to 90. At no time did the t statistic become significant at the .05 level or even the 0.1 level. There does not appear to be a discrete jump in hours worked at some critical value of course grade average. Hours worked do not increase sharply, once a certain grade average is reached.

In equations 2 through 4 we tested to determine if the elimination of any of the variables which were somewhat colinear[1] had any effect upon the overall predictive power of the model. In equation 2, we included the conduct grade and eliminated effort grade and number of absences from related instruction. In 3, we included effort grade (leaving out conduct and absences), while in 4, we included absences (leaving out effort and conduct).

The explanatory variables, effort, conduct and number of absences in equations 2, 3, and 4, respectively, were not significant at the .05 level.

Equation 5 uses a dummy (D) variable times course grade average (Q) to introduce a slope change in the relationship between hours worked and course grade.

The value of the dummy variable was adjusted as in equation 1 to be one if course grade average was greater than some critical value (e.g., if $Q \geq 40$, then $D = 1$; otherwise, $D = 0$). We selected different values of course grade average from 40 to 90 (in five-unit intervals) at which the dummy variable becomes one. The results indicate that there is no such slope parameter change in the relationship. The t statistic for the coefficient of course grade average, the over-all F ratio and the R^2, all indicate that there is no improvement in the model.

Equation 6 includes Q and Q^2. This allows for a non-linear relationship between hours worked and course grade average. This form of the model gave the highest t statistic (-1.36) for the coefficient of course grade average. It was, however, not significant at the .05 level. In addition, the sign was negative which indicates that as the course grade average rises, hours worked decline. This contradicts our hypotheses[2]; of course, the low t statistic means we cannot say that the true value of the coefficient is other than zero. In addition the R^2 was lower than in the original model indicating that the original model still explains more of the variation in hours worked.

One could object to the use of hours worked as a proxy for the apprentice's ability. There may be two reasons for this objection. First, the data period only covers five months, which may be too short a sample period or it may be a disequilibrium period. Secondly, there may be some objection to the assumption that employment is determined by productivity. That is, employers may not act rationally in selecting employees, or they may lack the knowledge

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1. *The following is the correlation matrix for C, F, Q, and B:*

	F	C	Q	B
F	1			
C	.757	1		
Q	.614	.231	1	
B	.327	.373	.389	1

2. If related instruction contributes to on-the-job performance, then hours worked and course grade average should be positively related.

to make the correct decision. Similarly, productivity may not determine the union's referral of apprentices. In other words, if ability does not determine hours worked, related instruction still may affect ability. In any case, in the next set of equations we used the "grade" given by journeymen as the dependent variable. We are substituting the journeyman's evaluation of the apprentice instead of hours worked as an index of performance. This has the advantage of being a more direct measure of ability and covers a longer time interval.

The following equations were estimated:

$$A = k_1 + a(B) + b(C) + c(F) + d(Q) \quad (1)$$

$$A = k_2 + a(B) + b(C) + c(F) + d(Q) + e\ (D)\ (Q) \quad (2)$$

$$A = k_3 + a(B) + b(C) + c(F) + d(Q) + e(Q)^2 \quad (3)$$

Equation 1 is a linear relationship between the dependent and independent variables. The underlying assumption is that the grade given by journeymen is a function of the number of absences from related instruction classes (B), the conduct grade (C), the effort grade (F), and the course grade average (Q) in related instruction classes. In equation 2, we have added a dummy variable (D) times Q. The value of D is either one or zero depending upon the value of Q. We selected different values of Q in an effort to identify the value which yielded the "best fit." Equation 3 gives a non-linear relationship between hours worked and course grade average.[1] The value of the coefficients for each equation follows:

Equation 1

Coefficient (variable)	Value of Coefficient	t-Stat
a (absences)	- 0.64693	-2.10506
b (conduct)	- 0.02679	-0.13140
c (effort)	0.02500	0.09877
d (grade average)	0.00884	0.04265
k (constant)	92.55960	5.27649

Corrected $R^2 = .015$ Overall $F(4/144) = 1.550$

1. $\frac{dA}{dQ} = d + 2cQ$ for equation three, whereas in equation one $dA/dQ = d$.

Equation 2

Coefficient (variable)	Value of Coefficient	t-Stat
a (absences)	- 0.630	- 2.057
b (conduct)	- 0.048	- 0.235
c (effort)	0.040	0.159
d (course grade)	0.262	0.964
*e (dummy variable-course grade)	- 0.075	- 1.433
k (constant)	76.916	3.733

Corrected $R^2 = .022$ Overall $F(5/143) = 1.1660$

*The best value found for D was D = 1 when $Q \geq 80$, otherwise D = 0 (e.g., when $Q<80$, D = 0).

Equation 3

a (absences)	- 0.724	- 2.245
b (conduct)	- 0.036	- 0.177
c (effort)	0.022	0.086
d (course grade)	- 1.309	- 0.787
e (course grade)	0.008	0.799
k (constant)	147.331	2.082

Corrected $R^2 = 0.012$ Overall $F(5/143) = 1.364$

We can hypothesize that the signs of the coefficients for conduct, effort, and course grade average should be positive. That is, as these grades rise, work performance and thus the journeymen's evaluations should rise. If the number of absences measures attitude, then its coefficient should be negative. In all three forms of the model, effort and absences have the correct signs. In all three equations, the sign of the coefficient of conduct violates our hypothesis. This indicates that the poorer one's conduct in class, the higher the journeyman's evaluation, which is not a very satisfactory conclusion. The coefficient of course grade average has the correct sign in equations 1 and 2. They indicate that the journeyman's evaluation increases as the performance in related instruction increases.

We have not discussed the sign of the coefficients of course grade average multiplied by the dummy variable, and of the course grade squared.[1] Equation 3 shows a decreasing marginal return, while equation 2 demonstrates a constant marginal return up to 80 and then a lower but constant marginal return from 80 to 100. It would seem likely that the marginal improvement in job performance (as measured by the journeyman's evaluation) should be subject to diminishing marginal returns. If it is constant, it should be reduced to a lower value at some critical value of Q. If the above is true, the sign of e in equations 2 and 3 should be negative. In fact, only in equation 2 is the sign of this coefficient negative.

1. The coefficient "e" stands for the former in equation 2 and for the latter in equation 3.

The only significant coefficient is for the number of absences from related instruction. Its coefficient is significant at the .05 level. All other coefficients are not statistically significant. Thus, the hypothesis that performance on the job is unrelated to performance in related instruction classes cannot be rejected. This of course assumes that the journeyman's evaluation accurately reflects the apprentice's performance on the job.

Summary

A brief summary of our results would be that the only significant determinant of the amount of an apprentice's employment is the grade given to him by the journeyman for whom he works. The only significant determinant of the journeyman's grade is the number of absences from related classes, which is most likely a measure of attitude or motivation. The greater the number of absences, the lower the grade.

The low R^2 in all of these models indicate that there are other factors which explain the greater part of both employment and grades given by journeymen. There may be a lack of information about where jobs might be found, as well as the element of "luck," which too often enters in finding a job. These factors lead to distortions in this labor market.

As was mentioned in an earlier section of this chapter, IUOE apprentices perform as oilers on the job, but much of related instruction is designed to teach apprentices the skills they will need as journeymen. Only some of the skills required to be an oiler are required to be a journeyman. Since a part of related instruction course materials relate to future work tasks as journeymen, their value does not become apparent until the apprenticeship has ended. These results should not be interpreted to mean related instruction has little value, but that it probably does not have a great deal of immediate value for an oiler. Related instruction does not appear to affect the apprentices' performance as oilers, but then, its primary function is not to train oilers. We might infer that a minimum amount of knowledge provided in related instruction is necessary to work as an apprentice or journeyman, but additional knowledge, as measured by grades, did not increase the hours worked by an apprentice. Under this condition, if all apprentices achieve the minimum level, one would expect grades to be unrelated to hours worked.

CHAPTER 4
RELATED INSTRUCTION IN THE ELECTRICAL TRADE

Description of the Trade

In the Boston area, the International Brotherhood of Electrical Workers (IBEW) has a total membership of approximately 2,100. About 1,800 of these electricians work in construction with the remainder employed in service and maintenance capacities. Using U.S. Census data, we estimated that two-thirds of the construction electricians in the Boston area are IBEW members. Construction electricians are most frequently assigned electrical work in new high-rise, commercial and industrial buildings. Electrical work in new single-unit housing, on the other hand, is done primarily by the unorganized sector.

Electrical tradesmen may serve as journeymen, foremen, or as contractors according to age, specialization, and training background. Furthermore, union electricians are employed by firms of all sizes.

Development of Apprentice Training and Related Instruction

Until 1947, apprentices were indentured directly to the local union. In that year, the employers and the union on the national level cooperated in forming an organization now called the National Joint Apprenticeship Training Committee, consisting of twelve members appointed by the president of the IBEW and twelve appointed by the National Electrical Contractors' Association. The expressed purpose of this committee was to shift indentureship from exclusive local union control to joint control. Nevertheless, the local union in Boston maintained control of apprenticeship until 1963 when a joint committee of union and employer representatives was established. Its primary responsibility was administering the local apprenticeship program including entrance exams.

Related instruction as an aspect of electrical apprenticeship in Boston followed a similar pattern of development to apprentice training itself. Related classwork was offered by the local until 1947 at which time the joint committee assumed the role of program coordinator. Until this time, instruction was not standardized among locals with respect to subject matter, depth or quality. With the centralizing of training, a national curriculum was developed. More than 90 percent of the local joint committees,including Boston, now use the National Training Program devised by the National J.A.T.C.

Existing Entrance Requirements for Apprentice Training

According to the local apprentice coordinator, there are four qualifications for entering the apprentice program:

1. The applicant must be between the ages of 18 and 24. This requirement applies only to those individuals new to the trade. Applicants with prior electrical experience in a non-union shop that has been organized, for example, face no such restriction. Adjustment of the age requirement for years in full-time military service is also made.

2. Applicants must perform satisfactorily on an entrance examination (the GATB) administered by the Division of Employment Security.

3. Applicants must have a high school diploma. Those applying for the 1972-1973 academic year were required to have one year of high school

algebra. The General Equivalency Degree is no longer acceptable for entrance into the union. (In addition to these formal educational minimums, it is preferred that applicants have general science, physics, and some shop training.)

4. All applicants who successfully complete the entrance exam must be interviewed to determine motivation and ability to perform the work. The latter is measured by the applicant's health record and experience.

Related Instruction Classes

Related instruction classes were held in Boston public schools until the academic year 1971-1972, when they were transferred temporarily to the union's facilities. The shift resulted from the insistence of the State Division of Occupational Education that apprentices attend classes in their home communities. According to State law, if a community does not offer a course, residents can attend it in another community, which then is reimbursed by the first - communities with their own classes did not want to pay Boston. The Joint Committee was disturbed that the resulting fragmentation would destroy the program's standardization,and continuity, and the ability of the Apprentice Coordinator to supervise instruction and attendance. When State law was amended to explicitly permit what had been done up to 1971-1972, related instruction returned to the Boston public schools in the fall of 1972, until the end of the 1973-1974 school year. However, the JATC decided to run its own classes after the 1973-1974 school year, because of the increasing need to provide manual classes, especially in motor controls. Manual classes do not qualify as reimbursable related instruction under state and federal law. In addition, the public schools lack the necessary equipment. The decision of the JATC to conduct its own classes indicates the importance the union and the contractors place on related instruction.

During the academic year 1971-1972, each apprentice attended school four hours a week on one evening; the four hours were divided into two classes. First-year apprentices attended classes on Friday, second-year apprentices attended on Tuesday night, etc. When related instruction classes were held in one of the Boston public schools, apprentices attended two evenings each week for three hours each evening. Again, each evening was divided into two-class periods. (See Table 1 for the list of the related instruction courses given in 1971-1972.)

Union View of High School Programs

The union believes that related instruction is necessary because relatively few apprentices have taken an electrical program in vocational high schools. Charlestown High, Medford Vocational and Boston Trade are the major sources of vocational school graduates accepted into the apprenticeship program. On the whole, vocational school graduates do not have a significant advantage over graduates of academic high schools. Initially, vocational school graduates, according to the apprentice coordinator, have a better understanding of the trade and better mechanical skills.

There is a drawback, however. Historically, trade and vocational school graduates have had trouble with the math and theory taught in related instruction.

TABLE 1
IBEW RELATED INSTRUCTION

CURRICULUM 1971-1972

Four Year Outline

A. First Year

1.	Orientation and job information	18 2-hour lessons
2.	Math	06 2-hour lessons (national curriculum) 12 2-hour lessons (local curriculum)
3.	Theory	22 2-hour lessons
4.	Code and Blueprint	18 2-hour lessons (residential blueprints)

B. Second Year

1.	Job Information	18 2-hour lessons
2.	Code	18 2-hour lessons
3.	Theory	18 2-hour lessons
4.	Math	02 2-hour lessons
5.	Blueprints	18 2-hour lessons (commercial blueprints)
6.	Parliamentary Procedure	02 1-hour lessons (first hour by students presentation)

C. Third Year

1.	Theory	18 2-hour lessons
2.	Blueprints	18 2-hour lessons (industrial blueprints)
3.	Job Information	20 hours (class length not specified)
4.	Code	18 2-hour lessons
5.	Motor Control	18 lessons (class length not specified)

D. Fourth Year

1.	Job Information	18 2-hour lessons
2.	Electronics	18 2-hour lessons
3.	Blueprints	18 2-hour lessons
4.	Shop Electronics	18 2-hour lessons

It is the union's opinion that vocational schools are limited in the amount of preparation they can provide, because the goal of these schools is to make students employable. They train for a broad range of jobs, but not in depth. In addition, it is maintained that the quality of the courses is low. The JATC has the luxury of training for "one specific job." The vocational schools also do not have the money to teach everything that is necessary, although the new regional schools have better equipment.

Coordination of Related Instruction and On-the-Job Training

There is, of course, a desirable sequencing of on-the-job tasks with related instruction classwork that would facilitate the learning process. Such coordination is difficult to achieve in practice, however, because of production schedule requirements. Coordination would impose, in our opinion and in the opinion of the industry, costs in excess of any gains.

As a result, on-the-job training is systematic only to the extent that production schedules permit. The first-year apprentice performs unskilled work helping the journeymen, occupied with housekeeping, material hauling, and coffee fetching. During this time, his training consists of familiarizing himself with the demands of journeymen and supervisors, and learning the discipline of the job-site routine. In class he is learning the trade fundamentals of wiring, insulators, and math.

The second and subsequent years see progressive growth in apprentice job-site duties and responsibilities, while related classwork becomes more complex and sophisticated. Nevertheless, the inability to coordinate work in class and on-the-job continues.

Apprentices have work cards on which they note their daily work assignments. The card must be turned in to the apprentice coordinator each month, who uses the card to see if apprentices are receiving training in all phases of the trade. If the coordinator finds that an apprentice is not receiving varied assignments on the job, he calls the contractor or the foreman and requests that the apprentice be shifted to another job task. Its purpose is primarily to promote as full an exposure as possible to all aspects of the trade. However, this does not achieve coordination, nor was its intent to do so.

During training, the apprentice's wage rate rises from 40 to 80 percent of the journeyman's rate. Five percent increases are given at six-month intervals. The apprentice must maintain a 90 percent rate of attendance at related instruction in order to receive them. Because of these costs, employers believe it is imperative to get as much production work from the apprentice as they can. There are enough unskilled tasks in the job of the electrician to use apprentices profitably.

Data Sources

The analysis of the related instruction program in the electrical trade draws on personal interviews with a random stratified sample of 73 apprentice electricians of the IBEW, apprenticeship records, and a mail questionnaire sent to journeymen electricians in the Boston area.

It should be recalled that it was impossible to stratify the sample of journeymen to insure that we had included both journeymen who have had formal apprenticeships and those who have not. The List of Licensed Electricians used to draw the sample of journeymen electricians did not identify union and nonunion journeymen, or those not having a formal apprenticeship.

Findings from Apprentice Interviews

The mean number of years of formal education of the apprentices interviewed was 12.0. Nearly all were high school graduates.

The type of high school programs from which they graduated is diverse: 28.8 percent graduated from vocational high schools; 24.7 percent from general education programs; 42.5 percent from college prep programs; and 4.1 percent from co-op programs. The fact that the highest percentage graduated from college prep programs may indicate a relatively high level of academic achievement. College prep programs tend to be more rigorous in academic subjects such as English and math than co-op, vocational, or general education programs.

About one-fourth (24.7 percent or 18) of the apprentices graduated from high school electrical programs. It is possible in the Boston area to receive high school training in the electrical trade either in a vocational or a co-op school. A large majority of the graduates of the vocational or co-op schools had taken the electrical curriculum. The large percentage of apprentices from college prep programs may indicate a desire by the JATC for a strong academic background.

In addition to the 24.7 percent who graduated from a high school electrical program, there were 16.4 percent (12) with post high school training in the electrical trade at a trade or technical school. These two groups overlap to some extent. Seventeen apprentices (23.3 percent) had vocational training only, and one (1.4 percent) had both vocational high school and post high school training in the electrical trade. A large percentage of apprentices (39.7 percent) thus had course work similar to that currently presented in related instruction.[1] This is even more apparent when one considers the fact that related instruction classes are often taught by vocational high school teachers. An overlap of material and interchange of techniques between vocational high school and apprenticeship classes is inevitable.

Despite the large number (29) who had some form of classroom training in the electrical trade, only two had received some credit towards the term of their apprenticeship. These two had the length of their apprenticeships shortened because of prior training. They had been working as apprentices in a nonunion shop when it was organized, and this probably was the reason for the credit.

1. Of the 73 apprentices, 17 only had an electrical program in high school, 11 had such a program only after high school, and one had both.

The average age of the apprentices interviewed was 24.0 years. The mean age at which they decided to become electricians was 18.5 years. Their fathers' education level on average was 10.6 years, and 30.1 percent of the fathers were in the electrical trade. Also 30.1 percent stated that they had decided to enter the trade prior to high school graduation. However, only six apprentices (8.2 percent) decided to become electricians while still in high school and also had fathers in the trade.

When asked who influenced them most in their decision to enter the trade, the following responses were given: 54.8 percent stated that a parent or relative had influenced them most; only 2.7 percent specified a friend. Nearly two-fifths (38.4 percent) stated they had been influenced by some source other than the above. The most common response from this group was that the decision had been reached without outside influence (i.e., self influenced).

A large portion (about one-third) had made an early career decision to enter the trade (i.e., made their decision while still in high school). This was the result of having a relative or friend in the trade who influenced their decision, or made them aware of the opportunities in the trade and in apprenticeship. Again, this may reflect the lack of an adequate information system to inform other qualified individuals.

In our discussions with apprentices, it appears that many of them had tried to get into the program before. Failing this, they took a nonunion job, a trade-related job, and/or went to post high school or technical school and waited for an opening in the union apprenticeship program. The reasons many did this were higher wages and less seasonal unemployment in the union sector.

In addition to those individuals who had received formal classroom training, 33 or 45.2 percent of the apprentices had trade-related full-time jobs prior to their entrance into the apprenticeship program. Of this group, 13.7 percent (10) also had high school training in the electrical trade and another 13.7 percent (10) had post high school training in the trade.

We thus have three sets of apprentices: those with high school training in the trade, those with post high school training, and those who had full time trade-related jobs. Taking into account individuals who are in more than one set, the result is that 42 people have had some exposure to the trade either in formal classroom work or in trade-related full-time employment prior to entering apprenticeship; in fact, 20 have had two or more of these types of experiences. Thus, 57.5 percent have had some form of previous classroom experience in the trade or trade-related employment.

We also asked a series of questions to determine why the apprentices entered the trade and how valuable they considered related instruction. While the answers to these questions are subjective, we believe that the perceived value of related instruction is important. It is a factor in the apprentices' decision to make the sacrifice in terms of time and effort to complete the course work.

The most frequent response to the question "Why did you enter the trade?" was that the apprentice liked the type of work. This response was given by 37 apprentices or 50.7 percent, while another 18 or 24.6 percent, gave high wages as their reason. The remainder answered: had no where else to work (8.2 percent); family influence (6.8 percent); job security (5.8 percent); and either not afford or did not want to go to college (2.8 percent).

A large majority of the apprentices (82.2 percent) believed that related instruction is very valuable in learning the trade. Almost 10 percent believed it was valuable, 6.8 percent thought it was somewhat valuable, and only 1.4 percent believed that it was not valuable at all. While 42.5 percent of the apprentices stated that the penalty was an important reason for attending related instruction classes, 89.0 percent said they would attend even with no penalty, but they would have a higher number of absences.[1] Only 15.1 percent thought they could be as good a tradesman without related instruction.

Most apprentices (87.7 percent) believe that material learned in related instruction (particularly blueprint reading and math) also would be useful if they ever decided to leave the trade. This feeling that what they were learning had some broader application is probably an additional reason for their judging related instruction as desirable.

Our evaluation of the course material is that the math content is equivalent to high school algebra and to some high school trig. Math and theory were the courses most often rated as being the most difficult. In support of our evaluation, 67.1 percent of those interviewed stated that they would have understood the material had it been presented in high school. The most frequent qualification was that in high school they were not motivated to learn the material.

The quality of instruction appears high. While most of the teachers are journeymen who work in the trade, the math and theory courses are taught by vocational high school instructors who are also journeymen. The students' evaluation of the quality of instruction was uniformly high. All said that the instructors were well prepared and up-to-date on current practices in the trade, and all but one stated that the instructors explained the material clearly.

Course material is usually presented in lectures with demonstrations. Also some portion of class time may be devoted to doing workbook type assignments. In addition, the electrical program had a shop course which third- and fourth-year students attended. The most frequently given suggestion for improving related instruction was to include more shop or manipulative courses in the curriculum. This implies that apprentices do not receive all of the necessary manipulative training at work, and want more of it in related instruction.

In attempting to determine the relationship between related instruction and on-the-job training, we asked apprentices whether there was systematic training on the job. Only about one-third (34.2 percent) responded that they believed there was systematic training. Data gathered from union records indicate that there probably is not systematic on-the-job training. This will be discussed in a later chapter. Most apprentices believe that they were assigned to jobs on the basis of the type of work available and that there was no plan to task assignments.

In addition to the question of whether there is systematic training on the job, we asked apprentices if they were kept on some types of work

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1. The penalty can range from a reprimand to dismissal.

longer or shorter than was necessary to learn the skills required to perform the job. A large portion (69.9 percent) responded that they were kept on some types of work too long, and 58.9 percent responded that they were kept on some types of work too short a time. Again, this lends support to the contention that on-the-job training is haphazard. The work assignments depend upon market forces (i.e., the product mix at any point in time) and the job site to which the apprentice is assigned. The employer and not the individuals responsible for apprentice training determine the site at which the apprentice will work.

The lack of systematic training on the job and of direct control by the apprentice coordinator over job assignments indicates a situation in which coordination between on-the-job training and related instruction is difficult to achieve. If coordination is achieved, it is coincidental. The fact that manipulative classes are taught in related instruction, indicates the inability of on-the-job training to adequately provide all of the manual training needed by the apprentice.

Our assessment is that related instruction and on-the-job training are not coordinated and that on-the-job training is not systematic. Because of the large number of apprentices with prior work and/or classroom experience, it does seem that part of related instruction is repetitious for some apprentices. Many, however, believed that the repetition was desirable because they had either not learned the material before, or had forgotten it.

Findings from Apprenticeship Records

We are assuming here that the number of hours worked by an apprentice is a measure of the apprentice's ability to perform on the job. This follows from the assumption that firms are profit maximizers and as such will choose the most productive workers.

The data used in this section include hours worked, number of employers for whom the apprentice worked, and grades in related instruction. These data are annual and are for apprentices in their second, third and fourth years of apprenticeship. The first-year apprentices were omitted because a full year's data were not available for them.

The data were gathered for each active apprentice. The total population of the universe was 251, distributed into 116 second-year, 113 third-year, and 22 fourth-year apprentices.[1]

The dependent variable used in all equations below, was percent of "full-time" employment. "Full time" was defined as the number of days the apprentice could have worked had he worked five days a week including holidays. We used percent of "full time" because: (1) We wanted to compare difference in employment of apprentices in the same year of apprenticeship who may have had different starting dates, and (2) we wanted to compare apprentices in different

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1. Differences between the universe size here and in Chapter I, are due to graduations and dropouts.

years of apprenticeship. Apprentices who worked overtime, Saturdays, Sundays, or holidays, could have had more than 100 percent employment.

The number of employers for whom the apprentice worked was divided by the year of apprenticeship to give the average number of employers per year. This eliminated a potential bias in that the number of employers should rise with the years of apprenticeship; if we had used for the absolute number of employers as a variable, it would have contained some element which was a function of years of experience.

Since we gathered grades for each year of related classes, we averaged the grades to determine an average grade for all years completed.

The following are the equations and results of the model.[1]

$$DW2 = k_2 + a(Nem\ 2) + b(G2) \qquad n = 116 \quad (1)$$

$$DW3 = k_3 + c(Nem\ 3) + d(G3) \qquad n = 113 \quad (2)$$

$$DW4 = k_4 + e(Nem\ 4) + f(G4) \qquad n = 22 \quad (3)$$

$$DWS = k_s + l(Nems) + m(GS) \qquad n = 251 \quad (4)$$

Where:

DW2 = Percentage of full time employment in second year by second-year apprentices

DW3 = percentage of full time employment in third year by third-year apprentices

DW4 = percentage of full time employment in fourth year by fourth-year apprentices

DWS = combined variable DW 2, DW 3, and DW 4 (all years used together)

Nem 2* = total number of employers for whom second-year apprentices have worked

Nem 3* = total number of employers for whom third-year apprentices have worked

Nem 4* = total number of employers for whom fourth-year apprentices have worked

Nems = combined variable of Nem 2/2, Nem 3/3, and Nem 4/4 (total number of employers divided by years of apprenticeship)

G2 = average related instruction grades for second-year apprentices

G3 = average related instruction grades for third-year apprentices

G4 = average related instruction grades for fourth-year apprentices

GS = combined variable for G2, G3, and G4 (all years used together).

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1. Number of employers shown in Nem 2, Nem 3, and Nem 4, are not divided by years of apprenticeship, but the combined variable for all years Nems is. This was not necessary because equation (1), (2), and (3) each refer to a single year of apprenticeship.

* Number of employers shown in Nem 2, Nem 3, and Nem 4, is not divided by [years] of apprenticeship, but the combined variable for all years, Nems, is.

Variable	Range	Mean	Standard Deviation
Number of employers year 2 apprentices (Nem 2)	1-4	1.49	.72
Number of employers, year 3 apprentices (Nem 3)	1-7	1.95	1.34
Number of employers, year 4 apprentices (Nem 4)	1-9	2.27	1.98
Average number of employers per year, for all apprentices (Nems)	0.25-2.34	0.69	.41
(Combined and divided by year of apprenticeship)			
Grade, year 2 apprentices (G2)	39.05-96.0	79.11	8.25
Grade, year 3 apprentices (G3)	47.34-94.0	80.43	7.54
Grade, year 4 apprentices (G4)	55.75-97.0	75.86	11.48
Percentage - employment, year 2 apprentices (DW2)	0.52- 1.21	0.93	0.09
Percentage - employment, year 3 apprentices (DW3)	0.60- 1.11	0.93	0.07
Percentage - employment, year 4 apprentices (DW4)	0.81- 1.07	0.93	0.05
Percentage - employment years (DWS) 2, 3, 4 combined	0.52- 1.21	0.93	0.08

These data were used to estimate equations for each year and then for all years combined. The following results were obtained:

Coefficient (Variable)	Value of Coefficient	Standard Error	t-Stat
k_2	0.590	0.078	7.603
a (Nem 2)	- 0.009	0.011	- 0.877
b (G2)	0.005	0.0009	4.816
k_3	0.683	0.071	9.606
c (Nem 3)	- 0.010	0.005	- 2.103
d (G3)	0.003	0.0008	3.838
K_4	0.814	0.085	9.610
e (Nem 4)	- 0.003	0.006	- 0.531
f (G4)	0.002	0.001	1.513

(Continued)

Coefficient (Variable)	Value of Coefficient	Standard Error	t-Stat
k_s	0.668	0.047	14.240
l (Nems)	- 0.022	0.011	- 1.954
m (GS).	0.003	0.0005	6.180

Sample size = 73

Corrected R^2	equation 1 (year 2) =	.078
	equation 2 (year 3) =	.153
	equation 3 (year 4) =	.009
	equation 4 (all yrs.)=	.149
F Ratio	equation 1 (2/113) =	12.555
	equation 2 (2/110) =	11.724
	equation 3 (2/19) =	1.599
	equation 4 (2/248) =	23.564

Equation 1, 2, and 3 are separate regressions for years two, three, and four, respectively. All of the coefficients of grades are significant at better than the .05 level except for the fourth year. It is significant, however, at the .10 level.

One would hypothesize that the higher an apprentice's grades, the better his on-the-job performance and thus the higher the percentage of full-time employment.[1] In all four regressions, the sign of the coefficient for grades is positive, which supports this hypothesis.

In addition, we would expect the coefficient for number of employers to be negative for two reasons. First, individuals may lose work time as a result of changing jobs. Second and more important, poorer workers probably experience more involuntary unemployment. This would also be true of journeymen.

In our conversations with the apprentice coordinator and our interviews with apprentices, it did not seem that apprentices voluntarily move to get more well-rounded training. Apprentices preferred the security of remaining with one employer and employers attempted to keep the better apprentices. Thus, while we recognize the limitations of our interpretation, we believe high turnover does indicate poorer skills.

The coefficient for number of employers was significant (at the .05 level) for the regression for the third-year apprentices (equation 2) and for the

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1. We, of course recognize that grades may reflect "native intelligence" as well as acquired knowledge.

combined group (equation 4). Thus as a group, we can say that the number of employers for whom the apprentice worked is a significant predictor of employment.

In an attempt to improve the predicting power of equation 4 (the combined group), we tried a number of other forms. These included substituting for course grades a dummy variable whose value was 1 or 0, depending upon whether the course grade average was above or below a certain level, a dummy variable times course grade, and the course grade squared. The best results were obtained from the following equation:

$$DWS = k + a(GS) + b(GS)^2 + c(Nems)$$

The following results were obtained:

Coefficient (Variable)	Value of Coefficient	t-Stat
k	0.193	1.039
a (GS)	0.017	3.354
b $(GS)^2$	- 0.00009	- 2.676
c (Nems)	- 0.026	- 2.329

Corrected R^2 = 0.170

F Ratio = 18.467 (3/247)

We have increased the predictive power of the model, and the t statistic indicates that the coefficients are significant at the .005 level. The model indicates that there are positive but decreasing benefits to higher related instruction grades (up to the maximum grade of 100 percent). In addition, the model shows that employment declines for apprentices who change employers more frequently.

The low R^2, however, indicates that the variables which we have included only explain a modest portion of the variation in employment among individual apprentices. There is strong reason to believe that the variables which are omitted will not affect the signs nor the level of significance of related course grades. The omitted variables include the quality of on-the-job training, and a variable which measures the apprentice's access to job information and to jobs.[1]

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1. If these variables adversely affected only those people with higher grades, then we would possibly expect a lower significance and a change in sign.

Summary

The model does lend support to the view that related instruction is important in imparting skills to electrical apprentices. It also shows that the knowledge gained in related instruction is subject to decreasing marginal returns. We tested the relationship between the amount of work apprentices received, and their grades in related instruction; and the relationship between work received and the number of contractors for whom they worked. The higher the grade, the more hours worked. However, the apprentices who changed jobs frequently worked fewer hours.

CHAPTER 5
RELATED INSTRUCTION IN THE MACHINIST TRADE

Description of the Trade

"The functions of general machinists may be broadly characterized as production of parts, sub-assemblies, and assemblies which may either become parts of finished products or replace broken parts. Machinists use the entire range of machine tools, such as lathes, milling machines, drills, grinders, and shapers."[1]

Machinists find employment in a wide range of industries. Our sample reflects this diversity. The size of the firms in the sample ranges from four employees to several thousand.

Unions are not widespread in this trade in the Boston area. It is the large national craft unions in the two construction trades examined which have provided an institutional framework upon which to build standardized centrally administered apprenticeship programs. This missing element in the machine trades is reflected by the variation in standards, procedures, goals, and effectiveness of apprenticeship among the firms sampled. This diversity will be examined below.

Of the 18 firms in our sample only two had no apprenticeship programs. Of the remaining 16, eight did not require related instruction and most of these eight were small firms (mainly job shops).

Sources of Apprentices

Among both large and small firms which train apprentices, one important source of applicants has been local trade and vocational high schools, though several also depended upon newspaper advertisements and referrals by their own employees. However, two large employers recruit apprentices exclusively from within their companies. These firms enjoy two advantages from a human capital standpoint with this policy. First, each firm is providing an incentive to their workers because apprenticeship offers the opportunity of upward mobility. Workers who become apprentices do not suffer a cut in wages. Second, the employer has the benefit of training a known worker, one whose performance has been monitored for some time. On the basis of past experience, the employer can select apprentices who appear to have the high chances of success. Moreover, by using internal promotion, these firms minimize the possibility of losing trained employees.

Four small firms depend upon employee referrals or word of mouth to hire apprentices. Only one of these requires related instruction. Another firm had recruited apprentices from local trade and vocational schools but found the applicants had little aptitude for mechanical work and were poorly prepared in trigonometry and use of measuring instruments.

Only two firms made use of the State Employment Service. In addition, another firm had used it in the past but found service unsatisfactory. Applicants referred by the State Employment Service did not meet the firm's hiring standards.

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1. U.S. Department of Labor, Manpower Administration, Manpower Research Monograph Number 20, Toward the Ideal Journeyman, Volume 3, Apprenticeship Training in the Machinist and Tool and Die Maker Trades, page 1.

A summary of findings regarding sources of apprentices and hiring qualifications appears in Table 1.

Hiring Qualifications for Apprentices

The standards by which prospective apprentices are selected are as varied as the sources from which they are chosen. Again, in general, the formality of the qualifications breaks along lines of firm size with larger firms imposing the more restrictive hiring standards. Two notable exceptions exist. One of the largest employers of machinist apprentices had substantially reduced its educational requirements to avoid discrimination in hiring. The standards previously had required a high school diploma. The second exception is a small firm, with comparatively rigid age and test standards.

All large firms except one demanded the applicant to be a high school graduate, while only one small firm made such a stipulation. In addition, several firms, regardless of size, used extensive interviews and aptitude tests.

The dilemma of most machining firms attempting to attract and train qualified workers is the product of two conflicting forces. Young people are the most likely source of untrained talent, but tend to be a poor investment because of their high rate of job turnover.

Program Standards

As noted on Table 2, many of the characteristics of apprentice programs of our sampled firms are similar within size classes. Related instruction, for example, is required of apprentices in most large firms (more than 100 employees) and optional or even unnecessary in the view of many small firms.

Exceptions to this rule exist, however. One firm with only 55 employees required related classroom instruction and in addition had vestibule training. Among the eight firms not requiring attendance at related instruction classes, four were indifferent as to whether their apprentices attended. One, for example, conducts its training on the job in a traditional master-apprentice relationship and does not use classroom training.

Five firms conducted their own classes in the plant for the entire apprenticeship period. A sixth sent the second-through fourth-year apprentices to a local post secondary technical school, while conducting in-plant classes for first-year apprentices. Training officials with this firm regarded the first training year as an extension of high school skills and background. It felt that vocational high school programs were not rigorous enough, and sought to augment them by its own courses.

All other firms requiring or advising some related instruction training sent apprentices to evening courses in local high schools. In many cases, especially among smaller firms, the choice of courses was left to the individual apprentice. In one such firm, for example, the apprentice had to satisfy the company's requirement of two related courses per semester for a total of 144 hours annually.

Few firms, again only the largest, required a fixed number of class hours annually for apprentices, and in such cases, the greatest number of hours were required in the earliest years. Firm 10, which only recommended related instruction

TABLE 1. Characteristics of Apprentice Programs by Firms

Company	Related Instruction Mandatory	Source of Apprentices	Hiring Qualifications for Apprentices	Year of Program's Origin
1	*	Hires experienced journeymen	None	*
2	No	Newspaper ads, employee referrals	No specific qualifications, demonstrate motivation	1964
3	Yes	Ads, high schools	No qualifications at present, previously, high school diploma, 18 years of age	1930
4	No	Newspaper ads, word-of-mouth	No specific qualifications; demonstrate manual ability	1968
5	Yes	Vocational high schools	Pass aptitude test, interview	1971
6	Yes	High schools	High school diploma, or GED, entrance exam	1903
7	Yes	Vocational high schools, post secondary technical schools	High school graduate	1959
8	Yes	BAT recommendations, vocational high schools	Pass BAT exam, 18-25 years, high school graduate, prefer machine course in high school	1964
9	Yes	Co-op high school, employee referrals, DES	No specific qualifications, demonstrate manual ability	1968
10	No	Vocational high schools	No specific qualifications, demonstrate mathematical aptitude	1969
11	No	Vocational high schools	No specific qualifications	1923
12	No	National Tool, Die and Precision Machining Association pre-apprentice program	No specific qualifications, interview for motivation	1951

* No training program

(Continued)

TABLE 1. Characteristics of Apprentice Programs by Firms

Company	Related Instruction Mandatory	Source of Apprentices	Hiring Qualifications for Apprentices	Year of Program's Origin
13	No	Employee referrals	No specific qualifications, prefer trade or vocational high school graduates	1965
14	Yes	Internally, openings posted	Extensive interviewing	1967
15	No	Local vocational school, co-op high school students	No specific qualifications, mechanical aptitude	1944
16	*	Recall of laid-off workers	None	*
17	Yes	Internally, openings posted	Must be 18 years of age and submit to interview; must be employee of firm	1957

* No training program

had no fixed hour requirement and made little attempt to monitor an apprentice's curriculum or performance. In addition, the length of apprenticeship was given as four years, but the actual duration varied with individual ability. The employer was aware of the state's prescribed 150 hour annual minimum, but little effort was made to comply with it.

A second firm had a similar attitude toward fixed classroom exposure for its apprentices. Like firm 10, its prescribed apprentice term was variable, but unlike firm 10, it expected to train its apprentices in less than two years. This firm needed men trained to specialize in the operation of a single type of equipment necessitating less broadly-based training and more intensive exposure to one operation.

The prevailing opinion among the sample firms regarding the tenure of apprenticeship is that four years is the preferred length. Three firms had programs of less than four years' duration, while two had programs of variable lengths.

Firm 15 placed little or no emphasis on related instruction in its training program. The program's length, two to three years, was determined by the individual's capacity to learn by observing machining operations. Company officials cited the heavy expenses of formal training as a factor in both the shortened program and the lack of active training efforts.

As seen from Table 2, blueprint reading was the most frequently required or recommended course among these firms. In fact, where a firm recommended a specific course, it was blueprint reading.

Among the three mathematics courses traditionally considered important to all-round machinists, trigonometry was the one most commonly required or recommended. Presumably, apprentices were expected to have taken algebra and geometry in a full-time high school program, and most employers were unwilling to review such material because of the time involved. Trigonometry, being of a more sophisticated nature, was seldom a part of an apprentice's high school preparation but was necessary to his training as a machinist.

Finally, Table 2 indicates that eight firms conduct on-the-job training in a systematic fashion, which implies a logical progression of learning steps from simple to complex machining operations. In four of the eight firms this systematic training was conducted in a training shop under the direction of supervisor-instructors, thus enabling the apprentice to learn progressively more intricate techniques. This permitted the firm to coordinate shop training with related classwork.

Those firms training systematically, but not using a special apprentice shop, assigned apprentices to journeymen performing the operation to be learned and rotated the apprentices throughout the shop. Firms not training systematically cited reasons such as cost, production scheduling or crucial manpower needs as factors preventing such training.

In summary, the strongest determinant of apprentice training practices in the machine trades was firm size. In general, the larger firms required attendance at in-plant related instruction, specified the amount of class time and term of apprenticeship, as well as the courses to be taken. These firms were also of sufficient scale to sustain the costs of systematic on-the-job training.

TABLE 2. Summary of Machinist Apprentice Programs

Firm[a]	Related Instruction Required	Related Instruction Urged	Classes Held In-Plant	Classes Elsewhere	Hours of Class Time Per Year[b]	Length of Program In Years	COURSES REQUIRED OR ADVISED Blueprint Reading	Algebra	Geom.	Trig.	Mach. Theory	Is OJT Systematic
1 L	Apprenticeship program not offered											
2 S	No	Yes	No	Night Trade Sch.	NS	4	No	No	No	No	No	No
3 L	Yes	--	Yes	No	300 Average	4	Yes	Yes	Yes	Yes	Yes	Yes
4 S	No	No	No	No	NS	Variable	No	No	No	No	No	No
5 L	Yes	--	Yes	No	180 Maximum	5	Yes	Yes	Yes	Yes	Yes	Yes
6 L	Yes	--	Yes	Night Trade Sch.	150 Average	4	Yes	Yes	No	Yes	No	Yes
7 L	Yes	--	Yes (yr 1)	Yes (yrs 2-4)	170	4	Yes	Yes	Yes	Yes	Yes	Yes
8 S	Yes	--	No	Night Trade Sch.	144	4	No	No	No	No	No	No
9 S	No	No	No	No	NS	Variable	No	No	No	No	No	No
10 S	No	Yes	No	Night Trade Sch.	NS	4	No	No	No	No	No	No
11 S	No	No	No	No	NS	4 to 5	No	No	No	No	No	No
12 S	No	Yes	No	NTD & PMA	NS	4	Yes	No	Yes	Yes	No	Yes
13 S	No	Yes	No	Night Trade Sch.	NS	Less than 2	Yes	No	No	Yes	No	No
14 L	Yes	--	Yes (during Working Hours)	No	390	1	Yes	Yes	Yes	Yes	Yes	Yes
15 S	No	No	No	No	NS	2 to 3	Yes	No	No	No	No	No
16 L	Apprenticeship Program Not Offered											
17 L	Yes	--	Yes	No	120 to 390	4	Yes	Yes	Yes	Yes	Yes	Yes

a L means large firm of over 100 employees.
S means small firms.
b NS means no specific number.

As noted, exceptions to this conclusion existed. The smaller firms adopted a more casual attitude toward training due to their lack of flexibility and resources, leaving more of the responsibility for training to the initiative of the individual. In addition, smaller firms anticipated a higher turnover rate among employees.

Findings from Apprenticeship Interviews

The data for this section were gathered by personal interviews with machinist apprentices. We randomly selected firms in the Boston area which had machinist apprenticeship programs, and then randomly selected apprentices from each of these firms. The total sample was 63 apprentices.

The sampled apprentices averaged 11.8 years of education, and they had attended the following high school programs:

Vocational education	45.2%
General education	24.2
College prep	17.7
Co-op	1.6
Other	11.3

In the Boston area it is possible to receive machinist training in either a vocational high school or in a co-op high school program, and 37.1 percent of our sample graduated from a vocational high school machinist program. The remainder (8.1 percent) of the vocational high school graduates was not from a machinist program.

The mean age of the apprentices interviewed was 25.0 years. The average number of years between the time they took their first full time job (before entering apprenticeship) and the time they entered the apprenticeship program was 3.8 years. While 24.2 percent had fathers in the same trade, 53.2 percent decided to enter the trade when still in high school. Only 9.7 percent who had a father in the trade made this early decision. The apprentices' responses on who influenced them most to enter the trade were as follows:[1]

Parent or relative	27.4%
Friend	14.5
Advice from vocational high school	19.4
Advice from general high school	6.4
Advice from co-op high school	0.0
Advice from state employment office	1.6
Other	35.5

The major explanation under "other" was that the decision was purely the apprentice's and that no one had influenced him.

One third of those who had had a machinist program in vocational high school received credit toward their apprenticeship. This is a higher proportion

1. The sum of these percentages exceeds 100 percent because a small number of individuals indicated multiple influences.

than in the two other trades studied. Apprentice credit involves a reduction in the term of their apprenticeship and/or hours of related instruction, or additional credit towards admission.

In addition to the high school training, 24.2 percent had post high school technical training in the machinist or closely related trade. Before becoming apprentices 60 of the total sample (96.8 percent) had had full-time jobs which were trade-related, indicating a high level of both classroom and on job experience before entering apprenticeship.

When asked why they entered the machinist trade, almost two-thirds (63.4 percent) entered the trade because they liked the nature of the work, 13.3 percent wanted the security of the trade, and 15.0 percent had no where else to work. There were few responses to other reasons for entering the trade.

Obviously the dominant reason for entering the trade was that apprentices liked the nature of the work. Again this is consistent with the high proportion who had trade related jobs prior to entering apprenticeship. Apprentices seemed to have a knowledge of the nature of the work prior to entering the field.

We asked a series of questions designed to assess the apprentices' attitude toward related classes. The questions and percentages of affirmative answers were:

(a) Would you attend related classes if there were no penalty?
(Yes, 30.6 percent; no, 69.4 percent).

(b) Could you be as good a tradesman without related instruction?
(Yes, 25.8 percent; no, 74.2 percent)

(c) Would related classes be useful if you ever decided to leave the trade?
(Yes, 80.7 percent; no, 19.3 percent)

(d) Could related instruction be made more valuable?
(Yes, 69.4 percent; no, 30.6 percent)

We may conclude from these answers that related instruction does have value in learning the trade; 74.2 percent believed they needed related instruction to be a good tradesman. It also teaches them material which they believe is transferable to other occupations. The apprentices' enthusiasm for related instruction, however, is not carried over into their attitudes about attendance, since only 30.6 would attend if there were no penalty. In addition, 69.4 percent believed that related classes could be made more valuable. It seems that apprentices believe related instruction is valuable, but requires curriculum revisions.

As a cross check and also to get a more precise answer on the value of related classes, we asked apprentices to rank the value of related instruction from 1 to 4. The distribution was:

1	(not valuable)	6.8%
2	(somewhat valuable)	10.2%
3	(valuable)	18.6%
4	(very valuable)	64.4%

Thus, over 80 percent considered related instruction either valuable or very valuable. While this seems in conflict with the low affirmative response of attending class if there were no penalties, many of the latter indicated they would attend, but not regularly.

We judged the quality of instruction in related classes to be high. Over 75 percent of the apprentices stated that the instructor explained the material clearly, was up to date on current practices in the trade and was well prepared.

With reference to coordination, 80.6 percent of the apprentices believed that they received systematic training on the job. However, 51.6 percent believed they were kept on some types of work longer than necessary to learn skills, while 35.5 percent believed they were moved from some jobs too quickly. This indicates that while there is systematic training on the job, the pace at which apprentices are trained may need to be adjusted to meet some individual needs. This adjustment may be difficult because of limits imposed by the mix of tasks in a shop.

Most of the apprentices worked in firms that conducted their own classes. A number of these firms had once used the public high schools but left because of dissatisfaction with the quality and variety of the courses. In addition, firms not conducting their own classes made arrangements with private schools or else were ambivalent about requiring attendance at public schools.

Findings from Special Study

We could not obtain data from company records for machinist apprentices which were comparable to the data gathered from JATC records for operating engineers and electricians. Firms which sponsor machinist apprenticeship programs do not gather data on performance of apprentices at work. In addition, using hours worked by apprentices as a variable is not as acceptable for machinist apprentices. There is less seasonality in manufacturing; unemployment is caused by cyclical rather than seasonal fluctuations. Most apprentices work 40 hours and are attached to a single firm. The decision to retain or lay off is not as frequent an occurrence as in construction, and there is no common pool of apprentices from which the firm draws whenever it decides to hire an apprentice. Once a machinist apprentice is laid off, he may move to another firm and is less likely to be rehired.

Given that the use of hours worked is inappropriate, we decided to use data for toolmakers which were gathered from a previous study of the tool and die trade[1] to determine the impact of different kinds of training on skill level, breadth of ability, and time required to qualify as a tool maker.

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1. The data were gathered in 1966-1967.

The use of data gathered for tool makers in a study of machinists is justified because of the similarity of the trades. They perform essentially the same type of work, and in many plants the apprenticeship programs for machinists and for tool makers are very similar. Both groups take the same basic related instruction courses.

The data were obtained from a random sample of 330 tool makers in the Boston area. Each individual was personally interviewed and his supervisor was asked to rank numerically both his skill level and breadth of his ability. In the personal interview, detailed information on training path, educational experience, years in training, and years to be classified as a tool maker (paid at journeyman's rate) was obtained.

The following is a rank ordering of courses most commonly taken by the 330:

Blueprint reading	78.8%
Measuring instruments	73.0
Heat treating	67.0
Machine theory	65.8
Mechanical drawing	62.4
Trigonometry	57.9
Algebra	55.5
Tool design	54.5

Ignoring courses peculiar to tool making, all of these subjects were taken either before or during training, and if before training, usually while still in high school. If a course were taken during training, it was either through apprenticeship or independently at a trade or technical school; a high percentage of the men had had such basic subjects as trigonometry, algebra, and mechanical drawing and to a lesser degree, blueprint reading while still high school students. One exception was measuring instruments, which typically was not studied in high school.

The distribution of the total number of courses taken by each individual is as follows:

Number of Courses	Number of Individuals	Percent of Sample	Cumulated Distribution
0	12	3.6	100.0
1	24	7.3	96.1
2	19	5.6	88.8
3	17	5.2	83.2
4	16	4.8	78.0
5	23	7.0	73.2
6	20	6.1	66.2
7	32	9.7	60.1
8	22	6.7	50.4
9	24	7.3	43.7
10	33	10.0	36.4
11	25	7.6	26.4
12	27	8.1	18.8
13	19	5.6	10.7
14	8	2.4	5.1
15	6	1.8	2.7
16	2	0.6	0.9
17	1	0.3	0.3

As one can see, 50 percent of the people had had eight or more courses; only 3.6 percent had had none.

The mean number of years of formal education was 11.4, with 34.5 percent having had some form of education beyond high school. This included post high school work (at an evening program in a local high school, technical school, or college). In addition, 84.8 percent had had some form of related instruction. This, of course, does not indicate that all of these individuals had a formal apprenticeship. The distribution of individuals by major types of training was:[1]

Formal apprenticeship	22.7
Formal on-the-job training	21.2
Informal on-the-job training	46.7
Military training	1.2
Vocational high school	27.6
Picked up	22.1
Other	8.2

An individual may have had more than one form of training. The most frequent combination of training was vocational high school and informal on-the-job training (13.3 percent or 43 individuals). The next three most frequent combinations were formal plus informal on-the-job training (7.6 percent), vocational high school plus formal apprenticeship (5.8 percent), and vocational high school plus formal on-the-job training (5.2 percent). The remaining combinations of training paths constituted less than five percent of the sample.

The following regressions were run in an attempt to explain skill rating, breadth rating, the combined skill and breadth rating, years in training, years to qualify as a tool maker, and years to become competent.

$$YRT = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (1)$$
$$SR = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (2)$$
$$BR = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (3)$$
$$SRBR = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (4)$$
$$YCL = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (5)$$
$$YCT = k + a(FAPP) + b(FOJT) + c(IOJT) + d(MILT) + e(VOHS) + f(OT) \quad (6)$$
$$SR = k + a(YCL) + b(YCT) + c(CYRT) \quad (7)$$
$$BR = k + a(YCL) + b(YCT) + c(YRT) \quad (8)$$

where:

YRT = years in training
SR = skill rating
BR = breadth rating
SRBR = breadth rating times skill rating
YCL = years to qualify as tool maker
YCT = years to become competent as a tool maker
FAPP = a dummy variable equaling one if the journeyman had a formal apprenticeship (otherwise 0)
FOJT = dummy variable equaling one if the journeyman had formal on the job training (otherwide 0)
IOJT = a dummy variable equaling one if the journeyman had informal on the job training (otherwise 0)

1. Adds to over 100.0 percent because some people had more than one kind training.

MILT = dummy variable equaling one if the journeyman had military training in the machinist trade (otherwise 0)
VOHS = a dummy variable equaling one if the journeyman had vocational high school training in the machinist trade (otherwise 0)
OT = a dummy variable equaling one if the journeyman had some other identifiable form of training (otherwise 0)

The origins of each of the dependent variables are explained below:

1. Breadth and skill ratings were obtained from immediate supervisors by asking them to rate the skill of the journeyman interviewed and his breadth. Breadth was defined as his ability to perform diverse types of work.

2. Years in training was simply the length of either an informal or formal on-the-job training period. If an individual had attended vocational high school, this time was included as part of the years in training.

3. Years to qualify as a tool maker was obtained from the interview. Qualification was established by the date at which the man began to be paid the journeyman's rate. The years to qualify is the number of years in training before he received the journeyman's rate (this does not include time in vocational high school).

4. Years to become competent was also obtained from the interview. We asked the journeyman how long it took him from the time he began in the trade until he believed he was fully qualified. In most cases, this was longer than the time it took him to earn the journeyman's rate.

We may interpret equation (1) in the following way: the value of the constant is the length of time in training of the average person who had just picked up the trade. The coefficient a (formal apprenticeship) shows how much less time (because the coefficient is negative) was spent in training on the average by those who had a formal apprenticeship in comparison to those who just picked up the trade. A similar interpretation can be given for the other variables.

The following results were obtained for equation (1):

Coefficient (variable)	Value	t-Stat
k (constant)	4.878	15.589
a (FAPP)	- 0.723	- 1.848
b (FOJT)	- 0.980	- 2.572
c (IOJT)	- 0.817	- 2.624
d (MILT)	0.929	0.704
e (VOHS)	- 1.005	- 3.088
f (OT)	0.495	0.892

The coefficients for formal apprenticeship (a), formal on-the-job training (b), informal on-the-job training (c), and vocational high school (e), are significant. Vocational high school reduces average years in training by one year, formal on-the-job training by .98 years, informal on-the-job training by .82 years, and formal apprenticeship by .72 years. The coefficients of the other explanatory variables are not significant. That is, there is no difference in training time among individuals with military training, some other identifiable form of training, or those who just picked up the trade.

There were no significant explanatory variables in equation (2), which tried to explain skill rating; (3) which tried to explain breadth training; and (4) which tried to explain both skill and breadth rating. The type of training one receives does not influence a journeyman's skill rating, breadth rating, nor the combined variable , skill times breadth. There were also no significant explanatory variables in equations (5) and (6). Equation (5) attempts to explain the number of years to qualify as a journeyman (defined as the number of years to earn the journeyman's rate) as a function of the type of training received. Equation (6) tries to explain the years it took the journeyman to consider himself a competent craftsman as a function of the type of training. Equation (7) tries to explain skill rating as a function of years to qualify, years to become competent, and years in training. The only variable in equation (7) with a significant coefficient was (a), years to become competent, where (a) equals -0.015 (t-stat equals -1.65).

The only significant variable in explaining breadth rating in equation (8) is years in training. The R^2 for this equation is 1.1 percent. Years in training had a coefficient of 0.14 (t-stat = 2.13), which indicates that for each year in training the breadth rating increases by 0.14. Breadth rating was given on a scale from 1 to 7 with a mean of 3.1.

Summary

We must conclude that the training path is not significant in determining the length of time which it takes to qualify as a journeyman. Also, the training path does not affect the time it takes the journeyman to become competent (in his own judgment). The one factor which training path does affect is the years in training. This is simply a measure of the time which is required to "complete" a particular training path. However, once having completed training, he does not become a journeyman any more rapidly if he had selected one path as opposed to another. For example, a vocational high school graduate may finish his training (on average) in 3.9 years. Someone who has a formal apprenticeship may finish in 4.2 years, and someone who only picks up the trade will complete his "training" in 4.9 years. However, there is no significant difference in the number of years it will take to qualify as a journeyman or to be competent as one. That is, regardless of the type of training, it makes no difference in how long it takes to be a capable journeyman or paid as such. The type of training is irrelevant.

We also used a detailed list of courses taken by each journeyman in an attempt to predict skill and breadth ratings as a function of related courses taken. The results showed that neither skill nor breadth ratings are affected by courses or combination of courses in related instruction. Only trigonometry even approached significance.

CHAPTER 6
COMPARISON OF RELATED INSTRUCTION IN THREE TRADES

From the data presented in preceding chapters, we will make (in this chapter) comparisons among trades leading to policy recommendations in the concluding chapter.

In looking at the three trades, it is clear that entrants to each apprentice program have had quite different educational experiences. The electrical apprentices were more likely to have an academic background; 42.5 percent graduated from college prep programs, while only 17.7 percent of the machinist apprentices and 25.7 percent of the operating engineers did so. The largest single source of machinist apprentices (45.2 percent) was high school vocational programs, compared with only 28.8 percent of the electrical apprentices. It is unfair to make this comparison for operating engineers, since there is no vocational high school program in this trade. In spite of this, 24.3 percent of their apprentices graduated from vocational programs.

Of the 28 vocational graduates in machinist apprenticeship, 23 graduated from a machinist program. The other five graduated from unrelated programs. There were 21 vocational school graduates in the electrical apprenticeship program, 18 of whom graduated from an electrical program. We might speculate that the higher percentage of vocational graduates in the machinist trade is due to one of two factors or a combination of them.

First, the entrance into machinist programs is largely (or completely) under the control of the firm. Since the firm's objective is to minimize training costs, they are more likely to select as apprentices those who have had previous training (i.e., vocational high school). In the electrical trade, the union has a strong influence over entry to the program and is less sensitive to training costs. The reason why all machinist apprentices are not graduates of machine shop programs, is that employers are willing to trade off previous training for other desirable attributes.

Second, the electrical union (and firms) may believe that the intellectual requirements of related instruction and of the trade are such that they demand the type of individual who is more likely to complete a college prep program. This is not to say that applicants from other educational backgrounds do not qualify, but that a larger percentage of what they considered qualified individuals come from college prep programs.

The preference of machinist employers for previous training also shows up in the larger number of apprentices with post high school training. Nearly one-fourth (24.2 percent) of the machinist apprentices had post high school training (in trade or technical school) in the machinist trade before becoming apprentices, while only 16.4 percent of the electrical apprentices had such post high school training in the electrical trade. In addition, a much higher percentage of machinists (95.2 percent) had trade-related, full-time jobs prior to becoming apprentices than did electricians (45.2 percent).

This difference seems to indicate a greater effort or ability on the part of individual firms hiring machinists to select apprentices with prior work or educational experience. Also, it may reflect the policy of machinist employers to select apprentices internally.

In the machinist trade, a sample of 107 machinist journeymen was obtained through a mail questionnaire described in Chapter 1. Their educational backgrounds were quite similar to the apprentices interviewed.

MACHINISTS

Educational Program	Journeymen	Apprentices
Vocational	44.9%	45.2%
College Prep	18.7	17.7
General (including business)	30.8	24.2
Other	5.6	12.9

For both current apprentices and journeymen, vocational high school has been an important source of machinists. A large portion of entrants to this trade has had prior educational experience in the trade. In addition to high school experience, 24 percent of the apprentices and 15 percent of the journeymen had taken courses in the trade in post high school trade or technical school.

A lower percentage of operating engineers had attended vocational high school (14 percent) than either electricians (36.2 percent) or machinists (44.9 percent).[1] These results are consistent with the distribution of educational backgrounds of the operating engineer apprentices interviewed, but not the electrician apprentices.

ELECTRICIANS

Educational Program	Journeymen	Apprentices
Vocational	36.2%	28.8%
College Prep	13.8	42.5
General	32.6	24.7
Other	17.4	4.0

OPERATING ENGINEERS

Educational Programs	Journeymen Trained As Apprentices	Journeymen Trained as Oilers	Apprentices Interviewed
Vocational	13.2%	14.2%	24.3%
College Prep	23.7	14.2	25.7
General	52.6	47.8	41.8
Other	10.5	23.8	8.2

1. There were 196 journeyman electricians and 173 journeyman operating engineers in our sample.

Among the electricians, 42.5 percent of the apprentices had been in college prep programs compared to just 13.8 percent of the journeymen. We believe this difference results from the fact that our journeymen's sample was drawn from all licensed electricians in the area, while our apprentice sample was drawn from only the union program. The selection process of the electrician's apprenticeship program may favor college prep graduates. Only 18.0 percent of the journeymen electricians had formal apprenticeships, while 59.0 percent learned as helpers. We can see that apprenticeship has not been the major source of journeymen electricians in the Boston area. In contrast, proportionally more of the machinists (40.0 percent) said they had served apprenticeship.

The findings cast some doubt on models which try to compare hours worked by journeymen trained as apprentices and non-apprenticed journeymen. The apprentice graduate may have worked more hours even if he had not had an apprenticeship, because he had a better education before apprenticeship. In one such comparison,[1] the author did not take account of variables such as prior educational attainment, age, or years in the trade. (For instance, do more highly qualified people get in the front door or the back door?)

It appears that where there is a large nonunion sector in which labor is highly mobile, as in the electrical trade, firms are less likely to establish apprenticeship programs.

Machinists, which also have a large unorganized sector, have a higher proportion of apprentice graduates because training is more likely to occur in larger companies with their own particular skill requirements. These companies tend to be in different industries and to have well developed internal labor markets. These unique skill requirements result in specialization which makes machinists less mobile and therefore increases the likelihood that the firm will recoup its investment in training.

Of the journeymen sampled, about on-half of the machinists and about one-third of the electricians had taken some form of related instruction. The only related instruction (other than an auto or diesel mechanics course) offered for the operating engineer's trade in the Boston area, is the one sponsored by the union. This, of course, is not the case for electricians and machinists. Public vocational schools and private trade and technical schools offer courses in both fields. The operating engineers have had an apprenticeship program and thus related instruction only since 1963.

A substantial portion of the apprentices interviewed in the three trades were influenced in their decision to enter the trade by a parent or relative (57.5 percent of the electrical apprentices, 52.7 percent of the operating engineers and 31.9 percent of the machinists). Among the operating engineer apprentices, 36.5 percent had fathers in the trade, as did 30.1 percent of the electricians and 24.2 percent of the machinists. Among the journeymen sampled, 16.8 percent of the machinists, 26.1 percent of the

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1. Franklin, W. S., "A Comparison of Formally and Informally Trained Journeymen in Construction," Industrial and Labor Relations Review, July, 1973, pages 1086-1094.

electricians and 71.0 percent of the operating engineers trained as apprentices said that a parent or relative influenced their decision to enter the trade.

One reason for the higher percentage of journeyman operating engineers who were influenced by a parent or relative is that all the operating engineers were IUOE members, while machinists and electricians were both union and non-union. The higher percentage of "sons of members" in the operating engineers' trade may indicate the lack of information about the trade. Electricians are the "glamour" trade of the construction industry. They receive frequent publicity and it is well known that their wage rates are high. The operating engineers receive less publicity, and thus information about the trade may be confined to individuals who have some personal contact in the trade (i.e., from relatives). The fact that among operating engineers the percentage of apprentices was lower than the percentage of journeymen who were influenced by a parent or relative, may indicate a decline in nepotism within the union.

With one exception, the machinists, there were very few apprentices who were influenced by outside sources such as high school counsellors or state employment agencies. The exceptions among machinist apprentices were 19.4 percent, who were influenced by advice from vocational high school teachers and 6.4 percent who were influenced by academic high school teachers. The lack of outside influences in the construction trades may be due to the lack of information available to counselling groups and institutions or to a selection process which gives preference to individuals referred by personal contacts.

We conclude from our findings that personal contacts seem to be more important both as a means of disseminating information about apprenticeship and as a source of influence in decision to enter apprenticeship. This is more apparent in construction than in the machinist trade.

Individuals who enter the construction trades tend to make this decision after leaving high school. A much higher proportion of machinist apprentices made the decision to enter the trade while they were still in high school, possibly allowing them to better prepare for their career choice.

The average number of years of post high school training before entering apprenticeship was .65 years for machinist apprentices, .20 years for operating engineer apprentices, and .44 years for electricians. The average number of years between the time an apprentice begins his first full-time job after high school and the time he enters apprenticeship is 2.6 years for operating engineers, 3.1 years for electricians, and 3.7 years for machinists. The reason it took longest for machinist apprentices to become apprentices reflects the number of large firms that used internal sources to recruit apprentices, the weak labor market for machinists in the late 1960's, and the lack of upper age limits for apprentices.

Apprentices, it appears, do not enter apprenticeship immediately; during this period, the skills which they have learned in high school may be forgotten.

Machinists

In an attempt to measure the effect of related instruction, we tested in previous chapters a number of models in each of the three trades. In the case of machinists we concluded that related instruction did not reduce the time which it took to become qualified as a journeyman nor did it influence the skill or breadth rating of a journeyman. It appears that the path by which one learns the trade (i.e., whether one has a formal apprenticeship or not and also whether one has related instruction or not) makes no difference in training time or in performance.

The only effect which training path seems to have is on the years in training. Apprenticeship does reduce the time in training (as compared to just "picking up" the trade), but it does not shorten it as much as formal on-the-job training or vocational high school. It should be clear that when one leaves or finishes training one does not necessarily qualify as a journeyman. The length of time it takes someone to qualify as a journeyman is the critical factor and this is unaffected by training path.

The information obtained from the machinist journeyman questionnaires distributed through employers supported the conclusions that skill levels and length of time required to qualify as a journeyman were not affected by the type of training or related instruction. The measure of skill which was used was the tolerance which the journeyman must maintain in the machining he performs. It was assumed that the closer the tolerances the more skilled the journeyman.

We recognize that there may be two problems associated with using tolerances as a measure of skill. First this is only one aspect of skill. Speed, ability to work out problems in design, etc., also are measures of skill. Second, the tolerances which a machinist must hold are in part a function of the type of work done by the firm that employs him. The first criticism can only be countered by stating that while we recognize the limitations of this measure we believe it to be valid. It can be argued that while different firms have different types of work and therefore different tolerances, the firms which do the most highly skilled jobs probably hire the most skilled journeymen. The distribution of journeymen among firms is on this basis.

We estimated the following equations:

$$Tol = k_1 + a(VO) + b(CL) + c(GE) + d(FA) \quad (1)$$

$$Tol = k_2 + a(VO) + b(CL) + c(GE) + i(UP) \quad (2)$$

$$Tol = k_3 + a(VO) + b(CL) + c(GE) + l(RG) \quad (3)$$

$$Tol = k_4 + a(VO) + b(CL) + c(GE) + n(RI) \quad (4)$$

Where

Tol = Tolerances to which journeymen work (the lower the value, the higher the skill)

VO = Dummy variable for vocational high school program

CL = Dummy variable for college prep high school program

GE = Dummy variable for general high school program

FA = Dummy variable for formal apprenticeship

UP = Dummy variable for upgrading with no formal training

RG = Dummy variable for registered apprenticeship program

RI = Dummy variable for attended related instruction (which includes individuals who had and had not had formal apprenticeship)

In the case of all three models the only significant coefficient at the .05 level was GE, the coefficient for general education which equaled approximately .002 in each of the four equations. The positive coefficient of this variable indicates that the journeyman who graduated from a general high school program is less skilled (as we defined skilled). None of the other coefficients was significant. This indicates that there is no significant difference in the skill level for any of the major sub-groups. The sub-groups are: those who had apprenticeship versus those who did not; those who had related instruction versus those who did not; those who had registered apprenticeship versus both those who had no apprenticeship and those who had a non-registered apprenticeship; those who acquired their skills through upgrading versus those who had some kind of formal training (apprenticeship, formal on-the-job training, etc.).

The best prediction of skill level was obtained by using years in the trade as a journeyman (YT) and a dummy variable for general education (GE).

$$Tol = k + a(GE) + b(YT)$$

Coefficient	Value	t-Stat
k	.0032	3.693
a	- .00058	- 2.039
b	.0014	2.097

Sample size = 107

The results using the mail questionnaire data led to the same conclusions about related instruction as the data gathered from personal interviews in the tool and die study. Related instruction does not contribute to individual differences in skill. They also support the hypothesis that the skill level which one attains is sensitive to the type of high school background. This may be the result of having better basic skills such as math and reading. Given these fundamental skills, the machinist trade may be learned equally well in a variety of ways.

The other possibility is that while apprenticeship and/or related instruction does not affect skill levels, they may affect the length of time it takes to become a journeyman. One question which was asked in the journeyman questionnaire was , "How many years from the time you began training[1] did it take you to become an all-around machinist?" The following equations were estimated:

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1. Training was defined to include informal training and upgrading.

$$Yi = k_1 + a(RI) + b(VO) + c(GE)$$

$$Yi = k_2 + m(AP) + b(VO) + c(GE)$$

$$Yi = k_3 + n(RG) + b(VO) + c(GE)$$

$$Yi = k_4 + j(UP) + b(VO) + c(GE)$$

Where

Yi = Years to qualify as a journeyman

All other variables have been listed for the previous regressions.

None of the explanatory variables were significant as a determinant of the number of years to qualify as a machinist. Here as in the previous regressions the journeyman questionnaires support the findings of the tool and die study. Related instruction (or any other comparison by training) does not affect the training time.

It appears from these results that individuals can reach similar skill levels in about the same time period regardless of their type of training.

Electricians

Among the apprentice electricians a relationship was found between performance in related instruction and hours worked. Performance in related classes did, however, explain only a small portion of the variation in hours worked. The journeyman mail questionnaire was used to test the relationship between different types of training and weeks worked, as well as between different types of training and years to qualify as a journeyman.

The following models were estimated:

$$Y = k_1 + a(RI) + b(VOC) \quad (1)$$

$$Y = k_2 + c(AP) + d(VOC) \quad (2)$$

$$WPY = k_3 + e(YR) + h(VOC) \quad (3)$$

$$WPY = k_4 + i(RI) + l(VOC) \quad (4)$$

$$WPY = k_5 + m(AP) + n(VOC) \quad (5)$$

Where

Y = Years from time began training to time when became journeyman[1]
WPY = Number of weeks worked in 1972
RI = Dummy variable equaling 1 if had related instruction (otherwise 0)
VOC = Dummy variable equaling 1 if had full time vocational high school training (otherwise 0)

1. Time began training measured after leaving high school.

AP = Dummy variable equaling 1 if had apprenticeship, both union and nonunion (otherwise 0)

YR = Number of years of related instruction

The results were:

EQUATION (1)

Coefficient (variable)	Value	t-Stat
k_1	4.07	18.41
a(PI)	- 0.62	- 1.97
b(VOC)	- 0.79	- 2.54

R^2 = .039

EQUATION (2)

k_2	3.87	18.20
c(AP)	- 0.17	- 0.49
d(VOC)	- 0.76	- 2.45

R^2 = .021

EQUATION (3)

k_3	42.71	24.95
e (YR)	1.80	2.78
h(VOC)	0.57	0.24

R^2 = .028

EQUATION (4)

k_4	43.16	25.34
i(RI)	5.75	2.37
l(VOC)	0.23	0.10

R^2 = .018

EQUATION (5)

k_5	43.08	26.62
m(AP)	7.62	2.96
n(VOC)	0.24	0.10

R^2 = .034

Sample Size = 196

It will be recalled that equations (1) and (2) attempt to predict years to qualify as a journeyman. Equation (1) seems to be the best predictor of the length of time it takes to become a journeyman. While the R^2 is low, the model shows that related instruction shortens the time required to become a journeyman, on the average by six-tenths of a year. In addition, attending vocational high school also shortened the time by about eight-tenths of a year.[1] If a man had both related instruction and vocational high school, the time would be cut by about one and one-half years. The results are consistent with the verbal responses of many of the apprentices interviewed.

In equations (3) through (5), we have tried to explain the variations in weeks worked per year as a function of the number of years in training, whether the journeyman had taken related classes, and whether the journeyman had served an apprenticeship, respectively. In each equation we included a dummy variable for vocational high school training. Equation (5) explains more of the variations in hours worked and has the largetst "t" value for the independent variable (apprenticeship) of any of the three equations.

We would interpret these results to mean that it is more important to have an apprenticeship than to have related instruction to maximize weeks worked. Related instruction and apprenticeship are not synonymous; in our sample of journeymen, 54 (27.6 percent) had apprenticeship (either union or nonunion), 69 (35.2 percent) attended related instruction, 47 (24.0 percent) had both related instruction and apprenticeship, and 22 (11.2 percent) had related instruction but not apprenticeship.[2] The test of the difference in hours worked was between the 47 who had related instructions and apprenticeship, and the 22 who had only related instruction. If related instruction was the important factor in hours worked, there would be no significant difference in hours worked between these two groups. If apprenticeship was the key factor, the 47 (as well as the remaining 7 who had apprenticeship without related instruction), would have had more work than the 22.

These results do lend support to the hypothesis that apprenticeship (and not related course work) makes one a member of an "in-group." Individuals who go through an apprenticeship may be given preferential treatment in jobs or have better information about the availability of jobs. The data does not contradict an alternative hypothesis that apprentices receive better training on the job. A journeyman may devote more time to teaching the trade to an apprentice than to a non-apprenticed helper. In any case, the results do not support related instruction as a determinant of weeks worked.

We found, however, that the significant variable was apprenticeship and not whether it was a union or nonunion apprenticeship. There was no

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1. A vocational high school graduate is given one year credit against the three years in the trade before he can take the licensing exam. This is one possible reason for the shorter time to become a journeyman.

2. A regression equation to explain weeks worked was estimated in which both related instruction and apprenticeship were used as independent variables. Apprenticeship was significant but related instruction was not. This supports the position that apprenticeship and not related instruction is the significant variable in determining weeks worked.

significant difference in weeks worked between journeymen trained in nonunion apprenticeships and those trained in union apprenticeships.[1]

This last finding does contradict the results from the apprentice interviews which show a relationship between related instruction grades and hours worked (which is our proxy of job performance).

One explanation of this contradiction is that jobs among apprentices are allocated in part on the basis of grades in related instruction, while journeymen are not. The significant relationship between hours worked and related instruction is the result of the way the apprentice coordinator assigns work to apprentices.

In summary, we found that journeymen trained as apprentices worked on the average of 7.6 weeks more (in 1972) than journeymen without apprenticeships. Whether the apprenticeship was union or nonunion made no difference. We also found that men with related instruction worked 5.7 weeks more on the average than men without related instruction. (Some men with related instruction had served apprenticeships, others had not.)

The question then arose, "Which was more important, related instruction or apprenticeship?" Our regression analysis (see equations 4 and 5 above in this chapter) showed that it was apprenticeship, not related instruction. When apprenticeship was held constant and related instruction varied, there was no statistically significant relationship between weeks worked and related instruction. When related instruction was held constant, there was a significant relationship between apprenticeship and weeks worked.

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1. Specifically, those journeymen trained as union apprentices work 50.97 weeks in an average year, while those trained as nonunion apprentices work 50.42 weeks.

An equation using dummy variables for union and nonunion apprenticeship to explain average weeks worked per year was estimated to verify these findings. The regression results are as follows:

$$WPY = \underset{(32.0)}{43.2} + \underset{(2.6)}{7.8}\ UAP3 + \underset{(1.8)}{7.3}\ NUA3$$

Where

UAP3 = dummy variable for service as union apprentice
NUA3 = dummy variable for service as nonunion apprentice.

The numbers enclosed below in parentheses are "t" statistics. Both independent variables are significant at the 5 percent level.

Operating Engineers

Using data gathered from IUOE records we tested the relationship between hours worked and each of the following: grades in related classes, the journeyman's evaluation of apprentice performance on the job and grades indicating motivation. None of these relationships proved to be significant. Thus performance in related instruction did not affect either hours worked, or journeymen's evaluation of apprentices' performance on the job.

To test the relationship between apprenticeship and employment, we used the data gathered from the journeyman's mail questionnaires. Each journeyman was asked the number of hours he worked in 1971 and 1972. A number of journeymen, some trained as oilers and some as apprentices, indicated they had worked zero hours in the trade in 1971, or 1972, or both. Since no follow-up could be done to determine the reason why these individuals did not work, they were eliminated from the sample.

The average hours worked and standard deviations of each group by year are given below:

		1971	1972
Journeymen trained as oilers	(mean)[a]	1,860.37	1,749.94
Standard Deviation		522.60	580.77
Apprentices	(mean)	1,907.06	1,788.33
Standard Deviation		686.72	607.28

(a. Excludes journeymen working zero hours.)

While on the average apprentice-trained journeymen worked more hours than oiler-trained journeymen, the difference is not significant. It is also interesting to note that the dispersion in hours worked as measured by the standard deviation is greater among apprentice-trained journeymen than among oiler-trained journeymen.[1]

These comparisons must be made cautiously because the apprenticeship program in the IUOE local at which we looked has only been in operation since 1973. Thus the apprentice-trained journeymen have, on the average, less experience in the trade.

All journeymen who have served an apprenticeship in the IUOE have also had related instruction and vice versa. Thus, in this trade, we could not test the impact of related instruction and apprenticeship separately as we did in the other

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1. The large standard deviations are explained in part by high levels of seasonal and cyclical unemployment in certain phases of the trade and by lack of a systematic referral procedure for both journeymen and apprentices.

trades. There is no statistically significant difference between hours worked by apprentice-trained journeymen and oiler-trained journeymen.

Unlike the electricians, the operating engineers in Boston have no systematic way of allocating work; informal methods, especially personal relationships, play an important role. Such relationships could not be taken into account in our comparison of average hours worked. While our limited evidence fails to show that apprenticeship (and related instruction) has an effect, the factors we could not consider may have hidden any relationship that did exist.

Costs

The costs of related instruction are not difficult to identify conceptually. They are, however, difficult to measure empirically since they are incurred by a number of different groups, including the state and Federal governments, the employer, the apprentice, and the union, if one is involved. The cost records of these different groups and individuals are not comparable, nor necessarily complete.

Two approaches to identify the cost of related instruction are: (1) isolating input costs of physical facilities, teaching staff, administration, etc., or (2) measuring the level of expenditures of the various spending units such as employers, apprentices, public bodies, etc.

In most cases, the physical facilities used for related instruction are excess capacity. In the evening or on Saturday, when related classes normally meet, the public schools are not being used to capacity. Thus, the cost of providing the room space itself is zero. The only direct costs are for heat, light and custodial staff. Even the inclusion of custodial costs may be questionable. Do all such costs rise because rooms are used a few additional hours during the day? If they do not, the added cleaning costs are negligible. The same is true of heat.

Supplies and text materials are the next costs. In the IBEW, for example, the total cost of the texts which a student uses during the four years of his apprenticeship is about $70. This does not include the miscellaneous supplies like pencils and paper.

When classes are held in public schools, the teaching staff is paid from state and local school funds. In programs which are administered by individual firms, the teaching is done either by the staff in charge of apprenticeship, by journeymen, by engineering personnel after work hours (e.g., machine theory),or by specially hired vocational, or technical high school instructors. In some cases, apprentices attend private trade or technical schools paid by the employer.

The identification of administrative costs is much more complex because they tend to be joint costs. In the State Division of Occupational Education and in local school departments, there are staff members who devote part of their time to related instruction and part to other tasks. The same is true of the U.S. Department of Labor (BAT), and the State Department of Labor Industries (DAT). A field representative, for example, may spend only a portion of his time reviewing related instruction programs. Jointness of costs also in characteristic of administrative costs of unions and of firms. Even if a single individual or staff is responsible for apprenticeship, it is impossible to allocate the costs between related instruction and other activities related to apprenticeship. The problems of cost allocation involve the distribution of costs between related instruction and the other costs of apprenticeship, as well as the allocation of costs to the various organizations contributing to related instruction.

Cost data are most easily gathered by looking at the expenditures of each of the major spending units. These include the expenditures by the state (although they are in part reimbursed by the Federal government), local school districts, the BAT, employers, and unions. The State Division of Occupational Education and DAT provide administrative inputs and record keeping. In addition, teachers and other instructional costs are paid by the state and local committees.

The JATC expenditures in the two construction trades come from employer contributions (1 1/2¢ per hour worked by each journeyman in the IBEW and 2¢ in the IUOE).[1] These expenditures cannot be easily separated into expenses for related instruction classes and expenses for other JATC functions. In the machinist trade studied here, apprenticeship programs are run by individual employers. While joint costs in these programs as in others make it impossible to separate the cost of various functions, some firms send apprentices to related classes at private technical schools. In this case, at least some of the costs are directly identifiable.

A major cost in real as distinct from money terms of related instruction is borne directly by the apprentice in the form of the time spent in class and doing the classroom assignments at home. Each apprentice spends approximately 150 hours per year in school. Apprentices also average about two hours per week doing home work, or roughly 70 hours a year. In all three of the trades which we investigated, related classes last for four years. This means that an apprentice devotes to related instruction 600 hours in school and another 280 at home on his apprenticeship. On an annual basis, class and homework time together amount to about 10 percent of a full work-year of 2000 hours. In addition, there are transportation costs. These are minor, however. Most apprentices travel less than ten miles to related class; at a cost of 15¢ per mile this amounts to less than $3.00 per week.

The next problem is the value to the apprentice of the hours spent in class and on homework. We asked the apprentices in each trade how they would spend the time if there were no related classes. The following are their responses by trade:

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1. Recent negotiations have raised the electrical contractors' contribution to 5¢ per hour.

	Operating Engineers	Electricians	Machinists[1]
Overtime work	16.2%	1.4%	26.6%
Part time job	6.8	13.6	26.6
Leisure	72.9	65.8	33.3
Going to school	4.1	9.6	13.3
Other	0.0	9.6	0.0

The average number of hours per week spent by apprentices in each trade on homework follows:

	Mean	Range
Operating engineer	2.20	0-10
Electrician	4.38	1-20
Machinist	3.02	0-20

Theoretically, the value of the last hour of leisure is equal to the wage the apprentice would have received for that hour. For example, if the apprentice's wage rate is $6.00 per hour, then the value of leisure is also $6.00 per hour. This assumes that the apprentice is free to select the combination of work and leisure that he most prefers. An implicit assumption is that there are no institutional constraints (e.g., the work schedule) upon freedom of choice. This assumption of course, does not hold. Apprentices may wish to work more but be unable to get overtime, and other apprentices may wish to work less than 40 hours but be unable to do so.

Vickery[2] has pointed out if individuals are institutionally constrained to 40 hours when they in fact wish to work more, then the value of leisure time is <u>over estimated</u> by using the wage rate. If apprentices wish to work less than 40 hours but are institutionally constrained so that they must work 40 hours, then the wage rate <u>under values</u> the true value of leisure. We can always seek shelter by assuming that for the group the over estimates and under estimates cancel out. In view of the low average age of the apprentices and the likelihood that individuals in this period of their life are trying to accumulate savings, the wage rate probably over estimates the true value of leisure. Many economists in the transportation field have arbitrarily selected $2.00 per hour as the value of leisure time. This seems rather low for construction apprentices who average about $6.00 per hour.

If we choose a leisure value of $4.00 per hour for both home work and class time, the yearly cost of related instruction (including transportation) turns out to be:

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1. These figures do not include those apprentices who attend related instruction during working hours.

2. See Vickery, W., "The Value of Time and the Choice of Mode" in <u>The Demand for Travel in Theory and Practice</u>, R.E. Quandt (ed.), Heath Lexington, [illegible]on, 1969.

OPERATING ENGINEER

Class time (150 hours at $4.00)		$600.00
Transportation ($3.00 per week x 36 weeks)		108.00
Homework (80 hours at $4.00)		320.00
	TOTAL	$1,028.00

ELECTRICIANS

Class time (150 hours at $4.00)		$600.00
Transportation ($3.00 per week x 36 weeks)		108.00
Homework (158 hours at $4.00)		632.00
	TOTAL	$1,340.00

The salary of machinist apprentices tends to be much lower than that of operating engineers or electricians, and in addition, there are in general no transportation costs. Most firms have related instruction in the plant. Two firms which we visited gave time off during the day for related classes. Apprentices were paid for the time spent in class. If we consider the time spent by machinist apprentices who did not receive released time for class, our cost estimates using $2.00 per hour as the value of time are:

Related class (150 hours at $2.00)		$300.00
Homework (108 hours at $2.00)		216.00
	TOTAL	$516.00

One estimate of the public costs in the Boston area of related instruction is about $85.00 per apprentice per year. The major costs are borne by the individual apprentice rather than the public. The costs to the apprentice varies greatly by trade because of the pay scale in each. The employer contributions (as of 1971) to the JATC's was about $35,000 for the electricians and about $130,000 for operating engineers. The principal reason for this difference is the size of membership of the two unions. Because of the wide variation in type of training and of programs in the machinist trade, and particularly how the related instruction was conducted, no average figure for all programs is available.

Summary

In this chapter, we compared the three trades with respect to sources of apprentices, their educational backgrounds, and the relationship between related instruction and work performance. The chapter also dealt with costs of related instruction.

Despite the publicity given to apprenticeship in recent years, informal sources of information about it predominated. Schools and public employment agencies were unimportant. The educational backgrounds of apprentices differed sharply; employers of machinist trainees were more likely to hire beginners with previous educational or work experience in the trade. In contrast, in construction, apprentices were less likely to have had trade-related education or work experience. In addition, they were more likely to have decided to enter their trades after finishing their formal schooling, and actually entered apprenticeship a few years after being in the full time labor force. In the electrical trade formal educational requirements have increased, with an emphasis on college- preparatory high school graduates. Where employers controlled hiring, as in the machinists trade, apprentices typically had reached an occupational decision while still in school. Here also there was a lag, but the apprentices had been working in the trade or a related one before that.

Except in the electrical trade, there was little evidence that related instruction was an important explanation of apprentices' performance at work, and in the case of the machining trade, of journeymen's performance as well. Apprenticeship among journeymen in construction, even when nonunion, seemed more important than related instruction in explaining hours worked. It will be recalled that we have drawn a distinction between related instruction and apprenticeship.

Related instruction costs are of two kinds, explicit and implicit. Assuming contributions per hour worked of 1 1/2¢ for the electricians, and 2¢ for the engineers, the explicit costs are chiefly those of JATC administration and teachers' salaries. The latter are paid by public funds when public schools are used. The contributions to the JATC depend on the number of manhours worked in the industry multiplied by the negotiated cents per hour contribution. The amount of money collected is not necessarily connected directly with training needs or the number of apprentices in the local. It is likely that when the need for apprentices is falling (or has fallen), a cent per hour contribution continues, based on higher needs projected in the past. In periods of expansion, just the reverse probably occurs. The implicit costs of related instruction, which are the apprentice's unpaid time spent in class and on homework, however, far outweigh the explicit costs of administration and teaching. This is similar to the educational experience of many students preparing for a career.

CHAPTER 7
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations in this chapter are based upon more than the data presented and analyzed in prior chapters. The conclusions and recommendations also are based upon qualitative information, that could be presented, about the structure of, and manpower practices in construction and the machining trades drawn from other research, and extensive interviews with union officers, state and federal apprenticeship administrators, corporate training directors, other company officers, association directors, and educators.

Related instruction benefits different groups in different ways. The value of related instruction depends upon one's perspective. From the unions' point of view, related instruction makes for a better trained,more capable all-around journeyman. In turn, his superior skill may justify wage rate differentials between the organized and unorganized sector, as well as increase the regularity of employment. In addition, related instruction,as part of apprenticeship, may help promote the esprit de corps which is important in craft unionism, and justify the selection techniques for apprenticeship. Related instruction provides a place where apprentices can get to know each other and to develop the friendships which are important in promoting union solidarity. By requiring related instruction,which usually assumes a high school education, selection techniques, excluding those with less education, can be justified. Educational requirements limit the pool of potential entrants.

From the employers' point of view, the benefits of related instruction may be to increase productivity, and to reduce training costs by shifting part of the training from the work site to the classroom. Employers find that third- and fourth-year apprentices produce more than they earn in wages. This surplus helps to defray the cost of training in the first and second years. In addition, in the construction sector where jurisdictions may require journeymen to perform less skilled tasks, apprentices can serve as substitutes. A large portion of the burden of the cost of classroom training falls upon apprentices, while on-the-job training costs are borne by the employer. If classroom instruction reduces on-the-job training requirements, it reduces costs to employers.

From the point of view of union apprentices, their interest corresponds to the unions'. Journeymen who have had related instruction tend to be more confident in their ability and versatility as craftsmen. In addition, apprentices may receive some general education, such as math or blueprinting reading, from related instruction. This may make them more mobile both within the trade and among industries.

We will first summarize our major findings and then present our conclusions and policy recommendations. These findings are based upon the information presented here about the three trades in Boston and from interviews conducted with a variety of other company and public officials. While we believe our policy recommendations have general application, they should not be indiscriminately applied to other occupations and areas.

Summary of Findings

1. Related instruction takes on a variety of forms. The biggest differences are due to the particular technical needs of different trades and

industries. In addition, the structure and content of the work process helps determine the form of related instruction. In a given construction trade, however, the presence or absence of a union is the major factor. There are variations in the following features of related instruction: curriculum development, content and progression; financing; required attendance; and instructors' qualifications. In the operating engineers trade, related instruction is only offered through a union apprenticeship. In the electrical and machinist trades, related instruction can be obtained through local schools, private technical schools, and through a union or company sponsored program. Thus, there are individuals who have had related classes without having had a formal apprenticeship.

2. The role related instruction plays in an apprenticeship program is determined largely by the objectives of that program. Different apprenticeship programs have different objectives for related instruction. The more common objectives are to:

   - provide the knowledge and skills that impart breadth and flexibility, thereby increasing his ability to cope with unusual situations, to adapt new techniques, and to keep steadily employed;

   - provide the background necessary for promotion;

   - substitute for on-the-job training which is difficult or expensive to provide;

   - contribute to the apprentice 's acceptability by his peers as a competent craftsman;

   - contribute to his own self confidence in his skill;

   - have the apprentice identify with the trade and with fellow journeymen;

   - provide advance preparation for on-the-job training;

   - review and refresh material previously learned in school.

3. The primary goal of related instruction in all the trades studied was the requisition of knowledge and skill for the sake of breadth and flexibility. However, each trade emphasized in different degrees the other functions. In the electricians' trade, other important objectives were substitution for training not possible on the job, identification with the trade, and acceptability by fellow journeymen, personal self confidence, and promotability (since every journeymen was a potential foreman). In the operating engineers, the other goals for related instruction were as a substitute for on-the-job training, and as advance preparation for work tasks, especially as an oiler. Among machinists, advance preparation, self confidence, promotability, and review of prior learning, were the main secondary goals.

4. The ability to coordinate course work with on-the-job training depends on the continuity and diversity of work on the site or in the shop. In the machinist trade, coordination is possible and occurs when companies offer the courses; in construction, it is an unrealistic expectation. Here, despite attempts at coordination between related instruction and on-the-job training, it is rarely achieved. The most important reasons in construction are the variations in work flow and product mix, as well as the uniqueness of each construction project. The apprentice may perform some type of work and then not repeat it for many months; or he may not even encounter some tasks for a year or more.

5. Despite contrary expectations, data from apprentice records showed no progression from one task to another over the four years of apprenticeship in the two construction trades. First-year electrical apprentices, for example, do not work on only a given set of elementary tasks, second year on a more advanced set, and so on, but rather seem to work on much the same tasks, regardless of year of apprenticeship. This seems to indicate no progression of work assignments; apprentice records and interviews in the construction trades suggested that there was no systematic training on the job. However, we must qualify this finding because the classification of work assignments used in apprentice record may not be fine enough to identify skill differences within these categories, and therefore identify systematic training.

6. Among machinists and operating engineers, there is little evidence that systematic presentation of material in class accelerates training or substantially raises performance. Among electricians we did find that related instruction improves performance as measured by hours worked, as well as shortening training time. People learn in different ways; for some, a formal classroom is the best method, while for others, the direct acquisition on the job is best, especially where conditions at work permit it. Moreover, the quality of instruction and training can vary; such differences can mask the overall effectiveness of different training methods.

7. Despite strong evidence to the contrary (in two trades), a large majority of apprentices and journeymen in all three trades considered related classroom instruction valuable.

8. One way of defining the quality of related instruction is in terms of course sequence, monitoring attendance, monitoring apprentice performance, teaching effectiveness, and responsiveness to apprentice needs. In these respects, JATC programs and those of large corporations rate the highest. In the unorganized sector of construction and in smaller machine shops, attendance at related instruction is voluntary, and what little progression there is from course to course, is a personal decision. If there were no Davis-Bacon Act, there would be even less related instruction undertaken in the nonunion sector of construction, and probably only enough to pass state licensing requirements. For example, individuals familiar with related instruction in the electrical trade stated that in many nonunion programs, the related classes only teach the electrical code.

9. On the other hand, JATC programs tend to ignore individual differences in preparation, learning ability, and work experience. Little advance standing is given and programs are not self paced.

10. Use of modern educational techniques is limited. For example, there is little or no audio-visual presentation or programmed instruction. Moreover, because public funds cannot be used to finance shop courses in related instruction, hands-on-training is excluded even though essential, particularly where all aspects of the trade cannot be encountered at work.

11. On-the-job instruction apparently is at least as important as related instruction. While significant improvements have occurred in curriculum development in related instruction, comparable improvements have not occurred in the on-the-job portion of apprenticeship, especially in construction. If apprentice coordinators had the same authority to administer on-the-job training as they now have over related instruction, the effectiveness of apprenticeship would improve. Administration includes selection of work assignments and of journeymen with whom the apprentice works. Of course, even the most able coordinator will be constrained by employer attitudes and the kind of tasks available, an especially difficult problem in construction.

12. We independently tested related instruction and apprenticeship, and found that apprenticeship with or without related instruction seems to be more important than related instruction as an explanation of hours worked by journeymen electricians.

The content of related instruction courses may be needed by all journeymen, but our evidence indicates it is acquired in a variety of ways and does not determine who is the better craftsman. The formal acquisition of related instruction places a substantial implicit cost on the apprentice. The more informal methods of acquiring the same knowledge on the job shifts the cost to the employer.

13. In the organized sector of construction, the impetus for coherent related instruction has come from unions. Its overall quality seems better than that of programs offered independently by the public school system. In the electrician's and operating engineer trades, national union technicians prepare the curriculum. Courses offered by the public school system appear to be limited in number, not part of a sequential curriculum, and probably are at a level below the needs of the apprentice. Moreover, public school courses independent of union involvement are not limited to those with the same preparation or needs.

14. In the machinist's trade, larger corporations who administer their own related instruction had the best programs; here also the public school courses suffered the same defects as those courses offered independently of the JATC for construction workers. Larger

companies with machinist programs have developed their own courses partly as a reaction to the failings of the public school programs. The latter cannot meet the firms' special needs in terms of content or course sequence and level, nor can they be integrated with on-the-job training. Such integration is impossible if students come from different firms and vary in their preparation.

15. Related instruction does not seem to have been an important reason for apprentice dropouts, nor apparently has it led to potential candidates screening themselves out. However, it has been used as a reason for requiring a high school diploma and in some cases, for preferring individuals from college prep high school programs.

Recommendation for Government Policy

1. Different objectives for apprenticeship among the three trades studied and within each trade, require different approaches to related instruction. One frequent difference between program objectives is the effort to train journeymen only or to train journeymen with the background to be promoted; another difference is to substitute related instruction for on-the-job training. Government policies should not presume common objectives of apprentice programs and approval of registration should be based upon the consistency between the stated objectives of the program and the related instruction curriculum.

2. Because of the nature of the work in construction, coordination between related instruction and on-the-job training does not exist, and for technical reasons would be almost impossible to achieve. Solving the technical obstacles would be very costly. However, coordination, if possible to attain, might improve the performance of the apprentice, and shorten the time needed to become a competent craftsman. We recommend that the government sponsor a series of experiments which would simulate different types of construction jobs on which apprentices and journeymen would perform work in a rational sequence for training, and on which related instruction and on-the-job training would be coordinated. The objectives of such experiments would be to determine the costs of systematic training and coordination, and whether coordination improves quality.

3. Because of the formal structure created by the JATC's in the apprentice labor market and of the development of training curricula, the unionized sector offers a systematic apprenticeship program with a rational sequence of related instruction courses. Most training (both OJT and related instruction courses) in the nonunion sector is haphazard and unsystematic. Similar to what is now done for registered programs, the government should sponsor and help finance local industry associations of nonunion employers that could offer systematic apprenticeship programs.

4. In the nonunion construction sector, the local industry associations should administer training and be financed by a tax on all local

firms in the industry, whether members of the association or not. The control of related instruction should rest with these industry organizations and not with local school systems as it does now.

5. In view of the wide variation in the quality of programs offered by the school system and of their lack of a progression of courses, we recommend that the government redirect to JATCs or local employer associations the current funding of related instruction courses in public schools. This will allow each sponsoring group to seek out that educational or training system that best suits its needs.

6. In the unionized construction sector, related instruction is likely to be provided by a curriculum containing a rational sequence of courses by year of apprenticeship. Registered programs in the nonunion sector are free to send apprentices to the related instruction classes sponsored by the JATC, thereby taking advantage of the time and money spent by the JATC or the union in developing its curriculum. However, if no JATC program exists, or if the nonunion program is not registered, then any related instruction courses that may be offered are likely to be limited in number and not part of a rational sequence. The government sponsored local industry associations should offer related instruction in the same fashion as does the JATC. Under these conditions the government should finance related instruction, whether part of a registered program or not, and irrespective of location.

7. With some notable exceptions, training in machine shops, where no one firm is sufficiently large to engage in an organized apprenticeship program, is also haphazard and unsystematic. Here as well, the government should sponsor the formation of local industry associations to promote organized apprenticeship programs. The National Tool, Die and Precision Machining Association is capable of acting as sponsor for such programs. This recommendation could also apply to other industries which were not covered by this study.

8. Programs must be registered in order to qualify for benefits. Registration per se does not insure high quality related instruction. Quality and not registration should be the criterion for receiving financial aid from the government.

9. Current practice is to exclude shop courses from publicly financed related instruction. Since an important function of related instruction is to fill gaps in work experience not received on-the-job, shop classes are a legitimate part of related instruction. Shop courses should be financed and encouraged by the government.

10. Information about occupations, including the crafts and how to prepare for them and gain entry, still is not readily available to students when it would be most appropriate for them to seriously consider occupational choice. School should make better use of the representatives of the state and federal apprenticeship agencies, and of the Apprentice

Information Centers (AICs) of state employment services. Representatives of these agencies should be invited to make frequent visits to junior and senior high schools, and to conduct work shops for students interested in exploring occupations. These work shops would not only give students information about apprenticeship programs, but could also serve as a means of developing summer jobs.

11. This method of disseminating information could also serve as a basis for developing rosters of young people interested in entering different crafts. These rosters should be made available through the state employment service to local employers who are seeking trainees or helpers.

12. These rosters should also be used by unions and employers to promote a more equitable procedure for attracting interested applicants, by making available a number of summer pre-apprentice jobs for high school students who want to enter apprenticeship. In effect, the JATCs would begin their recruiting and screening process earlier. This summer work experience could serve as another source of information for selecting candidates, and could allow the student to decide whether a given trade is the one he prefers. Obviously, summer jobs should not be at the expense of the apprentice hires. If this involves considerably more work for the JATC's, then they should experiment by conducting screening sessions more frequently during the year, and by enlarging the number of committee members.

13. The current practice in the construction unions in our study is to screen all applicants for apprenticeship who have met a minimum requirement, the GATB test. All who pass are then interviewed by a committee of the JATC. The information dissemination system outlined above would open the chance of apprenticeship to more applicants with the necessary qualifications and probably give the trade an even wider range from which to select, as well as wider opportunities for potential applicants.

14. In order to simplify the filing of applications for apprenticeship, we recommend that application forms be available at local high schools for distribution by guidance counselors to students they consider seriously interested. The counselors would be responsible for forwarding the completed forms to the appropriate unions.

15. In the unorganized sector of construction and among machine shops, the local organizations should develop procedures for attracting and screening young people interested in the trade. A pool of applicants should be made available to all shops, many of whom might have limited sources of locating promising beginners who want to enter and remain in the trade. Our special pool is justifiable in the unorganized sector construction; here the casual nature of the labor market argues for a more orderly procedure. In machining, the labor market is not casual, but the large number of employers requires some form of organization to bring together potential apprentices and employers. We recommend that a special recruiting procedure on an experimental basis be developed to see if it improves the ability of young people to find full-time employment, and if it helps distribute job opportunities more equitably.

16. Our evidence indicates that related instruction as currently conducted is not the only, or necessarily the best, way of acquiring the basic technical information needed to be a journeyman. Research should be conducted to explore and evaluate alternative methods that would ensure the systematic and early acquisition of this knowledge in the easiest, or least costly fashion. One aspect of the experiment would be to determine whether certain kinds of on-the-job training are superior to classroom instruction. Another aspect would be to determine the effect of these alternative methods on the various functions of related instruction.

17. The BAT should be a more active participant in assisting the development of related instruction curriculum. This would involve (1) the identification of prototype programs in various parts of the country for use by programs with similar objectives; (2) the dissemination of all such information; and (3) the collection of data to determine the most successful programs.

18. Teaching techniques in related instruction courses tend to be traditional. The government should disseminate information concerning new teaching techniques directly to apprenticeship coordinators and company training directors, and should consider the possibility of subsidizing the equipment.

19. To the extent that training is needed to achieve national manpower goals, it is recommended that the government explore the possibility of a subsidy for training in those industries where rapid growth is forecast. This investigation should include the most effective way of providing this subsidy, i.e., to the firm, the industry or individual trainees.

Recommendations to Firms and JATCs

1. Advance credit is rarely granted for prior education and experience in the trade. We recommend advance standing be granted on the basis of achievement examinations. Government financing may be necessary to develop and validate nondiscriminatory tests.

2. Related instruction programs typically ignore individual difference by specifying a fixed sequence of courses over a fixed period of time. We recommend more flexibility in timing to permit self-pacing by apprentices, if it can be demonstrated that more than a small number of apprentices would benefit.

3. Most programs schedule courses after work or on weekends. The hours seem to be the worst for learning. We recommend that sponsors explore the feasibility of schedules better designed for more effective instruction.

4. The source of information about on-the-job assignments usually is the apprentice. While coordination would still be difficult to achieve, other ways of obtaining accurate information about assignments should be developed in order to ensure that the apprentice receives as broad an exposure to the trade as possible over the term of his apprenticeship. Records could be kept of the kinds of structure and phase of construction to which apprentices have been assigned.

5. In trades in which important manual tasks are unlikely to be met on the job, or are met only infrequently, more "hands on" classroom training should be offered.

6. In industries with large numbers of small employers lacking effective employer associations concerned with training, the development of company consortiums should be formed to share training costs, and to recruit and place apprentices. Here, government inducements might be necessary.

7. Within an industry, formal training programs are unequally distributed geographically. Differences in company size and in manpower needs cause these disparities. In construction, the organized sector accounts for the bulk of apprenticeship. In manufacturing it is the larger firms that perform this role. Larger firms tend to prefer specialized to more general training, while smaller firms cannot finance or recoup training costs. Industry-wide sharing of training would redistribute more equitably the expense and allocation of apprentices.

On Unanswered Questions Requiring Further Research

1. What are the advantages of training all-around craftsmen?

   Would the overall level of unemployment in an industry be higher or lower than the current rate if all journeymen were trained as specialists?

   In addition to the overall rate of unemployment, what is the impact of specialization on the incidence of unemployment?

   Are these results of specialization a function of the way in which the industry is organized, or some other factors such as product mix?

2. The training of all-round journeymen seems to imply that technological change has made the skill requirements higher. The continuation of this type of training seems to imply that the industry expects that stick by stick construction methods will continue (quasi handcraft). Is this contrary to the apparent trend towards prefabrication?

3. How widespread is prefabrication and does it result in simplification of work tasks? Similarly, is technological change, which is taking place in manufacturing, resulting in a demand for more skilled journeymen?

4. To what extent has the emphasis on training all round craftsmen affected the level of productivity within an industry? This particular project would be more feasible for the machinist trade within the United States. In the construction trade, this type of research would probably require a cross country comparison.

APPENDIX

APPENDIX TABLE I

APPRENTICE BACKGROUND CHARACTERISTICS COMPARED FROM INTERVIEW DATA*

	Electrician	Machinist	Operating Engineer
Mean number of years of formal education	11.97	11.75	11.96
Percentage in high school vocational education program	28.77	45.16	24.32
Percentage in high school general education program	24.66	24.19	41.89
Percentage in high school college preparatory	42.47	17.74	25.68
Percentage in high school co-op program	4.11	1.61	8.11
Percentage high school training in same trade	24.66	37.09	-0-
Age of apprentice in 1972	24.03	24.96	25.07
Percentage having father in trade	30.14	24.19	36.49
Mean number of years of father's education	10.60	9.00	10.23
Mean age of trade decision	18.51	20.54	20.43
Number of years in post high school trade or technical school	0.44	0.65	0.30
Percentage attending Boston, Cambridge, Somerville, high schools	38.36	12.90	13.51
Average number of years in military	1.73	1.65	1.43
Average years between full-time job and year entered apprenticeship	3.10	3.70	2.60
Percentage enrolled in same or trade-related post high school technical program	16.44	24.19	5.41

*Dashed line indicates that question was not asked because it was not appropriate. Sample sizes were: 73 electricians, 63 machinists and 74 engineers.

APPENDIX TABLE I

APPRENTICE BACKGROUND CHARACTERISTICS COMPARED FROM INTERVIEW DATA* (CONTINUED)

	Electrician	Machinist	Operating Engineer
Percentage making decision to enter trade while in high school	30.14	53.22	18.92
Percentage influenced most by parent or relative to enter trade	54.79	27.41	35.14
Percentage influenced most by friend to enter trade	2.70	14.51	17.57
Percentage influenced most by advice or training in vocational high school	1.37	19.35	-0-
Percentage influenced most by advice in academic high school	1.37	6.45	-0-
Percentage influenced most by advice by co-op high school	-0-	-0-	-0-
Percentage influenced most by advice of State Employment Service	1.37	1.61	1.35
Percentage influenced most by source not elsewhere classified	38.36	35.48	45.95
Percentage receiving advanced credit toward apprenticeship	2.74	12.90	14.86
Percentage responding yes to "Is RI mandatory?"	100.00	53.22	98.65
Percentage responding yes to "Is penalty important to your attending RI?"	42.47	22.58	67.57
Percentage responding yes to "Would you attend RI if no penalty imposed?"	89.04	30.64	74.32
Percentage responding yes to "Would you have understood RI in high school?"	67.12	75.80	83.78

*Dashed line indicates that question was not asked because it was not appropriate. Sample sizes were: 73 electricians, 63 machinists and 74 engineers.

APPENDIX TABLE I

APPRENTICE BACKGROUND CHARACTERISTICS COMPARED FROM INTERVIEW DATA* (CONTINUED)

	Electrician	Machinist	Operating Engineer
Percentage responding yes to "Should any course be added to RI?"	32.88	45.16	40.54
Percentage responding yes to "Should any course be dropped from RI?"	15.07	25.80	33.78
Percentage responding yes to "Would RI be helpful if you left trade?"	87.68	80.64	82.43
Percentage responding yes to "Is instructor well prepared?"	100.00	79.03	91.89
Percentage responding yes to "Is instructor up to date in trade?"	100.00	75.80	98.64
Percentage responding yes to "Does instructor explain clearly?"	98.63	77.41	89.19
Percentage responding yes to "Could you be a good tradesman without RI?"	15.07	25.80	29.73
Percentage responding yes to "Do you know of anyone dropped because of RI?"	12.33	16.12	21.62
Percentage kept on some work too long	69.86	51.61	48.65
Systematic OJT yes	34.25	80.65	35.14
Percentage kept on work too short a time to learn it	58.90	35.48	40.54
Percentage who would work non-union if not an apprentice	19.18	----	9.46
Percentage who would be in military if not an apprentice	8.22	3.22	1.35
Percentage who would enter college if not an apprentice	26.03	4.83	18.92
Percentage who would do some trade-related work if not an apprentice	----	30.64	24.32
Percentage who would do some work not trade-related if not an apprentice	34.25	24.19	36.49

*Dashed line indicates that question was not asked because it was not appropriate. Sample sizes were: 73 electricians, 63 machinists and 74 engineers.

APPENDIX TABLE I

APPRENTICE BACKGROUND CHARACTERISTICS COMPARED FROM INTERVIEW DATA* (CONTINUED)

	Electrician	Machinist	Operating Engineer
Percentage who don't know what they would do if not an apprentice	1.37	-0-	6.76
Percentage who would do something not elsewhere classified if not apprentice	9.59	43.05	6.76

*Dashed line indicates that question was not asked because it was not appropriate. Sample sizes were: 73 electricians, 63 machinists and 74 engineers.

APPENDIX TABLE II

COMPARISON OF JOURNEYMAN BACKGROUND AMONG MACHINISTS, ELECTRICIANS, AND OPERATING ENGINEERS*

DUMMY VARIABLES

Variable Description	Machinists % Yes	Electricians % Yes	Operating Engineers Trained as Apprentices % Yes	Operating Engineers Trained as Oilers % Yes
High school program:				
Business	6.54	10.20	-0-	-0-
College Prep	18.69	14.80	23.68	14.18
General	24.30	32.65	52.63	47.76
Vocational	44.86	36.22	13.16	14.18
Attended Post High School	43.93	64.80	34.21	23.88
Trade or Technical School	43.93	64.80	34.21	23.88
Attended full time	14.95	63.27	-----	-----
Received GED	11.21	4.59	13.16	2.99
Most Influential in Trade Decision:				
Parent or relative	16.82	26.02	71.05	35.82
Friend in Trade	14.02	14.28	23.68	17.91
Trained for Trade in High School	39.25	25.00	2.63	14.17
Worked at Trade Related Job	17.76	6.63	16.22	0.74
Trained in Trade in Military	4.67	8.67	0.30	2.98
Trained in Trade in Other Industry	4.67	3.06	10.81[a]	20.14[a]
Other	24.30	13.77	8.11	8.11

*Dashed line indicates question was not asked of this group because it was not appropriate. The sample sizes were: 107 journeyman machinists, 196 journeymen electricians, and 173 journeymen engineers.

[a]Worked non-union

APPENDIX TABLE II

COMPARISON OF JOURNEYMAN BACKGROUND AMONG MACHINISTS, ELECTRICIANS, AND OPERATING ENGINEERS*

DUMMY VARIABLES (CONTINUED)

Variable Description	Machinists % Yes	Electricians % Yes	Operating Engineers Trained as Apprentices % Yes	Operating Engineers Trained as Oilers % Yes
Do you specialize in certain part of trade?	42.06	32.65	47.37	60.45
Training Path:				
Formal Apprenticeship	40.19	17.86	97.37	-----
Non-union Apprenticeship	33.65[b]	10.71	-----	-----
Three or Four years Voc. Program in High School	23.36	25.00	-----	-----
Full-time Post High School Technical or Trade School	8.41	9.69	2.63[c]	-----
Evening Courses	27.10	38.27	-----	-----
Military	7.48	13.27	7.89	-----
Learned as Helper	21.50	59.18	76.32[d]	-----
Other	15.89	9.18	-----	-----
Do you operate a single machine?	23.36	-----	-----	-----
Do you machine an entire part?	73.83	-----	-----	-----
Do you attend related instruction?	49.53	35.20	92.11	-----
Credit toward length of Appr.	13.08	8.67	13.16	-----

*Dashed line indicates question was not asked of this group because it was not appropriate. The sample sizes were: 107 journeyman machinists, 196 journeymen electricians, and 173 journeymen engineers.

[b] upgrading on the job

[c] Heavy-equipment school

[d] Union oiler

PPENDIX TABLE II

COMPARISON OF JOURNEYMAN BACKGROUND AMONG MACHINISTS, ELECTRICIANS, AND OPERATING ENGINEERS*

DUMMY VARIABLES (CONTINUED)

Variable Description	Machinists % Yes	Electricians % Yes	Operating Engineers Trained as Apprentices % Yes	Operating Engineers Trained as Oilers % Yes
Did RI help you understand work?	54.21	25.00	92.11	-----
Did RI make you well rounded?	57.01	-----	89.47	-----
When should RI be taught?				
With high school shop course?	32.71	-----	-----	-----
With OJT?	34.58	-----	-----	-----
Before OJT?	17.76	-----	-----	-----
After OJT?	2.80	-----	-----	-----
Timing unimportant	7.48	-----	-----	-----
Given RI material already learned elsewhere	52.34	28.57	13.16	-----
RI given at convenient time	59.81	75.60	97.37	-----
Currently taking trade related courses	2.80	5.10	-----	-----
RI teach you what already known?	23.36	28.57	13.15	-----
Learned on job	16.82	27.04	10.53	-----
Learned in high school	14.02	9.18	0	-----
Learned in trade or tech school	10.28	11.73	0	-----
Could you have been as good a tradesman without RI?	19.63	16.84	23.68	-----
Do you recommend RI for apprentices?	87.85	94.39	94.74	83.58

*Dashed line indicates question was not asked of this group because it was not appropriate. The sample sizes were: 107 journeyman machinists, 196 journeymen electricians, and 173 journeymen engineers.

APPENDIX TABLE III

FREQUENCY DISTRIBUTION OF JOURNEYMAN RESPONSES TO THE FOLLOWING:*

Question	Alternative Answers	JOURNEYMAN ELECTRICIANS Frequency Per Alternative	JOURNEYMAN ELECTRICIANS % Responding	JOURNEYMAN OPERATING ENGINEERS Frequency Per Alternative	JOURNEYMAN OPERATING ENGINEERS % Responding	JOURNEYMAN MACHINISTS Frequency Per Alternative	JOURNEYMAN MACHINISTS % Responding
Was your Apprenticeship registered?	No	0	0	0	0	27	55.1
	Yes	56	59.6	36	97.3	19	38.8
	Don't know	38	40.4	1	2.7	3	6.1
Size of firm where trained	1 to 9	70	36.6	----	----	4	3.8
	10 to 49	36	18.8	----	----	25	23.8
	50 to 99	10	5.2	----	----	10	9.5
	100 to 499	28	14.7	----	----	19	15.1
	500 or more	37	19.4	----	----	47	44.8
Number of years in trade	1 to 4	1	.5	17	81.0	16	15.0
	5 to 9	43	22.1	0	0	15	14.0
	10 to 19	50	25.6	3	14.3	37	34.6
	20 or more	101	51.8	1	4.8	39	36.4
Was attendance at RI Required?	Yes Req'd by Union	36	20.5	0	0	----	----
	Yes Req'd by Employer	0	0	0	0	41	38.3
	No but attended	8	4.5	3	7.9	21	19.6
	Did not attend	132	75.0	35	92.1	45	42.1

*Dashed line indicates question was not asked because it was considered not appropriate. Sample sizes were machinists 107, electricians 196, and engineers 173.

APPENDIX TABLE III

FREQUENCY DISTRIBUTION OF JOURNEYMAN RESPONSES TO THE FOLLOWING:* (CONTINUED)

Question	Alternative Answers	JOURNEYMAN ELECTRICIANS Frequency Per Alternative	% Responding	JOURNEYMAN OPERATING ENGINEERS Frequency Per Alternative	% Responding	JOURNEYMAN MACHINISTS Frequency Per Alternative	% Responding
Were you assigned work not yet covered in RI classes?	Never	13	7.1	6	15.8	45	42.1
	Rarely	24	13.2	8	21.1	12	11.2
	Sometimes	92	50.5	22	57.9	32	29.9
	Often	53	29.1	2	5.3	17	15.8
Did you attend RI classes Regularly?	Rarely	6	3.5	9	23.7	2	3.1
	Occasionally	22	12.8	0	0	14	21.5
	Often	64	37.2	0	0	14	21.5
	Always	80	46.5	29	76.3	35	53.8
Were you taught material in RI not immediately useful on the job?	Never	4	2.3	2	5.3	----	----
	Rarely	11	6.3	2	5.3	----	----
	Sometimes	109	62.3	29	76.3	----	----
	Often	51	29.1	5	13.2	----	----
Length of Class in Hours	One	9	5.2	1	2.6	1	1.6
	Two	56	32.4	0	0	1	1.6
	Three	76	43.9	1	2.6	1	1.6
	Four	22	12.7	0	0	10	16.1
	More	10	5.8	36	94.7	49	79.1

*Dashed line indicates question was not asked because it was considered not appropriate. Sample sizes were machinists 107, electricians 196, and engineers 173.

APPENDIX TABLE III

FREQUENCY DISTRIBUTION OF JOURNEYMAN RESPONSES TO THE FOLLOWING:* (CONTINUED)

Question	Alternative Answers	Journeyman Electricians: Frequency Per Alternative	Journeyman Electricians: % Responding	Journeyman Operating Engineers: Frequency Per Alternative	Journeyman Operating Engineers: % Responding	Journeyman Machinists: Frequency Per Alternative	Journeyman Machinists: % Responding
What form did RI Classes Take?	Lecture	----	----	37	97.4	33	73.3
	Workshop	----	----	0	0	0	0
	Other	----	----	1	2.6	12	26.7
Were RI Instructors Up-to-date in trade Practices?	Rarely	0	0	1	2.6	2	2.7
	Occasionally	8	4.6			5	6.7
	Often	87	49.7	14	36.8	41	54.7
	Always	80	45.7	23	60.5	27	36.0

FREQUENCY DISTRIBUTION OF RESPONSES TO QUESTIONS SPECIFIC TO THE ELECTRICIAN'S TRADE

Question	Alternative Answers	Frequency Per Alternative	% Responding
Do you work in trade during off-season?	No	0	0
	Yes	22	12.9
	No, Off-Season	149	87.1

Where did you learn:	Math Frequency	Math %	Blueprint Reading Frequency	Blueprint Reading %	Theory Frequency	Theory %	Code Frequency	Code %
On job	0	0	37	20.4	5	2.6	3	1.6
RI Classes	11	5.8	25	13.8	38	20.1	61	31.2
Military	2	1.1	8	4.4	11	5.8	0	0
High School	146	76.8	69	38.1	72	38.1	54	28.3
Tech. Post High School	24	12.6	30	16.6	53	28.0	56	29.3
Other	7	3.7	12	6.6	10	5.3	17	8.9

*Dashed line indicates question was not asked because it was considered not appropriate. Sample sizes were machinists 107, electricians 196, and engineers 173.

'PENDIX TABLE III

FREQUENCY DISTRIBUTION OF RESPONSES TO QUESTIONS SPECIFIC TO THE OPERATING ENGINEER'S TRADE (CONTINUED)

Question	Alternative Answers	Frequency Per Alternative	% Responding
When did you receive your hoisting engineer's license?	Has none	0	0
	During Apprenticeship	25	73.5
	After Apprenticeship	9	26.5

Where did you learn:	Grades	Frequency	%	Rigging & Reeving	Frequency	%	Lubrication	Frequency	%	Motors	Frequency	%
	On job	10	28.6		13	34.2		0	0		7	18.4
	RI Classes	20	57.1		20	52.6		14	37.8		22	57.9
	Military	1	2.9		1	2.6		19	51.4		2	5.3
	High School	0	0		0	0		2	5.4		0	0
	Tech. Post High School	2	5.7		3	7.9		1	2.7		4	10.5
	Other	2	5.7		1	2.6		1	2.7		3	7.9

?ENDIX TABLE IV

ELECTRICIAN APPRENTICES: STATISTICS ON DAYS SPENT FOR SELECTED FUNCTIONS IN 1969 TO 1972

		FIRST YEAR			SECOND YEAR			THIRD YEAR			FOURTH YEAR		
DESCRIPTION OF FUNCTION	YEAR (CALENDAR)	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIAT.
"BX"	1969	FYA4	13.00	15.88									
	1970	FYA3	9.03	11.31	SYA4	8.45	10.16						
	1971	FYA2	11.47	16.18	SYA3	8.00	11.93	TYA4	7.41	11.00			
	1972	FYA1	10.06	15.21	SYA2	9.62	17.12	TYA3	6.64	11.03	FOYA4	1.59	3.38
Motors and Controls	1969	FYB4	6.45	9.02									
	1970	FYB3	8.84	13.67	SYB4	4.23	4.82						
	1971	FYB2	7.42	10.96	SBY3	10.89	19.08	TYB4	6.82	10.78			
	1972	FYB1	7.42	13.56	SYB2	6.89	11.07	BYB3	10.97	20.21	FOYB4	1.55	3.23
Rigid Conduit	1969	FYC4	42.14	45.95									
	1970	FYC3	43.12	36.18	SYC4	48.55	43.62						
	1971	FYC2	42.28	33.59	SYC3	45.18	37.04	TYC4	61.73	64.79			
	1972	FYC1	39.98	36.22	SYC2	39.89	36.58	TYC3	39.01	36.79	FOYC4	21.36	27.32
Steel Tubing	1969	FYD4	37.27	21.86									
	1970	FYD3	34.44	26.53	SYD4	36.36	24.33						
	1971	FYD2	31.42	22.46	SYD3	35.45	27.61	TYD4	40.55	35.52			
	1972	FYD1	33.51	24.26	SYD2	33.12	27.04	TYD3	35.63	28.50	FOYD4	29.68	27.40
FIXTURES	1969	FYE4	41.32	26.57									
	1970	FYE3	38.95	26.06	SYE4	35.91	20.80						
	1971	FYE2	38.04	26.44	SYE3	33.64	22.23	TYE4	37.00	43.96			
	1972	FYE1	35.34	25.90	SYE2	30.34	25.30	TYE3	28.98	24.97	FOYE4	16.36	23.77
Service	1969	FYF4	8.41	11.97									
	1970	FYF3	7.50	9.13	SYF4	8.77	8.25						
	1971	FYF2	6.42	7.98	SYF3	8.05	11.18	TYF4	7.18	9.28			
	1972	FYF1	5.53	7.54	SYF2	5.34	9.01	FYF3	5.86	8.14	FOYF4	3.45	5.98
Wiring	1969	FYG4	11.59	16.42									
	1970	FYG3	13.48	15.68	SYG4	15.41	18.83						
	1971	FYG2	16.36	16.73	SYG3	13.72	17.81	TYG4	19.91	35.27			
	1972	FYG1	11.11	20.90	SYG2	14.63	19.07	TYG3	10.57	18.62	FOYG4	5.86	9.89
Low Tension Signal	1969	FYH4	1.41	2.79									
	1970	FYH3	1.69	3.70	SYH4	4.36	7.76						
	1971	FYH2	1.96	5.33	SYH3	1.86	3.79	TYH4	2.77	4.87			
	1972	FYH1	1.34	4.13	SYH2	4.28	15.99	TYH3	1.81	3.75	FOYH4	6.36	25.93

APPRENDIX TABLE IV

ELECTRICIAN APPRENTICES:
STATISTICS ON DAYS SPENT FOR SELECTED
FUNCTIONS IN 1969 TO 1972

DESCRIPTION OF FUNCTION	YEAR (CALENDAR)	FIRST YEAR VARIABLE NAME	FIRST YEAR MEAN DAYS	FIRST YEAR STD DEVIATION	SECOND YEAR VARIABLE NAME	SECOND YEAR MEAN DAYS	SECOND YEAR STD DEVIATION	THIRD YEAR VARIABLE NAME	THIRD YEAR MEAN DAYS	THIRD YEAR STD DEVIATION	FOURTH YEAR VARIABLE NAME	FOURTH YEAR MEAN DAYS	FOURTH YEAR STD DEVIAT.
Metal Molding	1969	FYI4	8.55	14.22									
	1970	FYI3	2.96	5.86	SYI4	3.41	4.29						
	1971	FYI2	2.56	5.04	SYI3	2.83	5.32	TYI4	3.00	6.58			
	1972	FYI1	2.49	6.80	SYI2	2.34	7.37	TYI3	1.63	3.48	FOYI4	0.45	1.74
Jobbing	1969	FYJ4	21.14	27.71									
	1970	FYJ3	12.43	18.91	SYJ4	10.41	17.08						
	1971	FYJ2	7.51	16.22	SYJ3	11.81	19.18	TYJ4	6.14	23.31			
	1972	FYJ1	7.66	11.83	SYJ2	7.20	16.15	TYJ3	12.22	25.86	FOYJ4	2.32	5.49
Circuit Wiring	1969	FYK4	20.68	19.25									
	1970	FYK3	23.98	19.26	SYK4	20.27	14.14						
	1971	FYK2	24.91	21.55	SYK3	23.20	17.37	TYK4	16.50	15.33			
	1972	FYK1	24.14	22.52	SYK2	22.86	23.70	TYK3	19.10	17.09	FOYK4	12.59	15.87
Feeders	1969	FYL4	9.45	9.80									
	1970	FYL3	10.81	11.47	SYL4	12.45	10.93						
	1971	FYL2	12.51	16.84	SYL3	12.29	12.55	TYL4	14.14	14.16			
	1972	FYL1	9.58	13.80	SYL2	10.90	18.90	TYL3	10.25	12.05	FOYL4	4.00	5.75
Switch Boards	1969	FYM4	2.00	2.86									
	1970	FYM3	3.68	7.10	SYM4	4.32	8.03						
	1971	FYM2	3.84	6.28	SYM3	5.35	8.30	TYM4	6.73	9.49			
	1972	FYM1	3.30	6.51	SYM2	3.88	7.32	TYM3	4.40	8.29	FOYM4	3.50	6.99
Oil Burners	1969	FYN4	0.09	0.29									
	1970	FYN3	0.30	1.34	SYN4	2.09	7.86						
	1971	FYN2	0.29	1.15	SYN3	0.50	1.80	TYN4	0.45	1.60			
	1972	FYN1	0.22	.75	SYN2	0.28	1.08	TYN3	0.59	2.76	FOYN4	0	0
Air Conditioning	1969	FYO4	1.86	2.70									
	1970	FYO3	2.09	4.36	SYO4	2.32	3.29						
	1971	FYO2	1.57	4.67	SYO3	2.23	4.53	TYO4	1.32	3.47			
	1972	FYO1	1.84	4.24	SYO2	0.84	2.87	TYO3	1.16	2.84	FOYO4	0.18	0.66
Fire Alarms	1969	FYP4	3.91	6.67									
	1970	FYP3	5.62	13.10	SYP4	3.09	6.16						
	1971	FYP2	6.33	13.10	SYP3	5.88	8.04	TYP4	2.91	6.12			
	1972	FYP1	5.42	10.08	SYP2	5.80	8.82	TYP3	5.50	8.74	FOYP4	0.91	2.29

APPENDIX TABLE IV

ELECTRICIAN APPRENTICES:
STATISTICS ON DAYS SPENT FOR SELECTED
FUNCTIONS IN 1969 TO 1972

		FIRST YEAR			SECOND YEAR			THIRD YEAR			FOURTH YEAR		
DESCRIPTION OF FUNCTION	YEAR (CALENDAR)	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIATION	VARIABLE NAME	MEAN DAYS	STD DEVIAT.
	1969	FAB4	3.09	3.05									
NUMBER OF	1970	FAB3	3.41	2.47	SAB4	2.82	2.54						
DAYS ABSENT	1971	FAB2	3.48	3.40	SAB3	4.36	2.47	TAB4	4.68	4.19			
	1972	FAB1	3.21	4.06	SAB2	3.62	3.44	TAB3	4.06	3.02	FOB4	2.45	1.92
	1969	FIAB4	6.95	2.36									
TYPE OF	1970	FIAB3	6.74	2.60	SEAB4	6.59	2.72						
ABSENCE	1971	FIAB2	7.27	2.17	SEAB3	6.64	2.46	THAB4	6.36	2.59			
	1972	FIAB1	7.62	1.75	SEAB2	7.43	1.96	THAB3	6.84	2.39	FRAB4	7.36	1.97
AVERAGE GRADE	1969	FAG4	79.77	19.02									
IN RELATED	1970	FAG3	80.73	12.78	SAG4	74.75	25.00						
INSTRUCTION	1971	FAG2	80.89	7.17	SAG3	79.03	7.50	TAG4	71.50	24.52			
	1972	FAG1	81.24	9.79	SAG2	77.33	12.46	TAG3	81.26	9.63	FOAG4	77.73	18.18
TOTAL DAYS	1969	FTDW4	229.27	37.08									
ACTUALLY	1970	FTDW3	236.68	17.39	STDW4	220.32	51.93						
WORKED	1971	FTDW2	239.96	22.32	STDW3	234.35	20.46	TTDW4	231.00	37.48			
	1972	FTDW1	227.18	25.96	STDW2	212.74	51.46	TTDW3	205.47	48.25	FOTDW4	109.77	58.47