The purpose of this paper is to explore the circumstances under which in-plant training would be preferable to formal vocational schools in developing countries and to develop a methodology for the evaluation of vocational training schemes.

The paper includes an extensive review of the literature on the subject together with a checklist of variables for the analysis of evaluation studies of vocational training in developing countries.

A typology of vocational training alternatives ranging from the most formal to the most informal is proposed and the economic and institutional factors influencing the choice of a mode of vocational training are reviewed.

The instructional requirements for a number of job families are dealt with. They include statistical evidence about the duration of the training program, the specificity of courses together with the time distribution of instruction, the cost of equipment and the compatibility of training with the type of industry.

A methodology for the evaluation of a vocational training scheme is developed and illustrated with the help of a numerical example.
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This chapter reviews literature dealing with the evaluation of different types of vocational training to determine if there is a mode that is more efficient than others for the training of industrial occupations.

Purpose of this Review

1.01 Vocational training off-the-job for industrial occupations is a comparatively recent phenomenon, dating largely from the middle 19th century. Although the Industrial Revolution tended to downgrade the skills required by the working force, as technological knowledge advanced rapidly, there was an increased demand for large numbers of skilled workers with more theoretical knowledge. This theoretical knowledge could be imparted through a formalized education, which provided also an alternative to those who would not, or could not, follow the general academic stream into higher education or into white collar and managerial jobs. Historically, the question of formal vocational schooling versus general schooling, or formal vocational training versus on-the-job training never arose (although the issue dealing with the content of education—vocational vis a vis general subjects—was hotly debated in the last hundred years). But since the end of the Second World War, the preoccupation of developed countries with automation and unemployment on the one hand, and the pressing problems of providing the skilled manpower necessary for development in the newly-founded nations on the other, brought to the fore the question of the mode of training for skilled blue collar occupations. In developed economies, increased automation demanded workers with more flexibility and with a deeper and broader theoretical knowledge of their occupation. This type of knowledge could be better imparted in a classroom setting. New modes of training appeared when the abolition of some occupations or the creation of employment opportunities in others necessitated training or retraining workers in a relatively short time. So, rapid training and retraining systems using schools, factories, and skill centers, were tried and instituted.

1.02 In developing countries, the need to expand the supply of trained workers at rates unknown before also compelled decision-makers to look for different types of training: formal vocational schooling, apprenticeship training, rapid training, etc. But the most accessible type of training (and unencumbered the least by administrative and operational obstacles) was that of formal vocational schooling; the upshot was an expansion of vocational schools.

1.03 Yet, before continuing to pour resources into this type of training, some basic questions should be answered: How effective is this type of training compared with other forms of training? How do costs of this type of training compare with costs of other modes of training? What is the degree of substitutability between this and other forms of training? In an attempt to provide an answer to these questions, a thorough search of the literature evaluating all types of training for industrial occupations was made.
Description of The Literature

1.04 Surprisingly, only a very small number of comparative studies were made with the purpose of answering the questions posed above. The few available studies primarily concern developed countries. There are, however, a number of studies evaluating specific programs, and studies that try to isolate and evaluate variables that affect the effectiveness of training programs. For the sake of clarity, the studies were divided into five groups, although there is some overlapping between groups.

I = Comparative studies of formal vocational schooling with on-the-job training (OJT)

II = Comparative studies of vocational schools with general secondary schools

III = Evaluation studies of formal vocational schools

IV = Evaluation studies of non-school vocational programs

V = Miscellaneous studies evaluating the effects of important factors on the effectiveness of vocational training

1.05 The following section presents the summaries and conclusions of the reviewed studies. In the text the studies are identified only by the last name of the author and a number. This number corresponds to the identification number of the study in the full bibliography given in Appendix 1. Appendix 2 presents an analytic framework for comparing evaluation studies of vocational training. Appendix 3 presents a detailed analysis of each study in accordance with this framework.

I. Comparative Studies of Formal Vocational Schooling with OJT

A) United States Studies

1.06 Very few studies of this type were done in the United States and none of the existing studies contain data and a detailed analysis of OJT costs. The three studies analyzed in this group are not parallel. One is a theoretical study using available national data. The second compares only effectiveness, and the third one compares formal vocational schooling with cooperative schooling, a combination of institutional and OJT, not strictly OJT.

1.07 Mincer (1) used national census data to compare the rates of return to OJT and formal schooling. He imputes the cost of each kind of training from wage differentials paid to persons who enter a given job with different levels of previous education. The benefits consist of lifetime earnings. The study concludes that there is no significant difference between social rates of return to OJT and to formal vocational school training. Private rate of return is higher for formal schooling.

1.08 Merenda (2) compares the performance of persons trained on the job and in a formal training school in the United States Navy by using the U.S. Navy's promotion test. Of the two sample groups, matched for their pre-training ability, the graduates of formal schools did better. The author concludes that formal schooling is a superior method of training, but this result cannot be accepted from a cost-
effectiveness viewpoint, since no analysis of costs was made.

1.09 Sanders (3) provides a more detailed analysis of the costs and benefits of a cooperative educational program and formal vocational schools in a city of the United States. He considered most, but not all, of the costs and benefits to the individual and society. The study concludes that there is not much difference in the benefits of the two kinds of programs, and that the costs of the formal school are much greater, thus implying that cooperative training is more cost-effective than formal schooling.

1.10 This rather small number of United States studies comparing OJT with formal vocational schooling does not lead us to any definite conclusion. None of these studies can be called a careful or complete cost-benefit or cost-effectiveness study. Specification of trainees was far from complete; only one study considered costs to the enterprise in a systematic way; benefits such as the probability of getting the first job, satisfaction from the job, increase of occupational options, etc. were not considered. In summary, it is impossible to state, from the evidence available from the U.S. studies, that OJT is more or less cost-effective than training in a formal setting.

B) Studies Outside the United States

1.11 The number of studies which compare formal vocational training with OJT is very small. Most available studies come from the USSR where there is a keen interest in the problem. The most specific and complete study from the USSR is found in a book edited by Jagodkin (4) where academic vocational training is compared with OJT, using a small sample of machine operators and metal fitters from two factories. The study offers some data on costs of OJT and uses vocational schools' costs derived from national averages. The study shows that costs of school training are many times those of in-factory training. On the other hand, benefits -- faster progression in salary scales, more satisfaction on the job, lower turnover rates -- are also higher for school graduates. Although the study does not calculate cost-benefit ratios, it concludes that formal schooling is superior to OJT and recommends expansion of the formal vocational schooling in the USSR.

1.12 Krevnevic (5) cites a study that compares the efficiency of school-based and industry-based training for setters and fitters-repairmen for automatic production lines. The sample selected for the analysis was quite large: 4200 workers in many factories located in 6 cities. Data on costs and benefits are fairly detailed. Benefits also include the value of production of students in vocational schools. The study concludes that costs of each kind of training are similar but benefits from school training are higher than from OJT in terms of higher wages, more rapid promotion, and higher bonuses received for efficiency suggestions. However, the study does not calculate any cost-benefit ratios. Again, this study recommends the expansion of formal vocational schooling in the USSR.

1.13 A third study, Stepanov (6) compares school-based training with OJT training of lathe operators, using a small sample of lathe operators in two Leningrad factories. The study does not offer data on specific costs, although it states that costs in formal schooling are higher. Measured benefits, in terms of higher earnings and payback period, are also higher for those trained in schools. The conclusions of the study are also that training in school is more profitable than OJT.
1.14 Belkin (7) cites studies done at three mechanical engineering plants in Moscow and a few chemical plants in Lisiachnsk to compare vocational school graduates with those trained in the plants. He does not mention costs but points out the benefits in terms of increased productivity and earnings, and speed of advancement on the job. These studies favor vocational school graduates and the conclusion is, again, to expand formal vocational schools.

1.15 In another article, Belkin (8) discusses training of workers in vocational schools versus OJT in the USSR as a whole. The evaluation is qualitative and reaches the conclusion that vocational training programs in schools have to be expanded to provide the skilled workers necessary to operate the increasingly complex and automated machinery of industry. The major reason given for the justification of expansion of formal vocational schools is that they provide the theoretical understanding required for technologically advanced production.

1.16 A comparative study conducted by CIRF (9) of methods of training skilled metal workers in Europe does not deal with the cost-effectiveness of different training methods but provides a qualitative assessment of training in Belgium (primarily in schools), West Germany (a combination of school and apprenticeship), the United Kingdom (a loosely organized apprenticeship system), and the Netherlands (school and in-plant training). The conclusions of this study are that there is a common trend to increase vocational training in the plants, that it is wasteful when workers specialize too narrowly, and that wage classifications and formal training requirements hamper mobility of workers climbing the job ladder. The study also points out the difficulties in making international comparisons of vocational education -- even the definition of skilled worker in the metal trade became a sticky point in the comparison.

1.17 There are a few studies that try to calculate the cost-benefit ratios of just the income accrued to different types of education and training in general. Kullmer (10) using a one per cent sample of a national census in West Germany calculates the relationships between the type of training received and the net income by age and sex and nine types of education. These types of education ranked from high to low income are: university, technical college, teacher training college (except in the 14-29 age group, where this type ranks lower), business training, technical school, full-time vocational school, practical training only, in-plant training, and no training. The study does not compare incomes to costs.

1.18 Winterhager (11) states in connection with an evaluation of costs of plant training in West Germany that training in schools is cheaper than training in the factory because the factory has lower student-teacher ratios.

1.19 Blaug (12) in England conducted a pilot study to compare the costs and benefits of six levels of education and three types of programs. The pilot study provided the data to calculate the earnings of employees by age at five electrical engineering firms but cost figures were derived from general national studies. The study does not provide definite conclusions, only that more detailed data are needed.
1.20 From these studies it is possible to conclude that no country so far seems to have produced adequate answers to the question of the relative efficiency of formal vocational schooling and on-the-job training for its own system, let alone provide conclusions that can be translated or exported abroad. The studies done in the USSR tend to consider vocational school training more advantageous than OJT, although no cost-benefit or cost-effectiveness ratios are given. From all these studies, one can infer only that, in general, factory workers with formal vocational training may be more efficient than those trained on the job, but there is no explicit relationship between increased efficiency and costs. Even in the area of costs, there is disagreement; the general consensus is that OJT is cheaper than training in vocational schools. However, Winterhager's study mentions that training in schools is cheaper than training in the factory because the factory has a lower student-teacher ratio.

II. Comparative Studies of Vocational Schools with General Secondary Schools

A) United States Studies

1.21 The issue of cost-effectiveness of academic versus vocational high schools is a highly debated topic in the United States. A search of the literature yielded five major studies, comparing secondary general schools with vocational schools. Hu et al (13) uses questionnaire data to compare regular and vocational high school graduates in three cities. Results are corrected by a 2/3 no response bias. Costs and benefit analyses are fairly complete. Benefits include assessment of non-economic factors, such as voting behavior and economic aspirations. The study does not conclude that vocational education is more cost effective; rather it advocates that more funds should be allocated for vocational curricula in high schools rather than for non-vocational curricula.

1.22 Schriver (14) compares vocational school graduates with high school graduates in Tennessee using two rigorously matched groups drawn from a 25 per cent random sample. Costs per hour of instruction and per student in each type of school were calculated. Benefits included such factors as employment stability and mobility. The study concludes that vocational education has advantages over academic high school, and that the rate of return of vocational schooling is highest for students with the lowest aptitudes.

1.23 Corrazaini (15) compares vocational and academic high schools in one city by sampling 12 neighboring firms that employ their graduates. Most of the important cost elements of each kind of schooling are considered; benefits include earnings, a lower dropout rate, and geographic mobility. The study concludes that vocational education is, at best, only marginally profitable, and that the extra cost of vocational schooling may not justify these small benefits.

1.24 Taussig's study (16) compares vocational and academic high schools in New York City. Most important costs are considered, except joining costs, which the author says are too difficult to estimate. Benefits were inferred from a postcard survey of graduates, which no follow-up or correction for non-response bias. No calculation of cost-benefit was done. The study concludes that investment in vocational schools has not rendered significantly greater benefits than regular secondary schools and, therefore, should not be recommended for the future.
1.25 A study by Paulter (17) compares vocational secondary school graduates, vocational school dropouts, and non-vocational high school graduates not continuing their education. The comparison is based only on benefits and not on costs. The criteria for benefits were the time necessary to get the first job, earnings, and employment stability. The study did not find major differences among those employed from the three programs.

1.26 In terms of analysis of costs and benefits, these studies are fairly complete, yet the conclusions are contradictory: two studies conclude that vocational school education is more profitable than general secondary school education, while two reach the opposite conclusion, and one concludes that there is no difference.

B) Other Studies

1.27 Al-Bukhari (18) evaluates public secondary industrial (vocational) schools in Jordan. Ninety graduates from two institutions, plus employers, teachers, and non-graduates were interviewed. The study finds that the curriculum does not correspond to industry’s needs, as only 28 per cent of the graduates were using skills they had learned at the schools. Cost-benefit ratios for vocational school graduates are 1.6 to 1, and 6.7 to 1 for general academic school graduates. He recommends that the two kinds of schools be joined to give both kinds of education to all students.

1.28 Lourdesamy (19) in a follow-up study of graduates of vocational schools in Malaysia found that their average starting salaries were lower than those of graduates from the general secondary school and that unemployment rates were higher. Costs of vocational schools compare unfavorably with general academic secondary schools.

1.29 These two studies seem to reflect the prevalent general attitude towards vocational schools in developing countries. Namely, that normal vocational schooling has a high cost-benefit ratio compared with general schooling. However, the results do not address the basic question of cost-effectiveness. A major complaint against the vocational school is that the curriculum is not adapted to the demands of the economy; hence, graduates do not find ready employment. But this is an "external" inefficiency -- the choice of combination of factors to produce an output that is not highly valued in the market. The studies do not consider the problem of "internal" efficiency -- given the objective of producing a particular output, to choose a combination of factors that minimize the cost of production.

III Evaluation Studies of Formal Vocational Schools

1.30 These studies do not aim at comparing vocational schooling with other types of schooling. They generally evaluate qualitatively vocational school training with the aim of improving it. In the United States, Somers (20) compares three educational levels (high school, post-high school, and junior college) and six program areas (vocational and academic), using cost-benefit analysis. Cost figures were taken from sundry studies, while benefits were determined from a questionnaire sent to a national stratified random sample, which suffered from a low response rate (25 to 56 per cent). Monetary
and non-monetary benefits were appraised, including the socio-economic status of the respondent's job. The study concludes that job-relatedness of a person's schooling and the socio-economic status of the job, not the wages, are the major determinants of the satisfaction levels of a job.

1.31 Another U.S. study, the Five and Ten Year Follow-Up Study of Connecticut State Vocational Technical Schools (21) was undertaken in order to provide a basis for recommending improvements in the system of public vocational schools. The sample was adequate. The study found that a large proportion of graduates were working at jobs unrelated to their training and recommended better liaison between industry and the schools. Recommendations also included the improvement of courses, counselling, and placement services.

1.32 Binninger (22) evaluated the French system of vocational education and concludes that it fails to teach enough general skills and knowledge. No sample of respondents is specified. The study found that the main problem of vocational schools is that workers trained in them are unable to learn quickly the new production methods demanded by technological changes. The study concludes that the solution is to update the curriculum and use modern equipment and teaching methods.

1.33 Belkin (23), in a short article, points out that the 25-year trend in the USSR indicates that a growing proportion of the labor force constitutes vocational school graduates and that workers with these extra formal years of education adapt better to technological change and have lower rates of rejects in production.

1.34 Sokolov (24) describes and evaluates several methods of combining the training given in vocational schools with general secondary education. The study shows that graduates of a three-year school with a combined program were promoted more quickly than graduates of the regular two-year vocational school. However, the cost of this new program is higher.

1.35 Gruner (25) evaluates the public industrial schools (BFS) in West Germany. Ninety-six firms responded to a questionnaire. Their general opinion of the BFS's was favorable, but the firms noted a lack of relevant practical experience among graduates. The author concludes that apprenticeship periods of the post-BFS could be shortened, if the schools could provide more practical experience.

1.36 As we attempt to draw a conclusion from this summary of studies evaluating formal vocational schooling, we are deterred by the diversity of systems and experiments. Nevertheless, these authors have shown a common conviction that formal vocational schooling is an important and valuable part of their countries' educational systems. They also seem to have touched on a common problem, which is the reconciliation of industry's need for workers who have had practical experience with current methods. General and theoretical education is necessary for the former, and actual practical work is necessary for the latter; the question is, how can the limited amounts of training time and teaching resources be best allocated? Unfortunately, the studies in this survey do not seem to have confronted this question strictly enough to serve as examples for planners in countries at different stages of development.
IV Evaluation Studies of Non-School Vocational Programs

1.37 These studies evaluate specific training programs outside of the formal school system. Naturally, most of them include some on-the-job training. The programs range from adult training in schools to on-the-job training primarily run by firms.

A) United States Studies

1.38 In the United States, the largest system of adult vocational training programs is that established under the Manpower Development and Training Act (MDTA), and there are several studies of its effectiveness in general and the effectiveness of specific training courses.

1.39 Borus (26) evaluates the MDTA program in Connecticut. Most of the important costs and benefits are carefully considered, and ratios are given for the economy, the government, and the individual. They are all greater than one, greatest for the economy, followed by the government, and finally for the individual. Borus also found that unemployment is decreased by training only when there are vacancies in the labor market.

1.40 A study by Main (27) evaluates the nation-wide system of institutional job-training centers established by the MDTA, in terms of income and employment of graduates. The sample consisted of 1200 former trainees. There is no analysis of costs. Results showed that there is no significant difference in wages between those who completed the program and those who did not. The employment period for those who completed the program was longer by an estimated 13 to 23 per cent, whereas for the dropouts, it increased by only 7 to 19 per cent.

1.41 Mangum (28) also evaluates the whole system of MDTA. He considers total costs and benefits to society in terms of increased productivity and lower unemployment rates. He finds the cost-benefit ratio to the Federal Government to be 3.28 for MDTA on-the-job training and 1.78 for MDTA institutional training for all enrollees, based on the net additional earnings during the first year after training. There are also a series of cost-benefit and cost-effectiveness studies of different types of training programs in the United States.

1.42 Cain (20) offers cost-benefit estimates for the Job Corps from a postcard survey of a group of white Southern males. Most of the important costs were considered, and benefits consisted of increased earnings and various non-monetary benefits. The author also provides a cost-benefit ratio for various levels of educational achievement. He concludes that the Job Corps does increase lifetime earnings through its training in reading and math, as well as through vocational training. There are many significant non-monetary benefits also. He concludes that if there are fewer dropouts and a fuller use of the facilities the cost-benefit ratio would be greatly increased.

1.43 Bateman (30) evaluates an experimental vocational education program called the Training and Technology Project. He considered many of the important costs and benefits and found the rate of return on the government's investment to be 20 per cent. In addition, society achieved a more efficient allocation of labor because the skills taught were those actually needed by industries in that area.
1.45 Kraft (32) evaluates the cost-effectiveness of two vocational-technical training programs given at centers in Florida. Most of the important costs and benefits (including non-monetary benefits) were considered, and ratios and rates of return were determined. Since these measures were positive, the author considers the programs successful.

1.46 Scott (33) evaluates the economic effectiveness of an on-the-job training program run for Indians in Oklahoma. There were 78 respondents in the sample, who were trained at nine firms. Some of the important costs and monetary benefits were considered. High private and social cost-benefit ratios were found, and the program was considered effective. The study also recommends the shortening of training periods, most of which appeared to be longer than necessary for the skills required.

1.47 Roberts (34) evaluates a pre-apprenticeship program in Washington, D.C., that was designed to bring more blacks into the building trades. The average cost to the government is compared with benefits from increased earnings and employment stability. Half of the 143 persons completing the program were in an apprenticeship program a year later, and their wages had increased more than those of the control group of non-selected applicants (55 per cent vs. 25 per cent). The author considers the program successful because these results compare favorably with the results of other training programs. There are also a series of evaluations of non-school vocational programs that refer to costs and benefits in a qualitative manner.

1.48 Doyle (35) offers a qualitative evaluation of apprenticeship programs. He has gathered comments from an unspecified sample of union- and corporation-sponsored programs. He finds that instructors and apprentices begrudge the time they must spend together because only monetary incentives are offered. The length of time an apprentice must spend learning the skill is not determined by his aptitude or performance, but by a fixed rule. An improvement in non-monetary incentives would also lower the costs of training to a firm. Doyle recommends an improvement and expansion of apprenticeship programs.

1.49 Grell (36) focuses on a group of MDTA programs given in public schools in Lincoln, Nebraska and bases his study on a questionnaire sent to 389 students of the clerical, practical nursing, and dental assistant programs, and to 123 employers. No costs or quantitative benefits are considered. He reports general satisfaction with the programs.

1.50 Perlman (37) evaluates on-the-job training programs, basing his work on interviews with 245 firms in Milwaukee, Wisconsin, 150 of which had formal OJT programs. He describes the curriculum and methods of these programs, and the selection procedure for trainees. There is no specific analysis of costs and benefits. He finds that many vocational school graduates have to be retrained on the production line and, therefore, recommends that vocational schools concentrate on general skills, including language and math. He also observed that very few firms have formal ongoing training programs, as most are set up for current needs and keep the worker active in production.
1.51 Tuttle (38) presents a qualitative evaluation of a cooperative-education training program in Des Moines, Iowa, based on interviews with 135 graduates and 30 of their employers. The graduates were generally satisfied with the curriculum of their training, and 62 per cent were in jobs related to their training. Employers were also satisfied. Thus, the program was considered a success.

1.52 It is interesting to note that nearly all of these studies show that the programs were successful on a cost-effectiveness or qualitative basis. However, most studies do not present a comprehensive analysis of costs. This is especially true for programs that have a large component of OJT. There are also no comparisons of cost and benefit or cost-effectiveness of different modes of training to enable decision-makers to choose among training alternatives.

B) Studies Outside the United States

1.53 Evaluations of training programs for adults in developing countries with a few exceptions, do not provide a comprehensive analysis either. The first group of studies is made up of evaluation of national training systems. The study by Horowitz and Zymelman (39) evaluates the Rapid Retraining System of Adult Vocational Education in Brazil. A sample of 5,000 persons were interviewed (out of 57,000 enrollees). Graduates, teachers, and administrators gave a complete evaluation of the training process. Almost all of the important costs of the program to the government and benefits to the individual (including non-monetary benefits) were considered. The authors conclude that this mode of training is effective because most of the graduates were employed and well regarded by their superiors. Costs per graduate were also low because the program took advantage of existing excess capacity of buildings and equipment of industries and schools.

1.54 Esteves de Carvalho (40) evaluates a similar six-month accelerated course of adult vocational training in Portugal. The sample comprised 415 trainees in two series of courses at one training center in Lisbon. The costs of the two series were compared with the estimated increases in productivity, and the rate of return was found to be 25 per cent to 30 per cent, the payback period 328 working days. The author therefore concludes that this program is quite successful.

1.55 Chakravarti (41) evaluates the social return to a program of training unskilled workers in the heavy electrical industry, a public-sector enterprise, in India. He uses a sample of 1770 workers enrolled in a two-year program. Many of the important costs to the firm, and the monetary benefits to society (increased productivity) are considered. Rates of return are calculated using assumptions about shadow wages and training costs, including the domestic and world-market prices. The rates vary between three and 48 per cent, but the author concludes that since most are higher than six per cent, the program is profitable.

1.56 The study by Lucila Arrigazzi (42) is an a priori study made to determine whether or not some vocational training programs offered by INACAP, the National Training Institute of Chile, should be expanded. Some of the
important costs and most of the important monetary benefits are considered. The report predicts a rate of return to funds invested in the expansion of vocational education from 30 to 50 per cent.

1.57 There are many studies that evaluate off-the-job training in European countries, such as the following. Ziderman (43) evaluates the Governmental Training Centers for adult vocational training in the United Kingdom, analyzing data collected by the government. Most of the important costs and benefits (monetary and non-monetary) are considered. He develops rate of return and payback period criteria. From these he concludes that the programs at the Centers have net positive benefits to society. He urges that a more detailed survey follow his, using control groups, a specified sample, and analysis of indirect effects.

1.58 Lees (44) evaluates the training boards set up by the 1964 Industrial Training Act in the United Kingdom. No sample is specified. The author describes the training system and concludes that the Act should be revised because many firms are offering too specialized training (the skills are not transferable), and smaller firms are unable to compete with the larger ones for training funds.

1.59 La Formation Professionnelle des Adultes (45) is an evaluation of the French system of vocational training for adults (ATU). No sample is specified. The study describes the system and concludes that it is a success because many graduates found employment and two-thirds of them are now working in jobs for which they were trained. The expansion of the system is also recommended.

1.60 The study by Fenger (46) is a qualitative examination of the system of plant vocational schools in West Germany. These schools are designed to provide a secondary vocational education, which includes general and theory courses, to young people who are continuing their compulsory education. Data come from 23 large firms operating these schools and from 100 other firms with apprenticeship programs but no theoretical training. He concludes that the plant schools are successful from the students' point of view, but are rather expensive for the firms. The 100 firms expressed general satisfaction with the training given by the much larger system of public vocational schools and Fenger, therefore, expects that there will not be much pressure to expand the plant-school system.

1.61 Reinermann (47) evaluates the apprenticeship program in West Germany, summarizing the qualitative criticisms and defenses of the program. No sample is specified. The author concludes that there is still an important place in Common Market countries for apprenticeship programs in certain skills, such as plumbing, electrical installation, automobile mechanics, etc.

1.62 There are two excellent European studies of specific training programs, which are presented below. Thomas (48) studies the benefits of an improved training program at a clothing factory in the United Kingdom. The comparison in this case is between the presumably haphazard and unscientific training method before improvements, and the new system established by a group
of consultants who studied the factory's production line, prepared a manual of instruction, and trained experienced workers in teaching methods. Costs and benefits are analyzed in detail. The high cost-benefit ratio carefully calculated by the author leads clearly to the conclusion that factories should use the proposed ideas in their training programs. He points out that 75 per cent of the benefit to the firm in increased production was due to the lower turnover rates of employees graduating from the new program, which shows that they are more satisfied with their jobs.

1.63 Winterhager (11), already cited, evaluates the costs of comprehensive in-plant training programs in West Germany. All of the important costs of these programs (using a sample of three firms) are considered; benefits are not, although different turnover rates associated with the training are given. The author finds that the cost of training is higher per student than the cost to a vocational school because of lower student-teacher ratios, the high cost of teaching equipment, and student financial aid. There was no clear relationship between the cost of training and the turnover rate of trainees.

1.64 Castro (49) compares costs per student hour of programs (SENAI, PIPMO) in Brazil and formal vocational schools. Data were collected from a sample of establishments and schools. No definite conclusions were arrived at in this study. It was found that in some cases some schools exceeded those of training in establishments, while the reverse was true in other cases.

1.65 In reviewing the mixed studies in this group, one is struck by the variety of training systems, each with its own advantages and drawbacks. No definite conclusion can be drawn about any of the results. Only specific studies such as those of Thomas (48) and Winterhager (11) provide a detailed analysis. In general, the broader the system under analysis the less specific conclusions one can draw.

VI Miscellaneous Studies Evaluating the Effects of Important Factors on the Effectiveness of Vocational Training

1.66 In the last category of this survey, we have included several studies whose subject matter is represented in one or another of the previous categories, but whose main goal is to analyze the circumstances that affect the rates of return of the different kinds of training programs. These authors point to such things as the state of the labor market, personal characteristics of the trainee, and the effect of the first job on a graduate's earning expectations.

1.67 Hardin (50) analyzes several manpower development (MDTA) programs in Michigan. He compares cost-benefit ratios for different courses, trainee characteristics, and labor market characteristics. Costs were quite carefully determined for individuals and the governments (state and federal). The increase in disposable income is used as the measure of benefits to the individual, and pretax income as benefits to society; multivariate analysis is used to isolate the increases due to training from other causes, such as a favorable labor market or personal characteristics. Hardin finds that short courses give the best results and recommends that they be expanded to include more demographic and occupational groups than programs include at present.
1.68 Rawlins (51) compares four manpower programs for disadvantaged youth: the Job Corps, MDTA Institutional Centers, the Neighborhood Youth Corps (NYC) program for school dropouts, and MDTA on-the-job training (OJT). He examines one program of each kind in the Los Angeles area. Some of the important costs are considered; the benefits are increased earnings. Rawlins finds that the kind of program seems to make no difference in earnings, but that earnings increase the longer one attends the program. The Job Corps' strong point is its good counselling effort; the NYC's special benefit is that it encourages getting academic credentials which may be important in the future.

1.69 Gubins (52) compares the cost-benefit ratios applicable to a MDTA program in the Baltimore black ghetto with those applicable to larger populations, including an analysis of the effects of age and education attainment. His sample of 108 graduates represented a 33.8 percent response rate; the control group comprised all applicants to the program. Most of the important costs to the government and individuals were considered, while benefits consisted of earnings. Gubins found that there are substantial payoffs to the economy and society from training hard-core unemployed ghetto residents. The cost-benefit ratio is greater for persons younger than 22 than for those older, and greater for those with less than 9 years' education than for those with more, although the training is beneficial to trainees regardless of age, sex, amount of education, or the discount rate used in the calculation. He adds that the amount of investment in this MDTA program could be expanded two or three times, and the cost-benefit ratio would still be significantly high.

1.70 Schriver (53) uses samples from other studies to analyze the effects of the personal characteristics of the trainee on the rate of return to vocational training. The study concludes that the rate of return is higher for persons who had a low I.Q.; were married; had additional training; and who had only 15 months or less training at the area vocational school.

1.71 Greenberg (54) analyzes the effect of an enrollee's first job on his future performance. He sampled 289 graduates of four different Los Angeles training programs who were hired by 16 firms, but he is not confident of the representativeness of the sample (this is a pilot study for a larger project). No costs were analyzed, but monetary benefits were compared for carefully specified characteristics. Greenberg finds that the type of firm is the strongest variable in determining the wage rates of the first job. Being married, older and non-Negro all have positive associations with wages, while being female or Spanish-surnamed have negative associations. On-the-job training programs are significantly better than other kinds with respect to starting salaries.

1.72 Loewe (55) compared good and poor vocational-school pupils at several schools in West Germany and found that the poor pupils suffer primarily from a lack of motivation. They are not as sure of their aptitudes and interests as the good pupils, who were encouraged by a stable family life and urging from parents and teachers to explore many different interests.
What is clear from the work of this group of authors is that a training program cannot be evaluated just by a cost-benefit analysis and then applied equally to all parts of the population or all geographic areas. Proper planning will always require careful consideration of the personal characteristics of the trainees and of the labor-market conditions in the area. It is, once again, our conclusion that the studies on our list do not take account of these factors in a systematic way.

CONCLUSIONS

The purpose of this review was to ascertain the cost-effectiveness or cost-benefit of different models of vocational training from a thorough search of the literature on vocational training. The number of studies specifically designed to compare modes of vocational training is exceedingly small and most of the studies were done in developed countries. In general, it can be stated that there is no conclusive evidence that shows one type of training to be superior to others in terms of a cost-effectiveness criterion.

It is generally believed that costs of formal vocational training are higher than those of on-the-job training, although a detailed study in West Germany shows the opposite to be true. However, effectiveness of formal vocational schooling is believed to be higher than OJT, especially in developed nations.

Most studies done in developing nations comparing cost effectiveness of formal vocational schools with that of academic secondary schools conclude that vocational schooling is not profitable. This may be the result of inefficient operations, but it is primarily the consequence of offering training for occupations for which there is little demand in the labor market.

Studies evaluating special training programs generally show positive effects of the programs, but very few studies were done on a comparative basis. With few exceptions, the studies are not thorough when dealing with costs and benefits. A series of studies reveal the importance of background variables of the student in determining the success of the program. Seldom do these studies also combine a detailed and factual analysis of costs.

When comparing modes of training; two basic questions, not considered by most studies, have to be answered:

1. Do the measured benefits of training reflect the quality of training, or mostly the employment opportunities of the occupations trained?
2. Are the costs of a mode of training those of an efficient operation?

1.80 For example, some studies find that many graduates from vocational schools do not find jobs when they graduate. Is this due to being trained for occupations for which there is no demand, or to faulty instruction? In the first case, a choice of a different mode of training without correcting the decision-making process determining the content of instruction will not alter the result, unless the new mode of training assures a better conformity with market conditions. In any event, a correction of the decision-making process may be cheaper than changing modes of training.

1.81 Another set of studies may show very high costs per graduate of formal vocational schooling. But this may not be sufficient reason to claim that training outside of school may be more profitable (assuming benefits are the same) because the high costs are sometimes a result of a poor use of capacity. If better utilization is made of teachers and equipment, the picture of costs may change radically. Relationships between costs and economies of scale in different modes of training were not explored at all in any of the reviewed studies. A basic criticism, then, to the approach of determining the cost-effectiveness of a mode of training from past studies is that the observed costs and benefits may not be those of efficient operations.

1.82 Finally, it is doubtful that results from a comparative study can be transferable to situations that are not very similar; therefore, a far more important avenue for research leading to the right choice between alternatives is to explore systematically the conditions under which one mode of training is more advantageous than another.
II. CHARACTERISTICS OF INDUSTRIAL VOCATIONAL TRAINING AND FACTORS INFLUENCING THE CHOICE OF A MODE OF TRAINING

This chapter classifies and describes the different modes of vocational training; their advantages and disadvantages. The choice of a mode of training depends on a number of economic and institutional factors. These factors are analyzed to show how they can affect this choice.

General Classification of Training

2.01 Two fundamentally different methods are available for training in manual work in industry. One is training while working in the production process, and the other is training in some other environment, off the job itself. In the former, the individual is working on a specific job and simultaneously learning by doing. In the latter, the individual may or may not be employed but, in either case, he is being trained outside the production process. In turn, each of these two basic methods contains an array of discrete subgroups arranged along separate continua. The following outline summarizes the main training methods and their subcategories:

A. Training on the job
   1. Formal on-the-job training (OJT)
   2. Informal training

B. Training off the job
   1. Location and/or sponsor
      a. Public school
      b. Work place or employer
      c. Training center
      d. Private proprietary school
      e. Equipment manufacturers

C. 2. Kind of classroom and/or course
   a. Shop class
   b. Classroom
      (1) Vocational (related instruction)
      (2) Academic or nonvocational
c. Combined types of training

1. Formal apprenticeship

2. OJT plus related instruction

2.02 Training on the job takes a variety of forms, ranging from the highly organized program with a specified curriculum and special instructors, to a loosely structured, informal helper-craftsman relationship. Nevertheless, all such varieties of training in the work place involves trainees who are employees, with a job at the firm in which they are being trained. There need not be an explicit acknowledgement of a training relationship; the length of training and its contents can vary with the needs of the employer and the learning speed or ability of the trainee. Training on the job is imparted by either another worker, a special instructor, or a supervisor who acts as an instructor by assigning tasks to the trainees and evaluating his performance.

Similarly, there is no one discrete form of training off the job. The forms may differ in terms of timing, location, sponsorship, and course content. The training class can be held during the scheduled work day or outside it, and the program can be part-time or full-time. The class can be held in a shop or in a regular classroom. It can be conducted in the factory or outside it in a training center in a public school or in a private proprietary school. The sponsors can be public authorities, individual employers, an association of employers, private schools and even trade unions. The training can be classified by type of subject in the following way: academic related and shop course.

2.04 Just as there are a number of types of training on the job and a wide variety of types of training off the job, there is a whole range of combinations of training programs. Any type of training at work may require some course of related instruction given off the job. How these are combined into a single training program varies considerably, depending upon the sponsoring organization.

2.05 The array of training methods can be arranged along a continuum, with off the job training at one extreme and on the job at the other. The following diagram of indifference curves illustrates this last point. Training programs for the same skill can combine in various mixes, both training off the job and on the job. Each curve indicates the training of a specific number of trainees of equal quality. Successively higher curves show successively larger numbers of trainees. In the same way, these curves can depict successively higher quality of training of a fixed number of persons. The relative costs of training on the job and training off the job yield a budget line that determines which particular mix of methods is most efficient (i.e., cheapest).
Analysis of Training Types

2.06 A. Training on the Job

Description: In its broadest sense, training on the job involves learning to perform certain tasks and work while performing on the production line. At its simplest level, a new employee is hired and then shown how to perform certain tasks at the work bench, starting with the most simple task. As he succeeds in performing this first task, he is shown and taught how to perform successively more complex tasks. And while this learning process is going on, the trainee is also performing tasks in the production process. To a large degree, training on the job is basically a process of learning by doing.

2.07 In the more formal programs of training on the job, the training is imparted by an instructor whose principal responsibility is to teach groups of trainees to perform a certain job in an efficient and safe manner. Depending on the skill level of the job, the training may be quite short, or it may extend beyond a year or two. In numerous instances, the program is self-paced, and each trainee learns as rapidly as he can.

2.08 In some of the less formal programs, a supervisor may have the responsibility of conducting the training. Only in the larger firms where the number of trainees is substantial does an instructor or a supervisor spend considerable time in training. In the informal programs, instruction may be impar-
ted by a fellow employee who is asked by management to "show" the new employee how to do the job. In such situations, a great deal of learning by the trainee is accomplished by watching his co-workers. Such informal programs are normally in small plants where the number of trainees is very small.

2.09 Advantages: There are numerous advantages to the process of training on the job. For the trainee, the principal advantage is that he has a job and an income; he does not have that concern about finding a job after he completes his training. He also lessens the probability of being trained for an obsolete skill. In many situations, the trainee learns at his own pace and, therefore, is not pushed too hard to maintain a difficult pace nor is he bored by repeating tasks he has already learned. Where jobs are arranged in a promotional hierarchy, training on the job becomes the process of upgrading. The training can take the form of a helper-worker relationship. For the competent worker, this means that training offers the greatest opportunity for promotion.

2.10 From the viewpoint of a firm, training on the job has many advantages. It can impart those desirable work habits which the company considers important. Because it occurs in the context of the work environment, it can instill the appropriate attitudes toward work and shop discipline, as well as to reduce the danger of training individuals in obsolete practices or on obsolete equipment. It can automatically train the person on modern equipment and in up-to-date trade practices -- things that training schools find too expensive to do. It trains a worker for a specific job with his employer, making the worker valuable to the firm, but not necessarily valuable to other companies. This is a distinct advantage to the firm that does the training because it cuts down on costly turnover.

2.11 Trainees in a program on the job can make a positive contribution to output early in the training period, especially where a helper-journeyman relationship is customary and an essential part of the assignment of work tasks. Training on the job allows keeping abreast of current techniques. This is especially true in cases of dynamic or rapidly evolving technologies.

2.12 Another distinct advantage of training on the job, where the learning process for the trainee consists of being shown or told what to do, is that the intellectual requirements of the trainee is at a minimum. The trainee is generally not required to read or write (or the requirement is minimal), and the requirement of language or expression is also very slight. And even where language barriers might inhibit normal conversation, a worker can be taught the job by being shown what to do and what not to do. In the shop situation, the instructor can more readily adapt his teaching to the capability and needs of the individual trainee. In addition, the instructor need not be a skilled craftsman, schooled in pedagogy.

2.13 Where specialized training is needed for a very small number of persons, there is no effective alternative to training these few individuals on the job. Even one or two persons can be set into such a program without exorbitant costs because of small numbers.
2.14 From a social point of view, there is a distinct financial advantage in training on the job over training in public vocational schools. If development or industrialization is to some degree dependent upon an increase in the trained labor force, increasing the enrollment of trainees in the public vocational school involves a direct cost to the government in public outlays for education. The burden of on-the-job training is shouldered by those directly affected: the firm and the individuals.

2.15 Disadvantages: To some degree, training on the job is disruptive to the production of a plant. While a trainee is learning, the machine he is using is not fully productive, or as productive as other machines. In addition, the trainer who may be a fellow worker or a foreman is spending time away from his normal duties, and this too is a cost to the firm. When the number of trainees is relatively small, the amount of disruption to total output is also small, and the extra cost can be absorbed rather easily. However, as the number of trainees increases and the amount of time instructors spend away from their duties increases, the company's ability to absorb the costs diminishes. Training on the job is feasible only when the ratio of trainees to employees is small.

2.16 Training on the job has a relative advantage over vocational school training when the level of skill of the occupation to be taught and, hence, its theoretical structure is limited. However, if an occupation needs a theoretical background, the latter cannot readily be imparted solely on the job. Theoretical aspects of a job are best taught in a classroom situation.

2.17 From society's viewpoint, there are economic advantages to having broadly trained rather than narrowly trained craftsmen because of the job mobility this gives the workers. Clearly, a broadly trained worker who becomes unemployed has greater job opportunities than one who was narrowly trained. Workers who are trained on the job are being taught tasks and procedures peculiar to a single employer. Such training can be viewed as a disadvantage from the viewpoint of society.

2.18 Training at work presupposes the existence of job openings and often requires the individual to find his own job first, possibly without the guidance of someone with information about the labor market or someone able to provide occupational counseling. In the same fashion, training on the job assumes that the industry already exists, which is not always true in developing nations. Where the industry does not yet exist the training of manpower must be done outside the plant.

2.19 A major disadvantage of training on the job is the difficulty of insuring that trainees are receiving instruction from capable individuals able to teach, as well as insuring that the trainee is not becoming overly specialized in the work process of a single shop when the objective is a broadly trained person. The issue here is the uniform quality and breadth of training where the skill is a complex one used by more than one employer.

2.20 In general, training on the job by itself has disadvantages when a broadly trained worker is desired, when the work in a given firm is unique, or when it is difficult for experienced workers to stop what they are doing and instruct a trainee, when it is difficult to transfer workers among different shops or when the employer is reluctant to give the trainee varied work assignments.
2.21 B. Training off the Job

Description: Training off the job involves two different kinds of training: the shop class and the regular classroom, which serve different purposes. The former serves as a substitute for experience on the job and the latter provides vocational knowledge directly but not necessarily of immediate value at work. Because it is so broad in approach, off the job training serves many purposes. It can impart vocational knowledge of immediate use at work; it can impart vocational knowledge that must precede work; it can impart a stock of vocational knowledge that becomes useful over the working life of the individual but is not needed immediately. It can also refresh or sharpen academic skills or related instruction learned but forgotten or not learned well, such as arithmetic or "math" and reading in the first case, or shop theory in the second. It can also provide vocational skills that could be taught on the job but are not because it is technically impractical to do so or because it is too expensive in terms of lost production, in view of the time supervisors and experienced workers must devote to the training of trainees.

2.22 Training off the job can take place in a variety of ways, but there are four basic types of such training: (1) public vocational schools, (2) training in the enterprise, (3) training in skill centers, and (4) training in private schools.

Public Vocational Schools: The public vocational school normally is part of the regular public school system. In many countries, the choice is between the vocational school and the academic (college preparatory) school, and students who through examinations do not qualify for the academic are assigned to the vocational program. In other countries, the selection is left to the students, but with advice from guidance counselors. Where the vocational program has a good reputation, students who are manually-oriented make a positive choice of the program; where the vocational program does not have a good reputation, it is sometimes used as a dumping ground for the less qualified academic students. In most cases there are no tuition costs to the students.

2.23 The average public vocational school offers training in a number of basic crafts, such as woodworking, machine shop, electrical work, auto repair, etc. After some orientation in the various types of work, a student selects his area of interest, with the limits of pre-determined class sizes. Once the specialty has been selected, the student spends a substantial amount of his school time in the shop room, learning about and performing on the specialized equipment. In addition, the students take courses on related instruction; i.e., in shop math or theory related to the specialty involved, such as blueprint reading. In many countries, especially where the vocational school students are so young that they have not completed parts of their basic education, the vocational program offers courses in general education, such as history, literature, and grammar. Vocational school programs usually run for about three years, but this varies. As part of the public school system, it is administered by the Ministry of Education, and the instructors are governed by the general civil service rules. Nevertheless, the requirements for teaching the shop classes normally include some years of experience in the trade. Depending on the size of the program, the physical facilities may or may not be independent of other parts of the school system. If the program is small, it may be part of a larger secondary school where students in
different programs participate jointly in common courses as well as the administration. It should be noted that the facilities can be used after school, on weekends, and in the evenings for adult vocational training courses.

2.24 Training in the Enterprise: A second type of training off the job is the program provided in a firm's own facilities, but not as part of the production process. Depending on the size of the program, it may be conducted in a separate room in the plant, or it may be a separate building on the firm's property. Normally, students in such a program are assured of a job with the company upon successful completion of the program. The basic part of such a program are shop courses to train workers in the use of the firm's equipment, although related instruction courses may also be offered if they are relevant to the skill required. A large company may provide actual job equipment in a shop class so the trainees get all their experience in the classroom; other companies may use their regular production equipment for training, but select the time when little or no disruption to output occurs.

2.25 Training in Skill Centers: A skill or training center is an institution offering training in one or more skills to persons who normally have completed (or dropped out of) their legally required schooling. The training center may be sponsored by a government agency or by a private group, frequently a group of employers or an industry association. In addition to shop classes, there would be related instruction classes, but it would be very unlikely for a training center to offer any academic courses. If sponsored by a government agency, the center is likely to offer programs for occupations that are generally considered in short supply, and the trainees are likely to be broadly trained to meet the needs of a variety of firms and industries. However, if the center is sponsored by an industry group, it is likely to offer programs for occupations specifically needed by the industry, and the trainees will receive rather narrow training. An industry group is prepared to finance and sponsor a training center when the average firm in the industry is not large enough to support its own in-plant training program.

2.26 Training in Private Schools: Another type of training off the job is the private proprietary school. Such profit making organizations establish training programs for those occupations which seem to be in greatest demand and where the potential demand is likely to continue to grow. Generally, the courses are limited to those who have completed the legally required years of schooling, and they offer training in a limited number of areas. The facilities would contain shop rooms and classrooms where related instruction courses would be offered. The shops normally contain rather simple or obsolete machinery, and it is assumed that with a broad exposure to a trade, a reasonably able graduate would learn to handle any machine after a short time on the job. Courses are offered both day and evening, and the tuition charges are generally rather high.

2.27 Advantages: The basic need for off-the-job training rests on the assumption that trainees require a certain amount of vocational or technical knowledge before entering the plant or shop, or before being assigned specific work tasks. Thus, preliminary instruction is deemed necessary to prevent injury to the trainee, damage to equipment, or waste of materials. It also prepares the worker for the additional training he may get on the job. In short, the individual cannot perform safely or cannot be instructed or taught with reasonable effectiveness or at reasonable cost without some initial familiarity with the work process and work procedures, and without an understanding of the unique terminology used in the trade.
2.28 Training off the job, by itself, or in conjunction with on-the-job training, is appropriate for the more complex (i.e., higher) skill levels. Such skills demand a broadly trained individual who can apply his skill under a variety of work situations or in a variety of establishments and typically involve the use of discretion in meeting problems as they arise. The skills usually are based on a relatively organized, systematic body of "theory" that is best presented formally in a systematic way in class. Often such occupations are likely to require preliminary instruction before the trainee actively performs on the job. Such broad training offers the individual who completes the program greater mobility and more opportunity to find a job in a variety of industries.

2.29 The public vocational school generally has the advantage of being in a position to offer general academic courses in addition to the vocational training. In many countries, youths are often in a position to engage in vocational training, but have not completed their general education; and in some cases this means they have not learned to read and write sufficiently well to handle their training program. This ability of public vocational schools to offer general academic courses makes it possible for those youths not yet through their compulsory education to begin taking vocational courses along with academic courses. In addition, public vocational school programs can be generalized beyond the confines of particular traditional skills, so that a young worker is taught more than one trade. Many different trades now have a common basic training with specialization only toward the end of the program.

2.30 While training programs on the job are limited to a relatively small number of trainees because of the costs involved, off the job training programs can handle larger numbers. In addition, a single employer may lack the technical know-how to direct training and probably would find it uneconomical to employ training specialists. An off-the-job training center has none of these disadvantages. The center need not be a public one, but could be operated and financed by an employer association. Such an arrangement could capture the advantages of training by specialists, as well as the low per unit costs of institutional instruction.

2.31 Off-the-job training programs are more likely to be able to offer their courses at all times during the day and week, and on both a full-time and part-time basis. This type of schedule gives all persons an opportunity to participate in a training program, whether a youth interested in a full-time program or a working adult who is interested in an evening course.

2.32 Disadvantages: An obvious disadvantage to training off the job is that there are certain minimal requirements for successful training at reasonable costs. These requirements include (1) trainees who are literate (probably not below a sixth grade level) and have commensurate proficiency in computational skills, and (2) trainees sharing a common language (in order to facilitate group presentation of materials). In addition, there must be enough students per class in order to make economical use of the investment in facilities and equipment. Where the number of students is small because of the size and location of firms or the size of the local labor force, training off the job, otherwise desirable, may be extremely expensive per trainee.
2.33 Unlike training at work, training off the job requires instructors who are skilled craftsmen schooled in pedagogy and whose alternatives might be skilled production or supervisory work. There is an obvious cost advantage if it is possible to have the instructor performing a dual role when he cannot be fully utilized in either one. Training on the job allows the instructor to train and work simultaneously or to devote only part of his workday to teaching and the remainder to production work or supervisory activities. This dual role is of great importance when the instructor’s time would be underutilized if he were solely a classroom or shop teacher. In addition, training off the job requires other skilled personnel to be available to teach skilled craftsmen the necessary techniques and theory of pedagogy to become vocational teachers.

2.34 One must consider the possibility that public vocational schooling might encourage an individual to continue his education beyond that needed for the work in which he has been trained and, thus, never enter the trade. This would be particularly so if the vocational school is seen as a substitute for high school and a step toward acquiring a technical or engineering degree, or a white-collar job.

2.35 When training off the job is done in private proprietary schools, the direct cost in tuition is high and excludes low-income families from programs. Private schools become a realistic alternative only where the free training programs either are filled to capacity or are offering obviously inferior training. It also should be noted that resources devoted to job development and placement are additional costs to school programs.

2.36 Various on-the-job training programs have been developed because traditional systems of vocational preparation in public or private schools frequently did not meet the needs of modern industry. Vocational school programs often are too theoretical and not job-related; and unskilled school dropouts are not ready to enter the production process.

2.37 Training programs off the job have a tendency to become inflexible, especially when the school has obligations to teaching staff and where expensive equipment has been purchased. There is also the cost of revising or preparing curricula to accommodate changing techniques.

2.38 A final disadvantage of off-the-job training is the necessity of finding a job after the program is completed. While the whole program is geared to learning a trade, and to working at it, training graduates do not all find work in the trade for which they are trained. Also, many spend long periods looking for a job. This is an economic waste from society’s viewpoint.

2.39 C. Combined Types of Training

There are a number of training programs that combine some aspects of training on the job and training off the job, but there are three basic types: (1) apprenticeship, (2) training on the job plus related instruction, and (3) cooperative-work training (sandwich courses).

2.40 Apprenticeship: Apprenticeship is a formal program of training at work of a predetermined duration (which will vary by trade) combined with formal, mandatory related instruction conducted in the classroom or shop class
off the job. There is a prescribed curriculum of tasks to be taught in a
specified order with an explicit obligation by the employer to provide train-
ing in these tasks in order to produce a well-rounded journeyman. The employer
implicitly commits himself to employ the apprentice when his training is com-
pleted. The successful trainee receives a certificate that can be used much
like a high school diploma or college degree as evidence that the individual
has attained a certain proficiency in his trade. In a number of coun-
tries (United States and Canada are the prime examples), the apprenticeship types
of formal training is generally limited to a relatively small number of skilled
crafts, referred to as apprenticeable trades. These basically include the
skilled occupations in the construction industry, the printing industry and in
the machinery industry. In most countries around the world, the apprenticeship
type of training not only includes skilled crafts, but many semi-skilled as well
as white-collar occupations. Generally, the programs are supported and developed
by employers or employer associations, although there is frequent support by both
the government and the trade unions.

2.41 In many West European countries, related instruction classes often
are held during the scheduled work hours, and the apprentices are on released
time with pay. Thus, the apprentices receive their training on and off the job
during the regular workday, and they receive compensation for the total time.
In the United States, however, the common practice is the opposite; apprentices
attend related instruction classes on their own time. In apprenticeship programs
in the United States, related instruction occurs during the work week but usually
outside working hours in the evening (although Saturday morning classes are not
unheard of).

2.42 Training on the job plus related instruction: This type of
combination training program is one that combines some related instruction
courses (given off the job) with a specific form of training on the job. Many
on-the-job training programs, either because of the nature of the training or
because of the skills needed for the occupation, require or strongly urge
trainees to take specific related instruction courses. In most cases the
trainees take such courses on their own time, and frequently pay the tuition
out of their own funds. In other on-the-job training programs, it is recommended
or suggested that trainees take some related instruction courses, but such course
work is not integrated with the training on the job. Here, the related instruction
is used only as a broadening element in the overall training of the workers.

2.43 Cooperative-Work Training (Sandwich Courses): With younger
trainees whose formal education is still incomplete, mandatory classroom atten-
dance in public schools combined with training on the job is known as cooperative-
work training. The trainee is still a pupil and will spend more time in the class-
room than will adult workers whose mandatory schooling is over because the younger
trainee must take academic subjects required for a high school diploma. Such co-
operative training programs involve the cooperation of school and employer, and
the trainee spends part of his time (either day, week, or even month) in school
and the remaining time at work where he receives training and frequently with pay.
The school work does not consist entirely of academic courses. The trainee will
be taking shop courses and related instruction courses in the area of the occupa-
tion for which he is receiving training.
2.44 A variation of this cooperative-work training is common for adults and is called sandwich courses. Here an adult with a regular full-time job is given time off from work on a regular basis to take specific vocational courses. The courses may be geared to training for a specific trade or job, or to upgrading. Such sandwich courses make it possible to offer training to workers who could not afford to give up their jobs for this additional training. Generally the cost of such vocational courses are borne by the employer.

2.45 Advantages: Because of the diversity in the combinations of training on the job and off the job, the advantages of one combination need not apply to another. Apprenticeship, for example, has one general advantage over the other combinations in that it is generally recognized as the official training program by employers and public authorities, and the accepted program by unions. An apprentice who successfully completes his training program receives a certificate, which in many countries means top priority in jobs over those without such a certificate. The holder of such a certificate is assumed to have acquired the necessary skill and technique to perform adequately at his trade with little or no extra training on the job. Many countries have instituted tests of competence at the end of the apprenticeship period which is conducted by independent authority and leads to a nationally recognized credential.

2.46 Where theoretical aspects of an occupation are critical to the skill but cannot be taught economically on the job, there is no alternative but to combine on the job and off the job training. This combination also meets the needs of training highly skilled craftsmen when a considerable amount of theoretical material is necessary. For those occupations with complex skills using an organized body of theory, training on the job by itself, without related instruction courses, probably lengthens the training period or produces a worker with more limited skills.

2.47 In general, the breadth of work a trained worker may encounter over his working life—and on any one job or in any one shop can be a major argument for or against limiting training to that given at work. If the variety of work in a given shop is limited because shops are highly specialized, but it is desirable to produce a broadly trained worker, all-around vocational school courses might be an essential supplement in order to acquaint trainees with tasks and situations they are unlikely to meet with any one employer. If it is desired to train a versatile worker capable of working for a variety of employers with different needs and doing a variety of different tasks, no one of which is necessarily identical, instruction on the job combined with classroom courses off the job is essential. With solely on-the-job training, it would be necessary to rotate the individual among employers in order to maximize the opportunity for him to meet as much as possible of the full range of work in his trade. Such rotation however, can be difficult if not impossible to implement and even then may not expose the trainee to the full range of experiences desired. Depending on the relative growth potential among firms in an industry or among different industries, a highly mobile skilled work force may be desirable. If this is so, a certain amount of related instruction in a classroom situation would be required.

2.48 If workers enter the labor force at an early age before becoming fully literate, then a combination of classroom instruction and training on the job might serve as a control to curb leaving school early. There is some indi-
cation that the combination of schooling and on-the-job training (especially, there the trainee receives a wage while on-the-job training) has been a de-
terrent to potential school dropouts.

2.49 Disadvantages: Again, disadvantages of one combination of on-the-job and off-the-job training cannot be applied to another. For example, a basic disadvantage to apprenticeship is its tendency to set the duration of its training program longer than appears necessary in terms of the theoretical and technical knowledge required for skilled crafts. However, an argument in defense of the duration of apprenticeship is that it is necessary to enable an adolescent to adapt himself to life in a factory and to adjust to the physiological and emotional problems associated with this stage of life.

2.50 Another disadvantage to apprenticeship is its use by some trade unions to limit the supply of skilled workers. Where a significant per cent of a trade become journeymen through the apprenticeship route, controlling entrance to the training program effectively limits the number of skilled craftsmen. Cooperative programs require good coordination between schools and industry and intense supervision to insure that trainees are not regulated to perform menial tasks. Coordination and supervision of this kind is very difficult to accomplish. In addition, cooperative programs require that the administration of the program give assurance to participants that relevant jobs will be available throughout the period of the program. Because of the vagaries of the labor market, assurances of jobs are not always possible.

Factors in the Selection of a Training Mode

2.51 In general, the choice of training workers on the job, off the job, or with some combination of the two rests ultimately on economic and institutional factors. Among economic factors are: costs of training, urgency with which the skilled workers are needed and, in the case of training in the enterprise, the profitability of training to the enterprise. Among institutional factors are: the existing training environment, training laws, influence of unions and employer associations, attitudes of employers, nature of the labor market, etc.

Economic Factors Influencing the Choice of a Training Mode for Vocational Education

2.52 The decision to locate training in a school or in a plant, assuming that the output of the training process is the same, will depend on the relative average costs of training. But average training costs of a program are influenced to a large extent by the number of trainees in the program (size of program), the relationships of the training program to other training programs in the institution, and the nature of the laboratories and instruction needed in the program.

2.53 The Influence of Size of Program on Average Costs of Training: Given a scale of operations -- determined by a fixed plant or instructional staff -- there is usually a cost per unit of training which is lower than all other costs per unit of training which is lower than all other costs per unit that can be gotten with this scale. This is sometimes referred to as the "optimum" for a given plant size. In micro-economics this is usually represented by a U-shaped average cost curve.
The reason why this curve assumes the shape of a U is relatively simple. At very low quantities, average costs are high because fixed costs are spread out over few units. As quantity increases, fixed costs are spread out over more units. In addition, variable factors can be used more efficiently relative to the fixed ones and relative to each other as quantity increases. After the minimum is reached, average costs increase because variable factors cannot be used as efficiently as before, and the advantage of lower average fixed cost is outweighed by the increase of average variable cost. Since every scale of operations (plant sizes), theoretically, can produce a particular number of trainees at the lowest possible average cost, to compare average costs of training in two different settings, school and industry, it is necessary to elucidate first if the comparison is intended to find out which mode of training is cheaper for a given number of trainees to be trained, or what mode can provide the lowest average cost of training at an unspecified number of trainees needed.

The way to look at these problems can be portrayed as follows:

![Diagram of average cost vs. number of trainees](image)

At $N_1$ training in plant is less costly; however, at $N_2$ training in school is more advantageous. But the lowest possible average cost of training could be achieved in school only if $N_3$ could be trained.

2.55 The Influence of the Existence of Other Training Programs on the Average Costs of a Particular Training Program: It is sometimes possible to lower average costs of training of a particular program by increasing enrollments in related family programs within a cluster which share common resources, or by adding new clusters that could share existing resources. For example, if we need to train only 20 students in an oxy-acetylene welding program and costs are high because this enrollment level represents only fifty per cent time utilization of a welding instructor and laboratory, it is possible to increase utilization of available training capacity and, hence, lower laboratory costs per trainee by adding twenty students in arc welding or by increasing the enrollment in sheet metal and machine shops -- each of which requires some instruction in welding.

2.56 Of course, a decision to expand enrollments has to be based on the marginal costs increase (decrease) due to larger enrollments in these programs with the decrease (increase) of marginal costs of increased capacity utilization of oxy-acetylene welding. But the increase (decrease of marginal costs is
difficult to assess because most programs share resources in different proportions. For example, training in sheet metal skills requires the following weekly hours of instruction:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
<th>Stations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet metal</td>
<td>18</td>
<td>0.60</td>
</tr>
<tr>
<td>Welding</td>
<td>6</td>
<td>0.20</td>
</tr>
<tr>
<td>Mathematics</td>
<td>2</td>
<td>0.06</td>
</tr>
<tr>
<td>Drafting</td>
<td>4</td>
<td>0.14</td>
</tr>
</tbody>
</table>

In order to increase the utilization of welding by two stations, 10 more students would have to be enrolled in the sheet metal program. But 10 more students in the sheet metal program will require six more stations in sheet metal instruction. This may exceed the existing capacity** of the sheet metal laboratory. Therefore, it first has to be decided if there is a need to train more sheet metal workers, and secondly, how much it would cost to expand the laboratory for sheet metal instruction if there is no excess capacity available.

2.57 The Influence of the Nature of Laboratories on Average Cost of Training: Many laboratories and instructional staff cannot be increased in a continuous fashion, but must be provided in whole units rather than in the form of individual learning stations (number of students learning on a machine at one time). Thus, while a single lathe may be added to a machine shop to allow an increase of enrollments in the training of machine lathe operators, other laboratories, such as auto mechanics, require a group of machines in a given proportion, even for the training on only a few students.

2.58 In general, it is possible to classify laboratories into two types: Type 1: Laboratories composed of one or only a few types of machines necessary to train for a specific occupation, where the number of machines varies linearly with the number of students. In this type of laboratory, costs per student will vary with the use of capacity of the instructional staff. Average costs in this type of laboratory can be represented as follows:

One station = one student instructional site used 30 hours per week.

** Laboratory capacity is defined by queuing capacity of the machinery. This capacity varies sometimes with the locale. For instance, in the United States, a lathe would be considered a single instructional station and scheduled accordingly. However, in European countries it is not uncommon for two, three, or even four students to be working on a lathe at the same time. Besides, laboratories require at least 15% unused capacity to allow better scheduling and station loading, so an optimal utilization is around 85%.
Type 2: Laboratories that require a minimum configuration of equipment. For example, in auto mechanics a minimum laboratory would require an engine analyzer, wheel alignment system, electrical equipment, etc. Average costs vary with the number of trainees in the following way:

In case a) the minimum size of the laboratory corresponds to the maximum allowed student-teacher ratio. In case b) the capacity of the laboratory exceeds the maximum required student-teacher ratio.

2.59 In view of the intricate relationships between curriculums of different training programs and the varied characteristics of laboratories, the problem of maximizing the utilization of resources can only be met through the use of complicated optimism models. However, the maximization of utilization of capacity may be unnecessary and even undesirable if the school is to be flexible in its offerings over time. In fact, once a school reaches a moderate size in staff and equipment, a utilization of 80 per cent to 85 per cent of capacity is enough to provide sufficient flexibility to accommodate minor changes in enrollment levels or the addition of a small number of new programs. In some developed countries, it is felt that an enrollment of 500 to 750 students, depending, of course, on the nature of the programs being offered, is sufficient to provide flexibility and good capacity utilization. In
general, it is possible to approximate a "good" solution with relatively easy calculations. (Calculation of the costs of a training program can be seen in Appendix 2).

2.60 The Time Factor in Training: Where there is no urgent need for trained workers, the relative cost of training becomes the principal factor in determining the selection of the training method. However, where the need for the trained worker is urgent, the principal factor in determining the training method is its comparative speed of training. For example, if a plant cannot operate efficiently because it lacks skilled workers, the choice of a cheaper but longer training mode would be a case of sub-optimization -- optimizing a part of the system and not the whole system. The correct course of action would be to choose a faster, even though costlier, method of training as long as the increase in the costs of training is smaller than the cost of having an inefficient plant operation for a longer period of time.

2.61 Assume that we have a continuous spectrum of modes of training: \( T_1, T_2, \ldots, T_n \) and \( B_1, B_2, \ldots, B_n \), the budget lines.

The points \( A_1, A_2, \ldots, A_n \) are the modes of training that minimize costs of training. Points \( C_1, C_2, \ldots, C_n \) minimize the time of training (the sum of hours of on- and off-the-job training) and represent modes of training that are more expensive than the modes represented by \( A_1, A_2, \ldots, A_n \). However, as long as the difference in costs between the \( C \)'s and the \( A \)'s is less than the costs of lower efficiency in the plant due to a longer period of training, the training modes represented by the \( C \)'s should be chosen.

2.62 The time factor in training is especially important when staffing a new plant or industry. New plants usually face a variety of start-up problems that allow little or no time for careful training of inexperienced employees. There is then a good reason for off-the-job training. Usually, when a plant or industry needs trained workers (but could use some partly or semi-trained workers) to begin operations, it obtains such personnel from other domestic companies.
employing workers with the same or similar skills. The question for the training authorities is how critical are the trained workers in the establishments that will lose them and, since such recruitment might require raising the wages offered, how will this affect wage and price relationships. One alternative is recruiting foreign personnel on a temporary basis. A second is to have the companies who are losing personnel to the newer firms start an upgrading program in their own plants and hire unskilled workers at the bottom.

2.63 An alternative to having the new firm pirate skilled workers from other domestic companies is to establish a program for training before the start-up production. Some successful experiments have been done in this regard. Normally, many months pass between the time equipment is installed and the start-up of production. This time could be utilized for intensive training of skilled workers. Special foreign technicians could be used as trainers in some situations. In other situations, the representatives of the equipment manufacturers could be used as a resource for training workers on the new equipment.

Economic Factors Affecting Training in the Enterprise: Profitability to the Firm

2.64 The relative costs of training are but one factor in deciding the advantage of a mode of training. When training in private enterprise is contemplated, the profitability of training to the enterprise has to be considered. Employers will invest in training if expected returns to them will equal or exceed the costs of training. The equilibrium equation for a firm for the training of a worker in a plant can be written as follows:

$$\sum_{t=1}^{m} \frac{C_t + W_{at} - Q_{at}}{(1 + r)^t} = \sum_{t=m+1}^{n} \frac{Q_{st} - W_{st}}{(1 + r)^t}$$

where

- $C_t$ = cost of training a worker over a unit of time $t$
- $W_{at}$ = wage rate of trainee during $t$
- $Q_{at}$ = value of production attributable to a trainee during $t$
- $W_{st}$ = wage rate of a skilled worker during $t$
- $Q_{st}$ = value of production attributable to a skilled worker during $t$
- $r$ = rate of discount for the firm
- $t$ = length of training period
- $n$ = length of time the skilled worker remains in the firm.

These variables will be discussed below.
2.65 Cost of In-Plant Training: The decision to offer training in the plant depends to a large extent on the cost of training and trainee's wages.

Costs involved in training are:

- costs of initiating the training program
- costs of administering the training program
- costs of capital of the training program
- costs of supplies and materials of the training program
- fixed costs of instruction
- variable costs of instruction
- costs of training fees
- miscellaneous
- other

2.66 The costs of initiating training include the setting up of the program, by a designated person or persons already employed in the factory, by outside consultants or people especially hired to perform this function, or by a combination of both. When the setting up of the program is done in-house, it is difficult to determine the actual cost, especially when the people involved may be performing many other functions at the same time. Some criteria must be developed for these joint costs to the training program. The costs of initiating the program should be considered fixed costs and allocated over the life of the training program. Changes to update programs that have effect over long periods of time should be considered in the same vein.

2.67 Costs of administering the program include those of salaried people needed for administration; prorated costs of office equipment and materials; costs of selection and recruitment that include advertising for vacancies, school visits, costs of interviewing and testing, special follow-up of trainees in the factory; etc.

2.68 Capital costs for training include costs of land, buildings, and equipment used for training, allocated over the life of the training program. Special care has to be taken to specify a correct depreciation method and allocation methods when the equipment or buildings are used also for production.

2.69 Costs of materials and supplies are the variable and consumable costs that are related to capital costs.

2.70 Fixed costs of instruction include the preparation of teaching materials and the training of teaching staff. These should also be allocated over the life of the training program.

2.71 Variable costs of instruction are the actual costs of instructors, if specially hired for training, or the imputed value of the teaching services.

of plant personnel engaged mainly in the production process but whose duties include also instruction of trainees.

2.72 Costs of training fees. When the firm sends its trainees to take courses or be trained in programs provided by other institutions, sometimes it pays for the courses. These costs should be included in total costs of training.

2.73 Miscellaneous costs include a variety of items, such as statutory and social costs -- payment for statutory and annual holidays, insurance, contribution to pension schemes, subsidization of meals, travel and accommodations, etc.

2.74 Other costs include costs that cannot be directly assigned to training; these are costs related to the increase in the probability of damaging equipment and production, and to interference with the "normal" operations of the plant.

Note on the valuation of partial services of employees and capital of the firm when they participate in training.

2.75 When the expenditures for hired staff and purchase of equipment specific for training can be directly attributed to the training, their allocation is relatively simple. However, to evaluate the services of people and equipment in a plant whose main purpose is production is not an easy task. In accordance with strict economic theory, only opportunity costs of existing resources should be taken into account. But what is the opportunity cost of the short time a skilled worker spends teaching a trainee? The fact that the time is available should not be construed that opportunity cost is zero. The same goes for the idle time of a machine. Each production establishment needs a certain amount of flexibility in its scheduling and, therefore, requires a certain amount of "unemployed resources" to function properly. Full usage of resources due to added training may introduce inefficiency. However, any amount of free resources in terms of capacity of machinery and skills beyond that needed for flexibility of operations can be considered a resource with low opportunity costs. (It is seldom zero.) Here the problem of size of the training program is very important -- the smaller the training program, the more likely it is to be able to take advantage of available resources with low opportunity costs. The larger the program, the less it can do this. On the other hand, the larger the program the greater the chances for achieving economies of scale of structured instruction.

2.76 Wages Rates of Trainees: The level of wages paid to the trainee affects the profitability of training to the firm: the lower the wages, the more profitable the training. There is, however, a minimal limit for wages that the firm must exceed in order to entice trainees into the training program. This limit is largely determined by the opportunity costs of the trainee's time.

2.77 The value of a Trainee's Production: The value of a trainee's production is also difficult to determine. When trainees are segregated from the regular production workers, the valuation of production is straightforward:
(1) a per cent of the amount of trainee's time spent on production is calculated; (2) a level of productivity of a trainee in proportion to a skilled worker's productivity is computed; (3) finally, the total value of production for the firm is the product of (1) and (2) multiplied by the wage of a skilled worker. The value of production of a trainee working in a team with skilled workers can only be determined where it is possible to substitute trainees for skilled workers and to measure the difference in production between the team with and without the trainee.

2.78 Wage Rate of a Skilled Worker: In a competitive labor market for trained workers wages equal marginal product minus the cost of labor turnover that results in loss of productivity. A worker who quits produces a loss to the firm in the form of extra costs to hire a replacement and in the initial lower level of productivity of newly hired workers (before becoming acquainted with the machinery and environment). Many times a firm will offer training with the hope of minimizing labor turnover. The purpose of in-house training is to make withdrawal of a trained person more costly to him in terms of his investment in some specific training, social relationships, and adaptation to his work environment.

2.79 In a competitive market a firm will be willing to offer training only if the benefits from lowering the turnover rate is large, or there is a possibility of recouping the cost of training during the training period. The possibilities of doing so will be enhanced if it is possible to pay the trainee wages below the value of his production, and to lengthen the apprenticeship period with a legal restraint on deserting the training firm before completion of the contract.

2.80 When the market in which the firm hires its labor is not competitive -- as is the case of training that is specific to the firm or in the case of monopsony (when the firm has a de facto power on a segment of the labor market) -- wages are always lower than marginal productivity, although they are largely dependent on the bargaining power of the workers in the specific occupation. Therefore everything being equal, the probability of offering training in the firm is greater in a non-competitive labor market.

2.81 Elements Contributing to the Feasibility of Training in the Firm: There are basically two: market imperfections and non-economic behavior. The existence of market imperfections favors training in the firm. The importance of the lack of competition was explained above. However, other types of imperfections are as important. The existence of unemployment might limit mobility and induce employees to settle for wages lower than they might obtain elsewhere. Fragmentation of the labor market also hampers mobility between different occupations. Insufficient market information also induces workers to accept lower wages, at least by an amount that it would cost a worker to acquire the needed information. Among non-economic behavior reasons are: 1) business financing training for philanthropic, political and good will purposes and 2) fidelity of workers to the firm, inducing them to accept lower wages during and after training; thereby making training more profitable to the firm.
Economic Policies to Encourage Training in Industry

2.82 On the basis of the discussion of the economic variables that affect profitability of training in industry described previously, it is possible to design policies to induce firms to undertake training. When training is firm-specific, the conditions for training in the firm can be fulfilled probably without public support unless the cost of training is very high, either because of the nature of the training itself (some types of training may not be justified on economic grounds alone, rather only in terms of other broader goals), or because the size of the firm does not allow economies of scale in training.

2.83 When high costs of training are due to the small scale of operations, there is a rationale for providing the administrative machinery for developing an efficient scale of training. This administrative machinery may have to be financed with public funds. Where economies of scale of training can be achieved by an industry or group of industries willing to cooperate in training, there is no rationale for subsidizing training specific to a firm, nor for subsidizing a monopsonistic industry.

2.84 Where training is for cross-industry occupations (occupations that are commonly found in different industries), there is a case for subsidizing costs of training and/or wages paid to the trainee in order to attract him to the training program.

2.85 Where there is competition in the skilled labor market, public authorities may introduce legal time requirements for training that compel the trainee to remain with the firm after he reaches proficiency in the occupation, with a skill classification lower than that of a skilled worker. This period could be long enough to allow the firm to recoup the costs of training. To be effective, other firms that hire workers who did not fulfill their contract must reimburse the firm that trained the worker for a part of their training costs. This type of legal imposition on the trainee must be used carefully to avoid exploitation of workers at sub-standard wages.

2.86 Because benefits from training accrue to the firm long after the training is offered, a low discount rate increases the attractiveness of providing training. Public authorities can provide loans to firms offering training at interest rates lower than commercial rates. These loans could be managed and controlled more easily by assigning them for the purchase of machinery equipment, and materials specific for training, and/or the construction of special buildings for in-plant schooling.

2.87 Tax Incentives to Induce Training in Private Enterprises: Besides direct intervention in the form of subsidies and loans at low interest rates, public authorities may encourage training in enterprises by allowing the firm to deduct costs of training from its accrued taxes. A common procedure is to consider training as an expense. Thus, for the firm, the actual cost of training is the outlay cost of training multiplied by one minus the income tax rate. For example, if the tax rate is 50 per cent, training costs to the firm is only half of the actual outlay costs. This type of education has the disadvantage of
making training a function of profits rather than of needs.

2.88 Where there is a training levy in the form of a Payroll Tax or Value-Added Tax, there is usually a provision to reimburse firms for training done in their plants. As long as reimbursements exceed training costs minus benefits, there is an economic gain to the firm engaged in training.

2.89 It has been suggested also that an Ad Valorem Tax be imposed on imported machinery and the proceeds used for training. This tax can be justified on the grounds that training must complement equipment and, therefore, users of capital goods should bear the burden of the complementary good. Also, in developing countries where there is an acute unemployment problem, a tax on imported capital is in consonance with an employment policy that tries to make capital more expensive relative to labor. Now when establishing this "training-import tax," a provision can be made to allow firms to deduct from this tax the costs of training. This provides incentives for the firm to undertake training by an amount equivalent to that of the tax.

2.90 All of these incentives discriminate against small firms. Small firms cannot, in many instances, take advantage of tax deduction provisions because they do not employ enough trainees to have even minimum-sized classes for needed training courses. Larger firms, on the other hand, can organize full courses for many different skills, including the upgrading of management. Tax deduction for training costs benefit those firms that could have been training their own personnel in any case, especially, when the training is for jobs that are specific to an industry, or where the industry is operating in a monopsonistic labor market (i.e., where the industry is the only employer in the area).

2.91 There are two basic corrective measures. One is the application of a graduated tax. In the case of any payroll taxes, based on a firm's size, smaller firms would be taxed proportionately less, which would solve the inequity of the tax burden between small and large firms. Secondly, and more importantly, an administrative structure has to be created with public funds to encourage "training cooperatives" to achieve economies of scale of training and greater efficiency.

2.92 Non-Monetary Incentives: To encourage training in the firm, public authorities providing training may make available public facilities for use by private firms. A major cost of training is the production of didactic materials and pedagogic guidance. These can also be made available to the firm. Public authorities can also lessen the costs of training by providing teachers of general subjects, testing of students, and other ancillary services.

2.93 Incentives to In-Plant Training beyond the Firm's Training Needs: There is a limit to the amount of training a firm can offer. This limit is determined by the future demand, size, and characteristics of its labor force. If the public authorities wish to encourage the firm to take in more trainees than this limit indicates, costs of training of the extra numbers will have to be covered. If the firm is repaid its average costs, such an arrangement will only be profitable to the firm when average costs are higher than marginal costs.
Institutional Considerations in the Selection of a Mode of Vocational Education

2.94 Besides economic factors there are some institutional factors that influence a mode of training. There are: character of the labor market; attitudes of industry and unions toward training; power of the vocational school lobby; and availability of curricula, vocational teachers, and administrators.

A. The Character of the Labor Market

2.95 Among the major labor market factors influencing the choice of a mode of training are: entry requirements of jobs, wages, unemployment, and channels of labor market information, and government as employer.

2.96 Entry Requirement of Jobs: A very important aspect of the labor market process is the general entry requirements when new employees are hired. In certain industries union membership is required as a prerequisite for a job. In theory, this is based upon the notion that union membership is an assurance that the worker has a certain level of competence. Actually, however, the practice may be no more than an indication of the monopolistic position of the union. Other hiring-in qualifications may include a primary school or a secondary school graduation diploma, or a certificate indicating completion of an apprenticeship program or a vocational school program. Some firms are prepared to hire untrained persons with a certain minimum level of schooling, if the person agrees to enter the firm's training program. Continued employment at the firm is dependent upon successful progress in the training program.

2.97 If hiring at above the entry-level job, specific years of experience may also be required. If a firm follows the practice of promotion from within, then almost all new hires will be made at the lowest paid, least skilled, entry-level job. If a firm hires at all level positions, then obviously job experience will be required. Overall, such hiring-in qualifications vary from industry to industry, and from firm to firm.

2.98 Where entry requirements for new employees are relatively high and also rigid, especially where the requirements refer to education levels, then training in a school situation, off the job, is more appropriate. In the schools, trainees with deficiencies in general education can be given special courses to bring such trainees up to the required minimum level.

2.99 Wages: Wage structure is also an important factor. In any single industry what are the wage differentials between the skilled, the semi-skilled, and unskilled workers? What are the differentials between two industries for the same skill level? What is the wage differential between a skilled craftsman and a vocational instructor of the same craft?

2.100 In an industry where wage rates are relatively high, training on the job becomes expensive. Not only is the wage rate of the trainees rather high, but the cost of the production time lost by journeymen when they are "training" the trainee is also high. Training off the job, especially in the classroom, could be considerably cheaper.
2.101. Where the wage structure of an industry is compressed and the differential between the unskilled and skilled workers is small, there may be little incentive in the plant to enter training. In such a situation it may be preferable to have the training off the job. However, if the differential between unskilled and skilled is wide, there would be a strong incentive to enter an on-the-job training program.

2.102 Unemployment: When unemployment is relatively high, training on the job is clearly a preferable mode of training. Such training generally assures the trainee that he will have a job if he completes the program successfully. Other modes of training provide the program completer with a license to search for a job, an intolerable situation if unemployment is already high. On the other hand, when unemployment is high the opportunity cost of students is much lower, thus favoring the formal setting.

2.103 Channels of Labor Market Information: How employers broadcast the news about available job vacancies and how workers hear about these vacancies influences the placing of graduates from a mode of training. If the basic channel of information about jobs is word of mouth, then information about on-the-job training is more likely to be disseminated throughout the area. Information about any in-school training is not likely to receive the necessary publicity by word of mouth to attract large numbers of qualified training applicants. If there are labor exchange bureaus through which large numbers of job seekers pass, then all types of relevant information about training can be disseminated in this manner.

2.104 Trade unions may be a principal means of information about job vacancies in some industries. In some cases unions may actually to the placements; in other situations union membership may be a minimum requirement to get a job. Agreements on hiring between trade unions and employers may be on a formal or informal basis. In either case, this arrangement favors training under the auspices of unions and employers.

2.105 In some countries it is not uncommon for the government, through one or more of its agencies, to provide vocational placement services free of charge. Information is provided about projected needs of various occupations, the salaries paid and what kinds of training is needed to become a craftsman in that occupation. Such information is sometimes provided to young people at a critical point in their educational career, in order to help them select wisely according to the needs of the labor market. If vocational placement services are widely provided, the government could use these services to publicize any type of training program being undertaken.

2.106 Government as Employer: It is not uncommon in developing nations for the government to be a major employer of trained manpower. Where this is so the government has the opportunity of planning the whole process of training for the specific jobs needed; it operates both the public schools and the plants. Such a monopolistic position in the labor market permits the government to select the better employees and to select the best means of training.
B. Attitude of Industry and Unions toward Training

2.107 Depending on the economic environment and on the experience in industry, the attitude of firms toward training will vary. In most cases the attitude will be focused on a specific type of training, i.e., on public vocational schools, on industry-wide skill centers, or on in-plant training. If, for example, industry in general is biased against public vocational schools there would seem to be little merit in expanding training in the public school system, regardless of most other factors.

2.108 Often firms of a single industry form an employer association to engage in mutually beneficial activities. Where labor shortages exist, such associations will act in an effort to protect its members from firms outside the industry. One such act is to establish a skill training center where workers are trained for the specific and specialized needs of the firms in that industry. When workers are narrowly trained for specific jobs in a specific industry they do not have the necessary skills to move to jobs in other industry. Thus, through supporting a skill training center, an employer association can indirectly be tying the trained workers to the industry.

2.109 Employer associations could also help develop a cooperative type of training program, involving the school system and the firms. Classroom instruction could be given in the public schools, and the on-the-job training in the member firms of the association.

2.110 The existence of a strong labor union may make the initiation of an on-the-job training program difficult. Problems such as the wage rates for trainees and the ratio of the trainees to journeymen may result in delays and an ineffective training program. Under this set of circumstances, it may be preferable to use an off-the-job program in a school setting.

C. The Power of the Vocational School Lobby

2.111 Of all parts of a training system in a country, vocational schools are more in the public eye than other training programs. The relationship of vocational school personnel to other groups in the community is significant for the overall acceptance of vocational training. If the relationship of vocational school personnel and the Ministry of Labor and the Ministry of Education is a good one, then funds made available to vocational training programs will be high. The reverse is also true. Lobbying activities are an acceptable pattern of behavior, and if the vocational school lobby has muscle, many of its programs will receive political support. If vocational school teachers, or directors of vocational schools, are organized into associations, their political and economic leverage will be high.

2.112 The relations between the vocational school personnel and the leaders of the business community are also important. If the relationship is good, firms are more likely to employ vocational school graduates. When this occurs more youths become interested in gaining entrance to the vocational schools because of the good job prospects.
D. Availability of Curricula, Vocational Teachers, and Administrators

2.113 Availability of curricula: critical to all types of formal training programs is the availability of curricula. Information on the curricula that are available can be obtained readily from the school system and from some of the large employers. If any formal training is offered in the country then some curricula are available; and the existing programs can be expanded or can be used as models for new programs. Curricula for in-school training often can be adapted for use in training centers and for on-the-job training programs. Curricula also can be imported, but they are not likely to be usable without considerable modification. If no curriculum is available it would be almost impossible to start a program with any semblance of logical progression. Following the standard pattern of work in a shop, a foreman or trainer could show how various tasks are performed, and a trainee could learn by watching and doing.

2.114 Availability of vocational teachers: Vocational teachers are normally required to have about five years of practical experience at the trade, before being permitted to teach in a training program. In addition, an instructor may be required to take a 6-month course in pedagogy before being authorized to teach. The availability of vocational instructors depends to some degree on the number of available craftsmen and instructors.

2.115 There are different ways in which to train vocational teachers. One of the most common ways is to upgrade the skilled craftsman, by giving him a series of courses in pedagogy. In addition to such "upgrading," however, the individual must also be offered a compensation that motivates him to shift careers and to spend time taking courses in pedagogy. In some societies the prestige of a teacher is so great that little effort is needed to motivate skilled workers to shift careers. Where such prestige exists and vocational training researchers are plentiful, or readily available, then training in the schools has a distinct advantage. In some situations teachers of regular academic subjects shift to vocational teaching by learning a specific craft. It is also possible for an individual to go through a regular teacher-training program, with a specialty in vocational teaching.

2.116 Although scarcities of vocational teachers may be overcome, the fact that teachers may or may not be readily available becomes an important factor in deciding on a mode of training.

2.117 Availability of training program administrators: In some developing countries the shortage of administrators is a critical factor in the industrialization process. For a training program to be a success it needs competent administration. If there is a relative shortage of persons with administrative skills and experience, the available few are likely to work in that sector offering the highest compensation. Government competition for administrators is likely to be strong. If size of compensation is the most significant factor, then administrators are more likely to work in industry, where compensation is generally much higher than in a school system or a training institution. Only if the prestige of being affiliated with a training facility or program is very high will it offset the compensation differential in favor of industry.
The choice of a mode of training has no definitive solutions. Economic factors constitute only part of all the factors that have to be taken into account. Institutional and political factors sometimes become the deciding element in the choice of a mode of training. Only after a complete picture, that includes economic and non-economic factors, is presented can the decision maker provide a judicious choice.
III. BASIC PROGRAM DATA NEEDED FOR THE EVALUATION OR SELECTION OF A MODE OF TRAINING

The cost-effectiveness of a mode of training varies with the type of programs for occupations, or group of occupations, that are being taught with the training mode. Because the choice of a mode of training will, most likely, have to involve the analysis of the formal vocational school—the most popular form of vocational training—this chapter discusses the characteristics of the programs most commonly offered in vocational schools: program duration, specificity of courses and instructional time distribution, cost of equipment, and compatibility of training with the production process in industry, and presents tables with data on these characteristics.

Program Characteristics

3.1 Program Duration: A training program's duration is a function of the depth and breadth of the skills to be developed. In some programs it may be desirable to train a student with entry level skills for several families within a career cluster—a broad training program. In other programs, it may be desirable to develop students with accomplished skills in one family—a deep training program.

3.2 Consider, for instance, the 'electricity' cluster. There are five basic job families in the electrical cluster: Installation and Maintenance, Industrial Electricity, Electrical Production, Electro-Mechanics Production, and Electro-Mechanics Service. Separate training programs may be developed to prepare a student for entry into each of the families, or a single broad training program may prepare a student with the general entry level skills required by all families. The time needed to train a student for entry into each of these families separately may be determined by the requirements of that program alone. But the duration of a program training a student to enter the general field of electrical work—with appropriate skills for entry into all its families—is sometimes not calculated by adding up the requirements for entry into the individual programs. There are substantial elements of each program common to all. To plan programs it is necessary to determine the duration of the programs that develop entry skills for each job family and also for a program that develops entry skills for groups of related families, or the whole cluster.

3.3 In addition, it is important to determine the duration of training programs needed to develop skills for each job in the hierarchy within each family. These data are needed to determine the most desirable location for advanced as well as entry-level training. If it takes 500 hours to train a general electrician, it may be desirable to offer the first 250 hours in the setting of the school and the second 250 hours in an industrial setting.
3.4 Besides having a direct effect on the cost of a total program, the duration of the training program sometimes may influence the location of training depending on the production or training cycle of the training institution. Programs in glazing, painting, etc., are relatively short, highly specialized, and may take only a few weeks or months. Because a school must utilize facilities much longer than this to use its resources economically, such programs could not be justified without the likelihood of a continuous flow of students. At the other extreme, training a carpenter lasts much longer than the time to construct a house. Unless a trainee can move to a new construction project and continue learning, his total training program may be adversely affected.

3.5 Specificity of Courses and Instructional Time Distribution: The greater the percentage of instructional time, theoretical and practical, that can be shared with other programs, the greater the opportunities to achieve economies of scale, and the more attractive the school setting for training. All machinists must be able to read and interpret blueprints. Most machinists' programs require a course in drafting and blueprint reading. But electricians and carpenters also need skills in drafting and blueprint reading. A shop for blueprint reading can achieve economies of scale by training for machinists, electricians and carpenters together.

3.6 Similarly, in order to advance in the machine trades, a worker must have sufficient mathematical skills to adjust a machine or make conversions from fractions to decimal equivalent measurements. This portion of the training program involves classroom instruction in basic mathematics common to many programs. Economies of scale are achieved more easily in institutions that offer a variety of programs requiring mathematics.

3.7 At the other extreme, a program in auto body repair requires very little time in shops outside the auto body shop, and the program is not closely related to any other instruction programs. A training institution that offers a variety of programs has no special advantage of economies of scale in the providing of training in auto body repair shops.

3.8 Cost of Equipment: Certain programs obviously have equipment costs so high that they may be justified only on the basis of high utilization. A computer would be a relatively high cost machine to acquire just to train computer programmers. But the school may offer many courses in programming and computer operations, and also use the computer for other instructional applications or for administrative purposes. If the computer is thus used for longer periods of time, costs per student or costs per hour instruction may be reduced enough so that the school's acquiring a computer would be an attractive alternative to a computer program offered in an in-plant setting.

3.9 Specialized equipment--say, in a machine shop--that does not relate to different programs can only be justified by the total number of students in the program who use it. The total costs and hours of use determine the feasibility of acquiring equipment. A lathe may be used only a few hours a
day to train machinists, but if it has a sufficiently long lifetime for many
students to be trained on it, and a small obsolescence rate, it may still be an
attractive purchase for a vocational school. On the other hand, a numerical-
controlled machine that even in industry requires a very high use to be justified
economically, would require almost continuous use in a school to make its cost
per student attractive.

3.10 Compatibility of Training with the Type of Industry: The possibility
of shifting programs from school to in-plant training partly depends on the
availability of industries whose normal production operations include condi-
tions necessary for the training of an occupation. More general programs may
be offered in many industries. Thus, electricians, pipe fitters, and so on, do the
same type of job in many different industries and can be trained almost
anywhere. Some programs are more specific to the industry and can be trained
only in that industry. A textile worker can only be trained in a textile factory.
The availability of training facilities outside school becomes limited to the
size of the particular industry.

3.11 The higher up on the job hierarchy, the more limited the potential
number of industries available for training. A mechanic may learn his skills
in a great many industries. Engine mechanics in a smaller number, and turbine-
engine mechanics in a still fewer number of industries.

3.12 Some occupations call for a skill that cannot be developed in the
job environment where the trainee will work after his training. But these
skills can be developed in another industry that offers opportunity for the
particular training phase required by the occupation. Construction workers
assembling structural steel require a need to know welding and riveting, but
construction sites are not the best place to train welders. Those construc-
tion workers could learn to weld in the welding industry. The size of the
industry's labor force and the proportion of the occupation in the labor force
also affect the possibility of on-the-job training.

Distribution of Instructional Time--Raw Data

3.13 Tables 1 through 11 of the following pages summarize the distribution
of instructional hours associated with each of the clusters and job families
considered in this study. These data constitute the basis for translating
proposed enrollment mixes into facility and equipment requirements. They can
also be used in the analyses of instructional programs, skill transferability,
and allocation of costs.

3.14 Each of these tables refers to a cluster of jobs which share a sig-
nificant number of both theoretical and practical learning experiences. Each
skill cluster is subdivided into separate families of jobs which share learn-
ing experiences. These families are then further subdivided into three levels
of skill, or instructional program requirements, ranging from the minimum skills
required for entry into the job group to advanced specialization within that
group. This can be illustrated as follows:

Cluster I  ....  Cluster II  ....  Cluster VII

Family of Jobs 1
Entry
Advanced
Specialized

Family of Jobs 2

Family of Jobs n

3.15 The distribution of instructional time in each program is presented in two forms:

Table "a" presents the distribution of instructional hours by laboratory and classroom. In turn, classroom hours are divided into general and related instruction. These tables provide information for planners to choose programs which share specific laboratories. The data can also be a basis for allocating costs of shared laboratories.

3.16 Tables "b" present the same data of Table's "a" in percentages. This tabulation provides an idea of the possibility of offering training in a non-institutional setting. Specifically, programs having high percentages of their instructional time allocated to "general academic" and/or

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1 The following definition of terms has been used in these tables:

"Entry" - student has acquired basic practical skills required for the craft— he is thoroughly capable of safely performing these basic skills under direction but does not have sufficient knowledge to independently determine what actions should be performed. This classification would correspond approximately to I.L.O. designations X-YY.10.

"Advanced" - student possesses all required basic manipulative skills and the associated theoretical knowledge which permits him to both plan and perform the general tasks required of his craft. This classification would correspond approximately to I.L.O. designations X-YY.20 to X-YY.50.
"shared laboratory practical" instruction (columns 2 and 4) would be considered more attractive candidates for offering in the institutional setting than programs having a high percentage of their time spent in "related theory" and/or a single unshared laboratory (columns 3 and 5).

3.17 In most instances the instructional program data presented for the three levels of skill programs in each family constitute a hierarchy of skills in a single job ladder. That is, "advanced" skills build directly on "basic" or "entry" skills and "specialized" skills develop directly from advanced skills. Therefore, progress in the hierarchy of instruction is essentially linear and all hours identified for "advanced" job skills include the hours required for "basic" skill development. Thus, table 2a shows that an "advanced" cabinetmaker required 410 hours of instruction in cabinetmaking while a "basic" cabinetmaker requires only 290 hours. This means that the "advanced" student received 120 hours of instruction beyond those received in his basic course.

3.18 There are, however, some instances in which progress is not linear and the requirements for specialization do not incorporate the same instruction required to develop "advanced" skills. This is especially true in such programs as mechanics and machine shop where "advanced" study is usually interpreted to mean broader generalization while a program leading to a "specialization" may ignore much of what the advanced general student may study and apply a proportionally greater time to specialized tasks. For instance, table 8a shows that an advanced "general" machine shop student receives approximately 6-800 hours of instruction in the machine shop, while a single machine specialist receives only about 400 hours. However, the specialist may have received 300 or more of his hours on a single machine type while the generalist received only about 100 hours on each of six machine types. Where unusual circumstances of this type occur in the cluster of family hierarchy a special note is made on the appropriate table.

3.19 In the case of pure linear hierarchies of jobs it can be assumed that 100 percent of the instruction given to a trainee at one level of a single family can be applied toward training for a higher position in the same family. However, as indicated above, not all hierarchies are linear. Therefore there is not always a high degree of interchangeability of students being trained for positions exhibiting different degrees of specialization within the same job family. Similarly, while entry level jobs in all families may share extensive amounts of instruction, there may be very little interfamily similarity between instructional requirements for advanced positions in each cluster.

3.20 In planning programs which respond to a nation's broad manpower needs it is desirable to know both how much of a program of training in one family can be transferred to other levels of specialization within the same family and how much can be transferred to another cluster within the same family.

2"Specialized" - student possesses all the skills of an "advanced" craftsman plus the additional theoretical and/or practical knowledge to operate specialized advanced machinery or otherwise perform functions requiring highly specialized training and the development of advanced competencies. This classification would correspond approximately to I.L.O. classifications X-YY60 and above.
family and how much can be transferred to another cluster within the same family.

3.21 The first of these problems is most relevant to those clusters which, like welding, sheet metal, piping and plumbing, engine mechanics, drafting and auto body, have no "family" subdivisions. In such programs it is insignificant to consider the degree of transferability of instruction to other jobs and job families for two reasons. First, because these programs are characterized by only one core program hierarchy with multiple specializations the problem of transferring (or sharing) large units of instruction to (with) other families is meaningless. Secondly, since most of these programs offer many identifiable specialized positions (only the more advanced of which have been considered in developing these tables) it would be difficult to generalize about the degree of program transferability which exists between the core program hierarchy of instruction and the programs required for each of the many specializations. These data can only be derived on the basis of specific programs.

3.22 In other clusters--like construction/woodworking, electrical, electronics, and heating/refrigeration, all of which contain several distinct families of related jobs--it is appropriate to consider inter-family transferability of instruction for purposes of program planning and evaluation. For these clusters tables 1b through 11b present factors of program transferability. These factors identify the percentage of instruction in each family which may be applied toward the development of skills required in the jobs of another cluster. For instance, Table 5b, column 8, shows that 75% of the theoretical instruction and (from column 11) 65% of the practical instruction required by the "average" student in the electronic equipment installation program can be transferred to a program of training electronic equipment maintenance personnel, while only 50% of his theoretical and 40% of his practical instruction can be transferred to a program in industrial electronics. (Note: In developing these tables, no attempt has been made to cross-correlate specific curricula at each level within each family to each level of skill in the other families of the same cluster. Rather, these numbers are based on some indefinite "average" mix of students within each family. Therefore the transferability percentages are not directly related to the distribution of hours presented in the "a" tables, but should be regarded simply as best available estimates of the overall characteristics of an average program.)

3.23 The data presented in Tables 1a and b through 11a and b represent a synthesis of course syllabi from instructional programs offered in many parts of the world. Specific sources for these data include the curricula from community colleges and technical institutes in the United States, technical schools throughout Europe, selected European apprenticeship programs, and company sponsored training programs from many parts of the world. These data should not, however, be considered to constitute a model distribution of course hours for purposes of curriculum development. Actual curricula should be based on the requirements of the specific programs to be taught. Further, it must be recognized that the actual hours assigned to any one
course offered in an institutional setting will depend on the course organization of the individual institution. For instance, in a school operated on a "quarter" system a "75 hour course" may be shortened to meet five hours a week for thirteen weeks, (total 65 hours), while in a school operated on a semester system the same course may be drawn out to meet five hours a week for eighteen weeks (total 90 hours).

3.24 In these tables we assume that the hour distributions are essentially independent of where in the world a program is offered. That is, given students of similar educational background, it should take the same amount of time to train an auto engine mechanic in Nigeria as in Peru, Singapore, or in the United States, assuming that the type and quality of the students are the same. This assumption is based on the fact that the same basic occupational requirements will be imposed on this mechanic anywhere he works, that programs in developing countries are usually copied from those of developed countries, and that there is little association between culture and skills.

3.25 There are, however, exceptions based on differences in pedagogy and instructional program objectives. Most western countries have developed their training programs around broad general training programs, while developing countries have often attempted to train specialists at relatively low levels in the hierarchies of each job family. While this practice is now generally considered to be inefficient in the light of long-range plans for economic and human resource development, it is still common practice in some programs. Where such lower level specialization is of significance, as in the case of roofers and form-builders as sub-specialties in the construction industry, special comments are made in the appropriate tables.

NOTES

Table "a"

3.26 All numbers in the "a" Table represent the approximate total number of hours of instruction in each of the class or laboratory environments identified at the top of each column.

3.27 "Class" instruction refers to all instruction delivered in a classroom—as opposed to laboratory environment.

3.28 "General Academic" instruction includes any instruction shared by many instructional programs and, more specifically, the instruction in which one teacher may teach courses appropriate to many programs. This category includes primarily math and science instruction. These tables are based on the assumption that no general instruction in courses such as language, history, etc., are offered.

3.29 "Related Theory" instruction is classroom instruction specifically appropriate to the occupational program. It can be assumed that this
instruction will be delivered by the instructor of the main laboratory associated with the program and, therefore, these hours should be added to the program instructional hours for allocating staff costs.

3.30 "Laboratory" instruction refers to instruction delivered in each of the identified laboratories. In the development of these tables it has been assumed that a laboratory particular to a program is available. When this is not the case, facilities required for instruction must be provided in the main program laboratory. Thus, for instance, if a school intends to offer a sheetmetal program but no welding program, the sheetmetal laboratory must provide enough welding stations to offer the 70 hours of welding instruction identified in Table 10 "a".

Table "b"

3.31 The "b" Tables present all the instructional hour data of "a" Tables in the following way: Total hours of instruction in column (1), and columns (2) and (3) represent the hours under "class-general academic" and "class-related theory" in the "a" Tables in percentages of the total instructional time.

3.32 In columns (4) and (5) the instructional program data listed under "laboratory" in the "a" Tables are combined so as to show the percentages of the total instructional time offered in laboratories which are shared by other programs and the percentage of the total instruction offered in the laboratory planned specifically for the program under consideration. For instance, in the piping and plumbing program described in Tables 9 "a" and "b" instruction in drafting and welding are assumed to be offered in laboratories shared by other programs. This data is provided in columns (4) (21%); while instruction in piping is assumed to be offered in a laboratory planned specifically for the piping and plumbing program; this data is given in column (5) (53%).

3.32 "Transferrability of Instruction" data presented in the final columns of the "b" Tables relates both the theory and practical (manipulative skill) components of the curriculum for each family in the appropriate clusters (not all clusters are developed into multiple families) to those components of families in that cluster. Where applicable, each family is given an identifying index number in the columns under "index." Thus, for instance, in Table 1b, column 6, "1" is a reference index for the carpentry program and "2" is a reference index for the cabinetry/ furniture industry program. These same numbers are used as column headings under the "theory" and "practical" subcategories of the "Transferrability of Instruction" column.
Interpretation of the Tables -- An Example

3.34 The following example is offered as a guide for interpreting data presented in tables 1 through 11. This example is based on an analysis of the CONSTRUCTION AND WOODWORKING program presented in Tables 2a and 2b.

Distribution of Instructional Hours by Class and Laboratory Type (Table 2a)

3.35 The total hours of instruction for each level of instruction in each job family is the total of instructional hours listed under both "class" and "laboratory" for each program. Thus, for instance, a program to train entry level carpenters would require approximately 300 hours:

- 100 hours in related theory
- 50 hours in woodworking
- 150 hours in construction
- **300 TOTAL HOURS**

while a program to develop the more comprehensive skills required of an "advanced carpenter" would require 990 hours of instruction:

- 30 hours of general academic instruction
- 190 hours of related theory
- 20 hours of drafting
- 100 hours of woodworking
- 650 hours of construction
- **990 TOTAL HOURS**

3.36 It should be noted, for instance, that the 190 hours of instruction in "related theory" required of an "advanced carpentry" program represents the total hours of instruction in this skill area and not the hours in addition to the instruction required by an entry level carpenter. That is, an "advanced carpentry program" requires an additional 90 hours (190-100 hours) of instruction in "related theory" beyond the entry level program.

3.37 "Specialist" programs represent a slightly different problem because the training programs required to develop these skills are generally not linear extensions of a basic or "entry" program. For instance, table 2a shows that a carpentry specialist, such as a roofer, requires approximately 110 hours of "related theory" instruction. However, this should not be interpreted to mean that a specialist requires only 10 hours of instruction beyond that received by an "entry" level trainee. This is because the "related theory" learned by the "entry" trainee is related to many areas of construction while the "specialist" receives instruction in only one area. Thus, the "specialist" may share as little as 20-40 (1) hours of instruction with the "entry" trainee and take 60-80 hours of instruction to which the "entry" trainee would not be exposed.

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(1) This is an approximation made for discussion purposes only. Specific data relative to the degree to which programs within a family can share common courses were not computed during this study and will have to be derived on the basis of specific programs and curricula.
3.38 In Table 2a, as in all tables, the data presented opposite each "family" should be treated independently of all data listed for other families, in the same table. While there may be some commonalities in courses, these commonalities are discussed only in the "transferability of instruction" columns of the "b" tables and cannot be derived from the data in the "a" tables. For instance, the 240 hours of "related theory" instruction required by an "advanced cabinetmaker" represents a 130 hour (240-190 hours) increase over the instruction required by the "entry level" cabinetmaker, but is totally unrelated to the 100, 190, and 110 hours of instruction in "related theory" required by "entry," "advanced," and "specialist" carpenters.

Distribution of Instruction by Percent of Time in Each Class and Laboratory Type and Transferability of Instruction. (Table 2b)

3.39 The "b" tables contain two basic types of data:

1) Distribution of Instructional time by percentages of the total instructional time spent in facilities which may be shared with other programs in the same or other clusters of programs, and

2) Transferability of instruction which identifies the percentage of the curriculum or actual instructional time which is common to other families of programs in the same cluster.

3.40 Distribution of Instructional Time. The percentage distribution of instructional times are the data presented as instructional hours in the "a" Tables. Thus, table 2a reports that an "entry" carpenter receives 100 hours of instruction in "related theory" out of a total instructional program of 300 hours. This data is reported in Table 2b, column (3), as 33 percent of the trainee's program. Both columns (2) and (3), Class/general academic and Class/related theory, are derived directly from the "a" tables by dividing the hours listed under the comparable column headings by the total hours of instruction.

3.41 However, columns (4) and (5), Laboratory/Shared and Laboratory/Specific, represent slight modifications of the data listed in the columns under "laboratory" in the "a" tables. Here, column (5) reports the percentage of instruction which would normally be offered in a laboratory designed specifically for the instruction in the family under consideration; while column (4) reports the percentage of instruction offered in laboratories which would normally be provided for other programs. For instance, 65 percent (650/990) of the instruction in an "advanced" carpentry takes place in the "carpentry" laboratory, while 12 percent of the instruction (100 hours in woodworking plus 20 hours in drafting = 990 total hours) takes place in laboratories which would normally be provided for in other programs.

3.42 Transferability of Instruction. The data reported under columns (7) through (12) identify the percent of the total curriculum of a family
in the same cluster. Thus, it may be noted in column (8) that 50 percent of the "theory" instruction which refers to both "general academic" and "related theory" instruction, offered to students in an "average" carpentry program (identified in column (6) with an index number "2"). Similarly, in column (7) it is reported that approximately 20 percent of the theory offered to students in the "average" cabinetry program is common to the curriculum requirements of the "average" cabinetry program.

3.43 It should be noted that the numbers reported in the "Transferability of Instruction" sections of the "b" tables are highly subjective and cannot be rigorously substantiated. For example, in the derivation of the data reported in Table 2b, it was assumed that an "average" program in carpentry would have most students receiving only "entry" level skill development (because there are a great many opportunities to develop carpentry skills in industrial settings) while the "average" student in a cabinetry program would receive "advanced" training. Therefore, 50 percent of the approximately 100 hours of theory instruction required for an average carpentry program are the same as the 20 percent of the approximately 240 hours of theoretical instruction required for an average cabinet maker. Similarly, 50 percent (column 11) of the 200 hours of practical instruction (50 hours in woodworking and 150 hours in construction) required of the "average" carpentry student is approximately the 10 percent (column 10) of the 860 hours of practical instruction (400 hours of woodworking, 410 hours of cabinetmaking, and 50 hours of drafting) received by an average cabinetmaker.
TABLE 1a
Distribution of Instructional Hours by Class and Laboratory Type in AUTO BODY

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Class</th>
<th>Laboratory</th>
<th>Auto Body</th>
<th>Sheet-Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto Body</td>
<td>(General)</td>
<td>0</td>
<td>40</td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>(Specific)</td>
<td>0</td>
<td>0</td>
<td>100-200*</td>
<td>100-300*</td>
</tr>
</tbody>
</table>

*Specialities such as paintman, bodyman, glassman, frame straightener, etc. Program duration depends on specific specialty.

TABLE 1b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in AUTO BODY

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Class</th>
<th>Transferability of Instruction</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>General</td>
<td>Related</td>
</tr>
<tr>
<td>General</td>
<td>General</td>
<td>670</td>
<td>0</td>
</tr>
<tr>
<td>Auto Body</td>
<td>Specific</td>
<td>200-500</td>
<td>0</td>
</tr>
</tbody>
</table>

(Not Applicable)
TABLE 2a
Distribution of Instructional Hours by Class and Laboratory Type in CONSTRUCTION AND WOODWORKING

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Class</th>
<th>General</th>
<th>Related</th>
<th>Laboratory</th>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drafting</td>
<td>Theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Woodworking</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cabinet/Making</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpentry</td>
<td>(Entry)</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td>30</td>
<td>190</td>
<td>20</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>90</td>
<td>110</td>
<td>20</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>Cabinet/Furniture Makers</td>
<td>(Entry)</td>
<td>0</td>
<td>90</td>
<td>0</td>
<td>200-400</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td>0</td>
<td>240</td>
<td>50</td>
<td>400</td>
<td>290</td>
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</tbody>
</table>

1"Specialist" programs range from those for roofing or framing specialists (up to 200 hrs.) to concrete frame specialists (up to 400 hrs.).

TABLE 2b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in CONSTRUCTION AND WOODWORKING

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Total Hours</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory Shared</th>
<th>Laboratory Specific</th>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6) (7) (8) (9) (10) (11) (12)</td>
</tr>
<tr>
<td>Carpentry</td>
<td>(Entry)</td>
<td>300</td>
<td>0</td>
<td>33</td>
<td>17</td>
<td>50</td>
<td>1 50 50</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td>990</td>
<td>3</td>
<td>20</td>
<td>12</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>420-620</td>
<td>21-15</td>
<td>26-18</td>
<td>5-10</td>
<td>47-58</td>
<td>2</td>
</tr>
<tr>
<td>Cabinet/Furniture Makers</td>
<td>(Entry)</td>
<td>700</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>87</td>
<td>20 10</td>
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<tr>
<td></td>
<td>(Adv)</td>
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<td>0</td>
<td>22</td>
<td>5</td>
<td>73</td>
<td>-</td>
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</tbody>
</table>

1"Specialist" programs range from those for roofing or framing specialists (up to 200 hrs.) to concrete frame specialists (up to 400 hrs.).
### TABLE 3a

Distribution of Instructional Hours by Class and Laboratory Type in DRAFTING

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory Drafting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drafting</td>
<td>(General)</td>
<td>0</td>
<td>50</td>
<td>690</td>
</tr>
<tr>
<td></td>
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<td>0</td>
<td>50</td>
<td>400-820</td>
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</tbody>
</table>

Variability in both related theory and drafting practice depends on area of specialization.

### TABLE 3b

Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in DRAFTING

<table>
<thead>
<tr>
<th>Family</th>
<th>Total Hours (1)</th>
<th>General Academic (2)</th>
<th>Related Theory (3)</th>
<th>Laboratory Drafting (4)</th>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Drafting</td>
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<td>7</td>
<td>0</td>
<td>93</td>
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<tr>
<td></td>
<td>450-870</td>
<td>0</td>
<td>11-6</td>
<td>0</td>
<td>89-94</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(Not Applicable)</td>
</tr>
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</table>
### Distribution of Instructional Hours by Class and Laboratory Type in ELECTRICAL/ELECTROMECHANICS

<table>
<thead>
<tr>
<th>Class Type</th>
<th>Installation &amp; Maintenance (Bldg.)</th>
<th>Industrial Electrical/Electronics (Entry)</th>
<th>Industrial Electrical/Electronics (Adv)</th>
<th>Electromechanics (Entry)</th>
<th>Electromechanics (Spec.)</th>
</tr>
</thead>
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<td>Related Theory</td>
<td>Laboratory</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>70</td>
<td>140</td>
<td>180</td>
<td>400</td>
<td>450</td>
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<tr>
<td></td>
<td>1</td>
<td>70</td>
<td>140</td>
<td>180</td>
<td>250</td>
</tr>
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</tr>
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<td></td>
<td>70</td>
<td>140</td>
<td>180</td>
<td>400</td>
<td>450</td>
</tr>
</tbody>
</table>

1. Such as Radio and Television, Radar, communications systems, etc.

**TABLE 4b**

Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in ELECTRICAL/ELECTROMECHANICS

<table>
<thead>
<tr>
<th>Class Type</th>
<th>Installation &amp; Maintenance (Bldg.)</th>
<th>Industrial Electrical/Electronics (Entry)</th>
<th>Industrial Electrical/Electronics (Adv)</th>
<th>Electromechanics (Entry)</th>
<th>Electromechanics (Spec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Academic</td>
<td>Related Theory</td>
<td>Laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>10</td>
<td>24</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>29</td>
<td>4</td>
<td>67</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>50</td>
<td>2</td>
<td>44</td>
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</tr>
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<table>
<thead>
<tr>
<th>Class Type</th>
<th>Installation &amp; Maintenance (Bldg.)</th>
<th>Industrial Electrical/Electronics (Entry)</th>
<th>Industrial Electrical/Electronics (Adv)</th>
<th>Electromechanics (Entry)</th>
<th>Electromechanics (Spec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Academic</td>
<td>Related Theory</td>
<td>Laboratory</td>
<td></td>
<td></td>
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<td>0</td>
<td>50</td>
<td>2</td>
<td>44</td>
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### TABLE 5 a

Distribution of Instructional Hours by Class and Laboratory Type in ELECTRONICS

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<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory</th>
<th>Total Hours</th>
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<td>Electricity</td>
<td>Electronics</td>
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<td>Installation</td>
<td>Entry</td>
<td>80</td>
<td>70</td>
<td>0</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Adv) 80</td>
<td>70</td>
<td>150</td>
<td>500</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Entry</td>
<td>80</td>
<td>70</td>
<td>200</td>
<td>500</td>
</tr>
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<td></td>
<td></td>
<td>(Adv) 100</td>
<td>0</td>
<td>300</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Spec.) 240</td>
<td>0</td>
<td>400</td>
<td>700</td>
</tr>
<tr>
<td>Industrial</td>
<td>Entry</td>
<td>80</td>
<td>70</td>
<td>300</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Adv) 100</td>
<td>0</td>
<td>350</td>
<td>630</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Spec.) 100</td>
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<td>400</td>
<td>770</td>
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</table>

### TABLE 5 b

Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in ELECTRONICS

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Total Hours</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory</th>
<th>Transferability of Instruction</th>
</tr>
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<td>Entry</td>
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<td>19</td>
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<td></td>
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<td>20</td>
<td>5</td>
<td>68</td>
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<tr>
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<td>Entry</td>
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<td>30</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
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<td>9</td>
<td>29</td>
<td>4</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>1380</td>
<td>17</td>
<td>29</td>
<td>3</td>
<td>51</td>
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<td>Industrial</td>
<td>Entry</td>
<td>990</td>
<td>9</td>
<td>37</td>
<td>4</td>
<td>51</td>
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<td>(Adv)</td>
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<td>9</td>
<td>31</td>
<td>4</td>
<td>56</td>
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<td>(Spec.)</td>
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<th>Theory</th>
<th>Practical</th>
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<td>1</td>
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<td></td>
<td>2</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>30</td>
<td>25</td>
</tr>
</tbody>
</table>
TABLE 6a
Distribution of Instructional Hours by Class and Laboratory Type in ENGINE MECHANICS

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Class</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory</th>
<th>Auto Mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Mechanics</td>
<td>(Entry)</td>
<td></td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>2-500</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td></td>
<td>50</td>
<td>300</td>
<td>50</td>
<td>6-900</td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td></td>
<td>0</td>
<td>0</td>
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<td>1-300</td>
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</table>

TABLE 6b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in ENGINE MECHANICS

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Total Hours (1)</th>
<th>General Academic (2)</th>
<th>Related Theory (3)</th>
<th>Laboratory</th>
<th>Transferability of Instruction</th>
</tr>
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<tbody>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td><strong>Index</strong></td>
</tr>
<tr>
<td>Engine Mechanics</td>
<td>(Entry)</td>
<td>250-550</td>
<td>0</td>
<td>20-9</td>
<td>0</td>
<td>80-91</td>
</tr>
<tr>
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<td>1000-1300</td>
<td>4-5</td>
<td>30-23</td>
<td>2-3</td>
<td>62-70</td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>1-300</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>
TABLE 7a
Distribution of Instructional Hours by Class and Laboratory Type in HEATING, REFRIGERATION, VENTILATION

<table>
<thead>
<tr>
<th>Family Level</th>
<th>General Academic Hours</th>
<th>Related Theory Hours</th>
<th>Drafting Hours</th>
<th>Welding Hours</th>
<th>Sheet Metal Hours</th>
<th>Electro-Mechanics Hours</th>
<th>General Mechanics Hours</th>
<th>Plumbing Hours</th>
<th>Refrig. Heat Hours</th>
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</thead>
<tbody>
<tr>
<td>Heating Planned Maintenance (Home)</td>
<td>50</td>
<td>70</td>
<td>40</td>
<td>0</td>
<td>70</td>
<td>50</td>
<td>50</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>(Industry)</td>
<td>50</td>
<td>120</td>
<td>40</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>50-100</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Refrigeration (Home)</td>
<td>100</td>
<td>200</td>
<td>40</td>
<td>0</td>
<td>70</td>
<td>50</td>
<td>50</td>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>(Industry)</td>
<td>100</td>
<td>200</td>
<td>40</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
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<td>250</td>
<td>40</td>
<td>40</td>
<td>70</td>
<td>100</td>
<td>50</td>
<td>25</td>
<td>300</td>
</tr>
<tr>
<td>(Industry)</td>
<td>100</td>
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<td>40</td>
<td>70</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>400</td>
</tr>
</tbody>
</table>

TABLE 7b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in HEATING, REFRIGERATION, VENTILATION

<table>
<thead>
<tr>
<th>Family Level</th>
<th>Total Hours</th>
<th>General Academic Index</th>
<th>Related Theory Index</th>
<th>Laboratory Shared Specific Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Plant Maintenance (Home)</td>
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<td>13</td>
<td>42</td>
<td>36</td>
<td>1</td>
<td>-</td>
<td>50</td>
<td>100</td>
<td>-</td>
<td>33</td>
<td>100</td>
</tr>
<tr>
<td>Industry</td>
<td>820-870</td>
<td>6-6</td>
<td>15-14</td>
<td>48</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Refrigeration (Home)</td>
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<td>14</td>
<td>27</td>
<td>33</td>
<td>26</td>
<td>2</td>
<td>50</td>
<td>-</td>
<td>100</td>
<td>33</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>Industry</td>
<td>950</td>
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<td>23</td>
<td>36</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>28</td>
<td>27</td>
<td>34</td>
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<td>80</td>
<td>90</td>
<td>-</td>
<td>66</td>
<td>66</td>
<td>-</td>
</tr>
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<td>11</td>
<td>26</td>
<td>28</td>
<td>35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### TABLE 8a

**Distribution of Instructional Hours by Class and Laboratory Type in MACHINE SHOP**

<table>
<thead>
<tr>
<th></th>
<th>Class</th>
<th>Laboratory</th>
<th>Inspection &amp; Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General</td>
<td>Related</td>
<td>Drafting</td>
</tr>
<tr>
<td>Family Level</td>
<td>Academic</td>
<td>Theory</td>
<td></td>
</tr>
<tr>
<td>General Operator (General)</td>
<td>30</td>
<td>90</td>
<td>70</td>
</tr>
<tr>
<td>Single Machine Specialist (i.e., lathe operator, milling machine operator, screw (Entry))</td>
<td>0</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 8b

**Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in MACHINE SHOP**

<table>
<thead>
<tr>
<th>Family Level</th>
<th>Total Hours (1)</th>
<th>Distribution of Instruction</th>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Operator</td>
<td>9-1140</td>
<td>3-3</td>
<td>27-37</td>
</tr>
<tr>
<td>Spec.</td>
<td>130</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>550</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-8</td>
<td>52-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27-37</td>
<td>52-60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Not Applicable)</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 9a
Distribution of Instructional Hours by Class and Laboratory Type in PIPING AND PLUMBING

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>General</th>
<th>Related</th>
<th>Drafting</th>
<th>Laboratory</th>
<th>Welding</th>
<th>Piping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Academic</td>
<td>Theory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipers and Plumbers</td>
<td>(Entry)</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>40</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td>150</td>
<td>200</td>
<td>150</td>
<td>100</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>150</td>
<td>300</td>
<td>50-200</td>
<td>100</td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

1Specialty options such as gas and steamfitting, sprinkler fitting, etc.

### TABLE 9b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in PIPING AND PLUMBING

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Total Hours</th>
<th>General (1)</th>
<th>Related (2)</th>
<th>Laboratory (3)</th>
<th>Specific (4)</th>
<th>Index Index (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6) (7) (8) (9)</td>
</tr>
<tr>
<td>Pipers and Plumber</td>
<td>(Entry)</td>
<td>190</td>
<td>0</td>
<td>26</td>
<td>21</td>
<td>53</td>
<td>(Not Applicable)</td>
</tr>
<tr>
<td></td>
<td>(Adv)</td>
<td>850</td>
<td>18</td>
<td>24</td>
<td>29</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Spec.)</td>
<td>850-1000</td>
<td>18-15</td>
<td>35-30</td>
<td>23-25</td>
<td>30-35</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 10a
Distribution of Instructional Hours by Class and Laboratory Type in SHEET METAL

<table>
<thead>
<tr>
<th>Class</th>
<th>General</th>
<th>Related</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Academic</td>
<td>Theory</td>
<td>Drafting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Welding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sheet Metal</td>
</tr>
<tr>
<td>General Sheet Metal</td>
<td>240</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>(Entry)</td>
<td></td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>(Adv)</td>
<td>240</td>
<td>320</td>
<td>40-70</td>
</tr>
<tr>
<td>(Spec.)</td>
<td>100</td>
<td>250</td>
<td>70</td>
</tr>
</tbody>
</table>

### TABLE 10b
Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instructions Between Families in SHEET METAL

<table>
<thead>
<tr>
<th>Class</th>
<th>General</th>
<th>Related</th>
<th>Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Academic</td>
<td>Theory</td>
<td>Drafting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Welding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sheet Metal</td>
</tr>
<tr>
<td>Family Level</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>General Sheet Metal (Entry)</td>
<td>1070</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>(Adv)</td>
<td>1460</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>(Spec.)</td>
<td>710-740</td>
<td>14-14</td>
<td>17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory</td>
</tr>
<tr>
<td>Index</td>
</tr>
<tr>
<td>Index</td>
</tr>
<tr>
<td>(Not Applicable)</td>
</tr>
</tbody>
</table>
### TABLE Ila

**Distribution of Instructional Hours by Class and Laboratory Type in WELDING**

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>General Academic</th>
<th>Related Theory</th>
<th>Laboratory</th>
<th>Drafting</th>
<th>Arc</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welding</td>
<td>Gas</td>
<td>40</td>
<td>70</td>
<td></td>
<td>70</td>
<td>0</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>Arc</td>
<td>40</td>
<td>70</td>
<td></td>
<td>70</td>
<td>350</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combination</td>
<td>40</td>
<td>70</td>
<td></td>
<td>70</td>
<td>350</td>
<td>350</td>
</tr>
</tbody>
</table>

### TABLE Ilb

**Distribution of Instruction by Percent of Time in Each Class and Laboratory Type, and Transferability of Instruction Between Families in WELDING**

<table>
<thead>
<tr>
<th>Family</th>
<th>Level</th>
<th>Total Hours</th>
<th>General Academic</th>
<th>Related Academic</th>
<th>Laboratory</th>
<th>Transferability of Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Welding</td>
<td>Gas</td>
<td>530</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Arc</td>
<td>530</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Combination</td>
<td>880</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>79</td>
</tr>
</tbody>
</table>
Equipment Cost Tables

3.44 Tables 12 through 22 on the following pages summarize the equipment costs associated with the laboratories required for each of the programs considered in this study. The matrices presented in each of the following tables is intended to relate equipment requirements to the programs for which it is used. The relationship between equipment and instructional program is identified in the columns under the general heading Time Requirements (by family). These columns list the number of hours which a student in each family uses each piece of equipment. The range of hour requirements listed under each column corresponds to the range of requirements from "entry" to "specialized" career programs as shown in Tables 1 through 11 of the previous section.

3.45 In addition to the hours of utilization, the relationship between machines and skill families are noted with a priority rating (column P) from "1" to "3" - A rating of "1" indicates that the equipment is absolutely essential to the program to which it is related; a priority of "2" indicates equipment which, while desirable, is not essential; while a priority of "3" indicates equipment is a luxury. (Equipment required by some families in the cluster but unrelated to the family identified at the top of each column is marked with an "x"). A "g" in the "priority" column indicates general support equipment- representing a program supporting item.

3.46 The number of hours a piece of equipment is in use by a student in a specific program is not always linked to the priority of equipment. Thus, some equipment, such as a saw in a woodworking program, may be used only a small portion of the time, but it is essential to have such a power saw if the student is to be able to prepare lumber for further work.

3.47 It should also be noted that there is often a different priority association between a single piece of equipment and several different programs. For instance, a mortiser is an essential piece of equipment in a furniture making program, but it is merely a very desirable piece of equipment in a cabinetry program, and it has no use at all in a general carpentry program.

3.48 The Tables in this section are intended to fulfill various purposes. First, they provide data for computing total laboratory costs that are the basis for determining program costs of alternate curricula. Second, they provide basic planning data for development of curriculum for programs offered with different modes of training. Thirdly, data of these tables provide an added dimension for determining the feasibility of noninstitutional training.
### Table 12

**Equipment Cost and Level of Utilization in the AUTO BODY Laboratory**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (US $-1972)</th>
<th>P</th>
<th>Time Requirements (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment-Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray Booth</td>
<td>4-6000</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Spray Painting Equipment</td>
<td>600-1000</td>
<td>(1)</td>
<td>25-100</td>
</tr>
<tr>
<td>Frame Straightener</td>
<td>8-10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or Damage Dozer</td>
<td>1-3000</td>
<td>(1)</td>
<td>50-150</td>
</tr>
<tr>
<td><strong>Equipment-General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Support Package (1)</td>
<td>7-10,000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hoist (lift)</td>
<td>2-5000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sheet Metal Brake</td>
<td>6-8000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Slip Roll Forming Machine</td>
<td>2-5000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>General Support Tools</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>150</td>
<td>(g)</td>
<td></td>
</tr>
<tr>
<td>Basic Tools</td>
<td>50-80 per student</td>
<td>(g)</td>
<td></td>
</tr>
</tbody>
</table>

(1) Includes jacks, grinders, sanders, drills, buffers, etc.
(2) Usually provided in a ratio of one per five students
Table 13
Equipment Cost and Level of Utilization (in Hours per Program)
in the CONSTRUCTION AND WOODWORKING Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Carpenters</td>
<td>Cabinet/Furniture Makers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P Hours</td>
<td>P Hours</td>
</tr>
<tr>
<td><strong>Equipment—Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathe</td>
<td>600</td>
<td>(3)</td>
<td>(1)</td>
</tr>
<tr>
<td>Bowl Lathe</td>
<td>800</td>
<td>(3)</td>
<td>(2)</td>
</tr>
<tr>
<td>Jointer (6&quot;)</td>
<td>300</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>Jointer (12&quot;)</td>
<td>1700</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Planer (8&quot; x 24&quot;)</td>
<td>3000</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Router</td>
<td>260-650</td>
<td>(3)</td>
<td>(2-3)</td>
</tr>
<tr>
<td>Panel Saw</td>
<td>400</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>Belt &amp; Disc Sander</td>
<td>400</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Radial Arm Saw (16&quot;)</td>
<td>1550-1710</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>Tilting Arbor Saw</td>
<td>450-1050</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Bend Saw</td>
<td>15-2000</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Scroll Saw</td>
<td>300</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Shaper</td>
<td>5-600</td>
<td>(2)</td>
<td>(1)</td>
</tr>
<tr>
<td>Bench Saw</td>
<td>350-600</td>
<td>(1)</td>
<td>(1)</td>
</tr>
<tr>
<td>Drill (15&quot;)</td>
<td>75-320</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Trimmer (veneer)</td>
<td>15</td>
<td>x</td>
<td>(1-2)</td>
</tr>
<tr>
<td>Mortiser</td>
<td>950</td>
<td>x</td>
<td>(1-2)</td>
</tr>
<tr>
<td>Tennoner</td>
<td>1000</td>
<td>x</td>
<td>(1-2)</td>
</tr>
<tr>
<td>Spray Booth</td>
<td>950</td>
<td>x</td>
<td>(1-2)</td>
</tr>
<tr>
<td>Spray Gun</td>
<td>30</td>
<td>x</td>
<td>(1-2)</td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>200 per student</td>
<td>(g)</td>
<td>(g)</td>
</tr>
<tr>
<td>Basic Tools</td>
<td>50-70 per student</td>
<td>(g)</td>
<td>(g)</td>
</tr>
<tr>
<td>General Support Tools(a)</td>
<td>2000-3000</td>
<td>(g)</td>
<td>(g)</td>
</tr>
</tbody>
</table>

(a) Including power drills and saws, grinders, buffers, hand routers, etc.
Table 14

Equipment Cost and Level of Utilization (in Hours per Program) in the DRAFTING Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment—Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drafting Tables - large</td>
<td>460</td>
<td>(1-2)</td>
<td>400-600</td>
</tr>
<tr>
<td>Drafting Tables - small</td>
<td>140</td>
<td>(1)</td>
<td>200-400</td>
</tr>
<tr>
<td>Drafting Machine</td>
<td>150</td>
<td>(1-2)(a)</td>
<td>-</td>
</tr>
<tr>
<td>Tracing Tables</td>
<td>470</td>
<td>(2)</td>
<td>0-50</td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blueprint Machine</td>
<td>600</td>
<td>(1-2)</td>
<td>-</td>
</tr>
<tr>
<td>Blueprint</td>
<td>150</td>
<td>(1-2)</td>
<td>-</td>
</tr>
<tr>
<td>General Tools and Supplies</td>
<td>75 per student</td>
<td>(g)</td>
<td>-</td>
</tr>
</tbody>
</table>

(a) One per large table.
### Table 15

Equipment Cost and Level of Utilization (in Hours per Program) in the ELECTRICITY/ELECTROMECHANICS Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Installation &amp; Maintenance</th>
<th>Elect/Electronics</th>
<th>Electromechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P Hours</td>
<td>P Hours</td>
<td>P Hours</td>
</tr>
<tr>
<td><strong>Equipment-Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Electricity Learning Lab</td>
<td>13800</td>
<td>(2)</td>
<td>(1) 150-200</td>
<td>(2) 50-100</td>
</tr>
<tr>
<td>Basis Electricity Bench - Wired</td>
<td>100/station</td>
<td>(1)</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>Wiring Test Panels</td>
<td>300</td>
<td>(1)</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>Motor Starter Panel</td>
<td>4- 6000</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>AC Switchboard (for M/G)</td>
<td>1800</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>DC Switchboard (for M/G)</td>
<td>1500</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Slipring DC N/G</td>
<td>250</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Squirrel Cage Induction H/C</td>
<td>250</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>3-5 HP Synchronous H/G</td>
<td>4000</td>
<td>(3)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Exciter Switchboard</td>
<td>2000</td>
<td>(2)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>High Tension Transformer</td>
<td>130</td>
<td>(2)</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>Motor Trainer Systems</td>
<td>4- 5000 (15 stations)</td>
<td>(2)</td>
<td>(1) 50-100</td>
<td>(1) 100-200</td>
</tr>
<tr>
<td>Power Supply</td>
<td>4000</td>
<td>(1)</td>
<td>(8) (1)</td>
<td>(1) (8)</td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tools</td>
<td>75- 100/student</td>
<td>(8)</td>
<td>(8)</td>
<td>(8)</td>
</tr>
<tr>
<td>Basic Electricity Learning Kit</td>
<td>250/student</td>
<td>(1) 50-100</td>
<td>(1) 50-100</td>
<td>(1) 50-100</td>
</tr>
<tr>
<td>General Materials (a)</td>
<td>100/student</td>
<td>(8)</td>
<td>(8)</td>
<td>(8)</td>
</tr>
</tbody>
</table>

(a) Light fixtures, service boxes, meters, etc.
Table 16

Equipment Cost and Level of Utilization (in Hours per Program) in the ELECTRONICS Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment-Program Specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television Trainers</td>
<td>5- 800 each</td>
<td>(1) Time requirements</td>
</tr>
<tr>
<td>Communications Trainer</td>
<td>35-4000</td>
<td>(1) depend on specific program objectives</td>
</tr>
<tr>
<td>Digital Logic Trainer</td>
<td>4-1200</td>
<td>(1)</td>
</tr>
<tr>
<td><strong>Equipment-General</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Electronics Test Console</td>
<td>3000</td>
<td>(g)</td>
</tr>
<tr>
<td>Electronics Benches (instrumented)</td>
<td>4- 500 per station</td>
<td>(g)</td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics Benches - general</td>
<td>100 per station</td>
<td>(g)</td>
</tr>
<tr>
<td>General Support Equipment (a)</td>
<td>250 per station</td>
<td>(g)</td>
</tr>
<tr>
<td>Tools</td>
<td>75 per student</td>
<td>(g)</td>
</tr>
<tr>
<td><strong>General Supplies (b)</strong></td>
<td>600 per station (average)</td>
<td>(g)</td>
</tr>
<tr>
<td>Basic Electronics Kit</td>
<td>200 per student</td>
<td>(g)</td>
</tr>
</tbody>
</table>

(a) Including power supplies, general test equipment, etc.
(b) Electronics training kits, instruction boards, etc.
Table 17

Equipment Cost and Level of Utilization in the ENGINE MECHANICS Program

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (US $-1972)</th>
<th>P</th>
<th>General Merchandise</th>
<th>Program Specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment—Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve resurfacer</td>
<td>1000</td>
<td>(1-2)</td>
<td>10-20</td>
<td></td>
</tr>
<tr>
<td>Brake Service Equipment</td>
<td>2500-3000</td>
<td>(1-2)</td>
<td>10-20</td>
<td>50-150 brake mechanic</td>
</tr>
<tr>
<td>Electronic Engine Analyzer</td>
<td>1-2000</td>
<td>(1-2)</td>
<td>40-80</td>
<td>60-100 tune-up mechanic</td>
</tr>
<tr>
<td>Engine Dynamometer</td>
<td>5-7000</td>
<td>(2)</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>Chassis Dynamometer</td>
<td>7-10,000</td>
<td>(2-3)</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>Front-end Alignment</td>
<td>2-3000</td>
<td>(1)</td>
<td>30-60</td>
<td>50-100 front-end mechanic</td>
</tr>
<tr>
<td>Engines—gasoline</td>
<td>5-1500 (new)</td>
<td>(1)</td>
<td>150-300</td>
<td>100-200 tune-up mechanic</td>
</tr>
<tr>
<td>Engines—diesel</td>
<td>2-3000-10,000</td>
<td>(2-3)</td>
<td>(50-100)</td>
<td></td>
</tr>
<tr>
<td>Diesel Fuel Injection System</td>
<td>1-3000</td>
<td>(2-3)</td>
<td>(20-50)</td>
<td></td>
</tr>
<tr>
<td>Transmissions - standard</td>
<td>250*</td>
<td>(1)</td>
<td>{40-80}</td>
<td></td>
</tr>
<tr>
<td>Transmissions - automatic</td>
<td>250*</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chassis</td>
<td>1000</td>
<td>(1)</td>
<td>40-75</td>
<td></td>
</tr>
<tr>
<td>Generator Test Bench (1)</td>
<td>5-1000</td>
<td>(2)</td>
<td>30-50</td>
<td>50-100 front-end mechanic</td>
</tr>
<tr>
<td><strong>Equipment—General</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Support Package (2)</td>
<td>12-15,000</td>
<td>(1)</td>
<td></td>
<td>general support</td>
</tr>
<tr>
<td>Engine Degreaser</td>
<td>1000</td>
<td>(2-3)</td>
<td></td>
<td>for all programs</td>
</tr>
<tr>
<td>Welding Equipment (gas)</td>
<td>2-400</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheel Balancer</td>
<td>1-200</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoists (lifts)</td>
<td>2-5000</td>
<td>(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General Support Tools, etc.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Tools</td>
<td>75-100 (per student)</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>150</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Kits (4)</td>
<td>50-150 each</td>
<td>(2-3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Including armature lathe and other related repair equipment
(2) Including jacks, lubrication equipment, engine stands, parts cleaner, tire changer, misc. grinders, presses, compressor, spark plug cleaner, etc.
(3) Usually provided in a ratio of one per three students
(4) Electrical system trainers, fuel system trainer, etc.
Table 18
Equipment Cost and Level of Utilization (in Hours per Program)
in the HEATING - REFRIGERATION - AIR CONDITIONING Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Refrigeration/Air Conditioning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Home</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P Hours</td>
</tr>
<tr>
<td>Refrigeration cycle trainer -</td>
<td>3-4000</td>
<td>(1)</td>
</tr>
<tr>
<td>Industrial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>1800</td>
<td>(3)</td>
</tr>
<tr>
<td>Compressor and Refrigerator System</td>
<td>500</td>
<td>(1)</td>
</tr>
<tr>
<td>- water cooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- air cooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Conditioning Trainer</td>
<td>1000</td>
<td>(1)</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>2000</td>
<td>(3)</td>
</tr>
<tr>
<td>Gas/Oil Burner Trainers</td>
<td>4-700</td>
<td>x</td>
</tr>
<tr>
<td>Burner Test Equipment</td>
<td>1000</td>
<td>x</td>
</tr>
<tr>
<td>Heating Trainer (Home)</td>
<td>2000(a)</td>
<td>x</td>
</tr>
<tr>
<td>Boiler (Industry)</td>
<td>(b)</td>
<td>x</td>
</tr>
<tr>
<td>General Support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Benches, etc.</td>
<td>100</td>
<td>(g)</td>
</tr>
<tr>
<td>Tools and Supplies</td>
<td>80-100 per student(g)</td>
<td>(g)</td>
</tr>
</tbody>
</table>

(a) At least two systems, one each for forced air and hot water, with interchangeable gas and oil burners, are usually required.

(b) Boiler costs usually prohibit the installation of such systems for instructional purposes only. Heating systems required for the instructional facility are usually used for this component of the instructional program.
Table 19

Equipment Cost and Level of Utilization (in Hours per Program) in the MACHINE SHOP Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
<th>General Hours</th>
<th>Single Machine Specialty Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment-Program Specific</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathe (12&quot;) - Bare</td>
<td>660</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathe (15&quot;) Precision</td>
<td>5000</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathe (11&quot;) Turret</td>
<td>3100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathe (13&quot;) Turret</td>
<td>6900</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milling Machine, Horizontal</td>
<td>4200-7000</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessories</td>
<td>1000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milling Machine, Vertical</td>
<td>1200-2700</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaper</td>
<td>600-1200</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Punch Press</td>
<td>3500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screw Machine</td>
<td>160-230</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boring Machine</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Grinder</td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder Grinder</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grinder, Tool Cutter (6&quot;)</td>
<td>255</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial Gear Lead Drill</td>
<td>7000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic Discharge Machine</td>
<td>10-102000</td>
<td>(3)</td>
<td>0-100</td>
<td></td>
</tr>
<tr>
<td>N/C Tape Punch</td>
<td>2000</td>
<td>(3)</td>
<td>40-80</td>
<td></td>
</tr>
<tr>
<td>N/C Controller</td>
<td>48000</td>
<td>(3)</td>
<td>General Support</td>
<td></td>
</tr>
<tr>
<td>N/C Tracking Unit (3 axis)</td>
<td>2500</td>
<td>(3)</td>
<td>General Support</td>
<td></td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Support Package (a)</td>
<td>4-5000</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancillary Tools &amp; Equipment</td>
<td>75 per student</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>170 per station</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Includes miscellaneous drills, grinders, air compressors, etc.
Table 20

Equipment Cost and Level of Utilization (in Hours per Program) in the PLUMBING AND PIPING LABORATORY

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement P (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment-Program Specific</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>General Support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>200</td>
<td>(8)</td>
</tr>
<tr>
<td>General Support Systems(a)</td>
<td>2500</td>
<td>(8)</td>
</tr>
<tr>
<td>Tools</td>
<td>75 per station</td>
<td>(8)</td>
</tr>
<tr>
<td>Supplies</td>
<td>50 per station</td>
<td>(8)</td>
</tr>
</tbody>
</table>

(a) Including power hacksaw, pipe threader, pipe bender, welding system.

(b) Except for benches which are required for each student all equipment in this laboratory is used as general support for all programs in piping and plumbing.
### Table 21

Equipment Cost and Level of Utilization (in Hours per Program) in the SHEET METAL Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>Time Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment-Program Specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bender</td>
<td>400</td>
<td>(1)</td>
</tr>
<tr>
<td>Brake, Box and Pan</td>
<td>1200</td>
<td>(1)</td>
</tr>
<tr>
<td>Brakes Folder</td>
<td>700</td>
<td>(1)</td>
</tr>
<tr>
<td>Folder</td>
<td>340-850</td>
<td>(1)</td>
</tr>
<tr>
<td>Seaming Machine</td>
<td>475</td>
<td>(1)</td>
</tr>
<tr>
<td>Notching and Shearing Machine (6&quot; x 6&quot;)</td>
<td>400</td>
<td>(1)</td>
</tr>
<tr>
<td>Grooving Machine</td>
<td>500</td>
<td>(1)</td>
</tr>
<tr>
<td>Roll Former-Manual</td>
<td>250</td>
<td>(1)</td>
</tr>
<tr>
<td>Power</td>
<td>550</td>
<td>(2)</td>
</tr>
<tr>
<td>Slip Roll Former</td>
<td>300</td>
<td>(2)</td>
</tr>
<tr>
<td>Punch and Shear</td>
<td>400</td>
<td>(1)</td>
</tr>
<tr>
<td>Shear</td>
<td>250-400</td>
<td>(1)</td>
</tr>
<tr>
<td>Shear (Ring &amp; Circle)</td>
<td>1600</td>
<td>(1)</td>
</tr>
<tr>
<td>Shear (Rotary)</td>
<td>570</td>
<td>(1)</td>
</tr>
<tr>
<td>Shear (Cutoff) Manual</td>
<td>1000</td>
<td>(1)</td>
</tr>
<tr>
<td>Power</td>
<td>2-5000</td>
<td></td>
</tr>
<tr>
<td>Shear (Squaring)</td>
<td>1300</td>
<td>(1)</td>
</tr>
<tr>
<td>Welder (AC only)</td>
<td>325</td>
<td>(1)(a)</td>
</tr>
<tr>
<td>(AC/DC)</td>
<td>425</td>
<td>(2)(a)</td>
</tr>
<tr>
<td>(Spot)</td>
<td>280</td>
<td>(2)</td>
</tr>
<tr>
<td>(Torch, portable)</td>
<td>350</td>
<td>(1)(a)</td>
</tr>
<tr>
<td>Burring Machine</td>
<td>50</td>
<td>(1)</td>
</tr>
<tr>
<td><strong>General Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>200</td>
<td>(g)</td>
</tr>
<tr>
<td>Basic Tools</td>
<td>60-80 per student</td>
<td></td>
</tr>
</tbody>
</table>

(a) Basic instruction in welding provided in the welding laboratory.
### Table 22
Equipment Cost and Level of Utilization (in Hours per Program) in the WELDING Laboratory

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost (U.S. $ - 1972)</th>
<th>P</th>
<th>Time Requirements</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arc Gas Combination</td>
<td></td>
</tr>
<tr>
<td>Oxyacetylene Welding</td>
<td>250 (a)</td>
<td>(1)</td>
<td>250-300</td>
<td>250-300</td>
</tr>
<tr>
<td>Arc Welding (Booth and Welding)</td>
<td>1000 (1)</td>
<td>(1)</td>
<td>160-200</td>
<td>x</td>
</tr>
<tr>
<td>Welder - (MIG or TIG)</td>
<td>850-1500 (1)</td>
<td>(1)</td>
<td>20-50</td>
<td>x</td>
</tr>
<tr>
<td>Wire</td>
<td>800 (2)</td>
<td>(2)</td>
<td>0-40</td>
<td>x</td>
</tr>
<tr>
<td>Spot</td>
<td>200 (1-2)</td>
<td>(1-2)</td>
<td>0-20</td>
<td>x</td>
</tr>
<tr>
<td>Heliarc</td>
<td>1500 (2)</td>
<td>(2)</td>
<td>20-40</td>
<td>x</td>
</tr>
<tr>
<td>Portable Spot</td>
<td>525 (3)</td>
<td>(3)</td>
<td>0-10</td>
<td>x</td>
</tr>
<tr>
<td>Soldering Bench</td>
<td>200 (2)</td>
<td>(2)</td>
<td>0-10</td>
<td>20-50</td>
</tr>
<tr>
<td>General Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Support Package</td>
<td>3000 (b)</td>
<td>g(e)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake, Box and Pan</td>
<td>700 (2)(e)</td>
<td>(2)(e)</td>
<td>General support for all programs</td>
<td></td>
</tr>
<tr>
<td>Slip Roll Former</td>
<td>160 (2)(c)</td>
<td>(2)(c)</td>
<td>50-100 hours.</td>
<td></td>
</tr>
<tr>
<td>Hardness Tester</td>
<td>350 (1)(d)</td>
<td>(1)(d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tensile Tester</td>
<td>450 (1)(d)</td>
<td>(1)(d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weld Tester</td>
<td>200 (1)(d)</td>
<td>(1)(d)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment-General</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Tools</td>
<td>50-75 per student</td>
<td>(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benches</td>
<td>150 per station</td>
<td>(g)(e)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) Includes bench, vent hood and basic torch system and accessory.
(b) Including basic oxyacetylene manifold system, power hacksaw, pipe bender, drill, grinder.
(c) May be shared with Sheet Metal.
(d) Should be included in comprehensive materials testing facility associated with machine shop.
(e) Usually provided in a ratio of one per five students as general support.
Distribution of Workers Within Industries

3.49 These tables were derived from the occupational structures of industries of a group of developing countries. Together with data on the statistical distribution of plants by size (number of employees), this table provides a guideline for determining the feasibility of training on the job.

3.50 The ability to offer training on the job, or through an off-the-job and on-the-job combination program, increases the larger the plant and the higher the proportion of workers with a given occupation in the labor force. For example, in a country with a large machinery industry in-plant programs for training machine shop occupations can be contemplated since 15 to 20 percent of the labor force are machine shop operators. On the other hand, the machine shop industry is no place for training piping and plumbing occupations because these occupations constitute less than half of one percent of the labor force.
### Distribution of Workers within Industries (per 1000 employees in each industry)

<table>
<thead>
<tr>
<th>Industry/Worker Group</th>
<th>Auto Body</th>
<th>Cabinetry</th>
<th>Carpentry</th>
<th>Drafting</th>
<th>Electrical</th>
<th>Engine Mechanics</th>
<th>Machine Shop</th>
<th>Piping &amp; Plumbing</th>
<th>Sheet Metal</th>
<th>Welding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>3-5</td>
<td>3-6</td>
<td>9-12</td>
<td>1-3</td>
<td>12-20</td>
<td>7-10</td>
<td>1-2</td>
<td>7-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>175-225</td>
<td>2-4</td>
<td>30-40</td>
<td>2-4</td>
<td>3-5</td>
<td>45-60</td>
<td>6-10</td>
<td>2-4</td>
<td></td>
<td></td>
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<tr>
<td>Electrical Machinery</td>
<td>4-6</td>
<td>16-20</td>
<td>80-120</td>
<td>0-1</td>
<td>60-80</td>
<td>1-2</td>
<td>5-10</td>
<td>12-17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furniture</td>
<td>25-30</td>
<td>5-7</td>
<td>0-1</td>
<td>0</td>
<td>1-3</td>
<td>0-1</td>
<td>1-2</td>
<td>1-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery</td>
<td>4-9</td>
<td>25-30</td>
<td>8-11</td>
<td>2-3</td>
<td>150-200</td>
<td>3-4</td>
<td>8-12</td>
<td>18-30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal Products (Fabricated)</td>
<td>3-5</td>
<td>10-12</td>
<td>7-10</td>
<td>5-7</td>
<td>50-80</td>
<td>5-10</td>
<td>10-15</td>
<td>25-30</td>
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<tr>
<td>Paper</td>
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<td>10-15</td>
<td>0-1</td>
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<td>3-6</td>
<td>1-2</td>
<td>3-5</td>
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<td></td>
</tr>
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<td>5-7</td>
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<tr>
<td>Railroads</td>
<td>5-8</td>
<td>1-2</td>
<td>4-6</td>
<td>0-1</td>
<td>3-4</td>
<td>3-4</td>
<td>2-4</td>
<td>5-8</td>
<td></td>
<td></td>
</tr>
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<td>Textiles</td>
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<td>0</td>
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<td>1-2</td>
<td>0-1</td>
<td>1-2</td>
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<tr>
<td>(Mill Products)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation (Motor Vehicles)</td>
<td>20-30</td>
<td>5-8</td>
<td>12-20</td>
<td>175-200</td>
<td>70-100</td>
<td>3-6</td>
<td>20-30</td>
<td>40-50</td>
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<td></td>
</tr>
<tr>
<td>Utilities</td>
<td>5-8</td>
<td>10-14</td>
<td>85-115</td>
<td>6-10</td>
<td>5-12</td>
<td>30-50</td>
<td>1-2</td>
<td>5-8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Separate categorizations not available.
IV. EVALUATION OF A PROPOSAL FOR VOCATIONAL TRAINING

The following section provides an approach for the evaluation of proposals for vocational training. A final decision to choose one mode of training over another, of course, should include factors such as institutional and political ones, but the procedure outlines here is a systematic way of reaching decisions that lead to a logical economic choice.

The methodology is portrayed in a chart. Initially it is assumed that a proposal for a vocational school is submitted for consideration. The proposal need not be that of vocational school, the procedures that follow could be applied to a proposal for any mode of vocational training such as a skill center, a rapid retraining system, an in-plant training system, etc. The chart is designed in such a way that irrespective of the types of proposal the evaluator will be in a position to compare any modes of vocational training.

The arrows in the chart show the direction of the steps in the sequence. The numbers in the right-hand corner of the blocks refer to the explanations that accompany the chart.

Proposal for a vocational school (Block 1)

4.1 The proposal for a vocational school should ideally provide the following information:

a) Type of programs to be offered in the school
b) Number of students expected in each program every year for at least five to seven years, or for the lifetime of the equipment.
c) Number and types of machines in each laboratory
d) Number and types of machines in each laboratory
e) Costs of each laboratory
f) Areas of classrooms, laboratories, and other facilities.
g) Costs per unit of area
h) Cost of land
i) Number of instructors
j) Salaries of instructors
k) Annual costs of administration (including maintenance)
l) Annual costs of materials and supplies
m) Other costs
n) Hours of classroom and laboratory instruction by program
o) Time required for graduation (in years)
p) Length of school year
q) Entry requirements for trainees

4.2 Determine the probability of employment for graduates (Block 2)

a) Recent census data may provide unemployment rates by occupation, from which some indication of employment opportunities may be calculated.
b) Special unemployment surveys providing unemployment rates by occupation may also provide the basis for calculating the probability of employment for graduates of training programs.
c) Follow-up studies of graduates and of dropouts from training programs would provide direct information on the probability of employment for graduates.
d) Interviews with personnel managers of major firms and with union officials will provide information on the employment of graduates of training programs.

Compare job entry requirements with characteristics conferred by program.

(Blocks 3)

4.3 Job requirements vary from country to country. Nevertheless, basic information can be obtained from the International Standard Classification of Occupations, I.L.O.; the Dictionary of Occupational Titles, U.S. Department of Labor; and from interviews with experts in industry and in the Ministry of Labor. In addition, many large firms, especially multinationals, are likely to have detailed job descriptions of each job in the plant, with requirements for each.

4.4 Characteristics conferred by training can be obtained from instructors and directors of the training institutions. Finally, interviews with graduates from training programs as well as supervisors on the job can provide information on the discrepancy between requirements and characteristics.

4.5 In certain industries union membership is required as a prerequisite for a job. In theory, this is based upon the notion that union membership is an assurance that the worker has a certain level of competence. Actually, however, the practice may be no more than an indication of the monopolistic position of the union. Other hiring in qualifications may include a primary school or
a secondary school graduation diploma, or a certificate indicating com-
pletion of an apprenticeship program or a vocational school program. Some
firms are prepared to hire untrained persons with a certain minimum level
of schooling, if the person agrees to enter the firm's training program.

**Determine employers' preferences in hiring (Block 4)**

4.6 A small firm that is in no position to have its own training pro-
gram nevertheless must hire new workers every so often, to replace workers who
died, quit, or were fired. If he has a free choice what kind of worker does
he employ? He may prefer a person who completed training in a public vocatio-
 nal training school. Or, he may prefer someone who completed a program in an
industry-sponsored training center. In most cases his choice may be based upon
a very small sample of personal experiences, or upon the reputation of the train-
ing programs. It is very unlikely that any or a few employers has had actual
experience with all the different varieties of training programs and has made
a rational choice based upon his concern about effectiveness. Nevertheless, he
has indicated his preference by giving priority in his hiring, to worker from
one training program over another.

4.7 Larger firms have a wider choice. Not only can they indicate, through
hiring, their preference in types of training programs, but they can also set up
their own type of training. If they do the latter, they may be voting "no confi-
dence" in the various outside training programs. Although sometimes they prefer
training their own workers to fit the firm's narrow own needs to reduce the
firm's turnover because a narrowly trained worker is generally less mobile.

4.8 The attitude of industry toward training can be obtained by interview-
ing company managers, especially personnel directors. Questions such as the
following would have to be asked:

(1) Why are trainees from one program hired in preference to trainees
from other programs?

(2) Has the company had experience with employees from other programs?

(3) Have the trainees from the preferred program actually performed
better on the job as craftsmen? Are their wages higher?

(4) Have trainees from the preferred program been advanced more
rapidly to supervisory positions?

4.9 A sample survey of company officials (or large and small firms) from
a range of industries could provide sufficient detailed information on the above
questions. This would furnish guides in the selection of the mode of training.

4.10 Using current employees to obtain new workers is a common practice,
and is used widely by companies, to obtain blue collar workers. Obtaining in-
formation on such a practice is not easy since it is done in a very informal
manner. Interviewing a sample of employment managers of large firms will give
some indication of how widespread is the practice. Interviewing a small sample
of newly hired workers will also provide a clue for hiring preferences.
4.11 Other avenues by which employers hire workers include private employment agencies, newspaper and other advertisement, and their current employees. In nations where private employment agencies are permitted, their use is more common for the white collar and professional workers. Interviews with these employment agencies are also recommended.

**Determine cost per graduate in each program** *(Block 5)*

4.12 Total costs of a program are:

\[ TC_j = PC_j + EC_j + MC_j + FC_j \]

where

- \( TC_j \) = total costs of program \( j \)
- \( PC_j \) = personnel costs of program \( j \)
- \( EC_j \) = equipment costs of program \( j \)
- \( MC_j \) = materials costs of program \( j \)
- \( FC_j \) = facilities costs of program \( j \)

**Personnel Costs**

4.13 There are generally two types of personnel: administrative and instructional. In turn, instructional personnel can be divided into lab laboratory and classroom instructors. Since the determination of the costs of a program is on the basis of existing programs, only average costs are considered.

\[ PC_j + ADM_j + LP_j + C_{1P}_j \]

where

- \( ADM_j \) = administration costs allocated to program \( j \)
- \( LP_j \) = laboratory personnel allocated to program \( j \)
- \( C_{1P}_j \) = classroom personnel allocated to program \( j \)

The basis for allocation is student hours of instruction for a program as compared with total student hours of all programs.

* A numerical example is given in Appendix 4.
\[ ADM_j = TCA \times \frac{HRS_j}{n} \sum_{j=1}^{n} HRS_j \]

where

- \( TCA \) = total costs of administration
- \( HRS_j \) = student hours of program \( j \)

\[ LP_j = \sum_{k=1}^{m} [TCLI_k \times \frac{HRSL_{kj}}{n} \sum_{j=1}^{n} HRSL_{kj}] \]

- \( TCLI \) = total costs of laboratory instruction
- \( HRSL_{kj} \) = student hours laboratories instruction of program \( j \)

\[ C_{1j} = TCCI_{1j} \times \frac{HRSC_{1j}}{n} \sum_{j=1}^{n} HRSC_{1j} \]

- \( TCCI_{1j} \) = total cost classroom instruction
- \( HRSC_{1j} \) = student hours class instruction of program \( j \)

**Equipment Costs**

\[ EC_j = \sum_{k=1}^{m} TLC_k \times \frac{H_{kj} \times S_j / SSI_j}{n} \sum_{j=1}^{n} H_{kj} \times S_j / SSI_j \]

where

- \( TLC_k \) = total equipment cost of laboratory of type \( k \)
- \( H_{kj} \) = total number of instructional hours spent in laboratory \( k \) by students in program \( j \)
- \( S_j \) = number of students in program \( j \). This is the number of students that will be trained on the equipment over the life of the equipment, not the number of students in program \( j \) in a given year
SS_{ij} = \text{student stations per unit of equipment } "i" \\
m = \text{number of laboratories of type } "k" \\
\sum_{j=1}^{m} HkjSj = \text{class size } \times \text{duration of class (in hours)}

and \\
\text{TLC}_k = \sum_{i=1}^{r} \text{EC}_{ik} + \text{FC}_k

where \\
\text{EC}_{ik} = \text{equipment cost of item } "i" \text{ used in laboratory } "k"
\text{FC}_k = \text{fixed costs of } "k" \text{ type laboratory (equipment needed to support machines on which students learn)}

and \\
\text{EC}_{ik} = r_i \times C_i

where \\
r_i = \text{number of machines of type } i \\
C_i = \text{unit cost of machine } i

\sum_{j=1}^{m} HRS_{ij} \times \frac{S_j}{SS_{ij}} = \frac{\sum_{j=1}^{m} HRS_{ij} \times S_j}{SS_{ij}}

r_i = \frac{\sum_{j=1}^{m} HRS_{ij} \times S_j}{SS_{ij}} \times \frac{1}{HRSA_i \times u_i}

where \\
HRS_{ij} = \text{hours instruction on machine } "i" \text{ required by a student in program } "j"
\text{HRSA}_i = \text{hours available on machine } "i"
\text{u}_i = \text{utilization factor of machine } "i"
Materials Costs

4.15 Costs of materials and supplies are very difficult to estimate. These vary from activity to activity and in accordance to the intensive level of training. They have to be, therefore, determined on a case-by-case study.

Costs of Facilities

4.16 Total construction costs allocated to a program j (TCCP<sub>j</sub>) is:

\[
TCCP_j = \left[ \sum_{k=1}^{m} \frac{\text{TLCC}_k \times H_{kj} \times S_j}{\sum_{j=1}^{n} H_{kj} S_j} + \frac{\text{TCICC} \times \text{HRSCl}_j}{\sum_{j=1}^{n} \text{HRSCl}_j} \right] (1 + \text{BF})
\]

where

- \text{TLCC}_k = total construction of laboratory of type "k"
- \text{TCICC} = total classroom construction cost
- BF = building factor allowance to cover "overhead" space; hallways, officer, washrooms, etc.

This factor ranges between .4 and .6

\[
\text{TLCC}_k = \text{AREA}_k \times \text{CPA}_k
\]

\[
\text{TCICC} = \text{AREA}_{cl} \times \text{CPA}_{cl}
\]

\[
\text{AREA}_k = \text{area of laboratory of type "k"}
\]

\[
\text{AREA}_{cl} = \text{area of classrooms}
\]

\[
\text{CPA}_k = \text{cost per unit area construction of laboratory "k"}
\]

\[
\text{CPA}_{cl} = \text{cost per unit area construction of classrooms}
\]

Determine capacity utilization of facilities, equipment, and personnel.
(Block 6)

4.17 Capacity utilization is a relative concept: it is the actual use of capacity as percent of a "normal" measure of capacity. For example, normal capacity of a laboratory may be 30 hours a week multiplied by the number of students that can be taught effectively at one time in the laboratory. "Normal" instructor capacity might be 15 students multiplied by five hours daily, etc.
4.18 Given the types of laboratories and programs in the school (hours of laboratory and class instruction and number of students in each program) it is possible to calculate utilization of capacity. For example, utilization of laboratory capacity is:

\[
\text{Percent utilization of laboratory capacity} = \frac{\sum_{k=1}^{m} \sum_{j=1}^{n} \text{HRS}_{kj}}{\sum_{k=1}^{m} \text{HRS}_{nk}}
\]

\[
\text{HRS}_{kj} = \text{Hours in laboratory "k" spent by students in program j}
\]

\[
\text{HRS}_{nk} = \text{Normal capacity in student hours of laboratory k}
\]

4.19 Capacity utilization of teachers can be approximated by the student-teacher ratios of classrooms and laboratories separately. In general, utilization of capacity of less than 70% of "normal" capacity, should encourage a revision of programs, or in the programmed number of students.

Determine the rate of return for program (Block 7)

4.20 The rate of return calculation is usually based on available statistics on occupational earnings by age adjusted by the probability of employment. These data are not readily available in many developing nations. Moreover, the soundness of using present earnings of older people to represent future earnings of today's entrant to the labor market is highly questionable. It is therefore advisable to confine the computations to initial earnings and earnings for the first five years, for occupations obtainable through training and occupations that workers would have had without the training. It can be assumed that the differentials in the earnings of the two types of occupations remain constant thereafter. The rate of return can be calculated with the following equation:

\[
I_t = \frac{E_{t1} - E_{w1}}{(1+r)} + \frac{E_{t2} - E_{w2}}{(1+r)^2} + \ldots + \frac{E_{t5} - E_{w5}}{(1+r)^5} + \ldots + \frac{E_{t5} - W_{w5}}{(1+r)^n}
\]

\[
T_t = \text{investment in vocational training}
\]

\[
E_{t1} = \text{earnings of an individual with training in year 1}
\]

\[
E_{w1} = \text{earnings of an individual without training in year 1}
\]

Data on earnings can be obtained from interview in a few typical plants, employment bureaus, or labor unions.
Compare cost/graduate of vocational schools with cost/graduate academic schools. (Block 8)

4.21 In many developed and developing countries graduates from the academic stream compete successfully for jobs with graduates from vocational schools. Where this is so, and assuming that the type of student input to the school is similar, a comparison of costs/graduate of both types of schooling may provide a clue to the economic viability of vocational education. In general, it should be expected that vocational education in formal schools is more expensive than regular academic schools. However, when the discrepancy is more than 30% a closer scrutiny of the vocational programs must be made.

Survey of training modes in existence in this country (Block 9)

4.22 Vocational training may be offered in a wide variety of institutions.

a) Public schools: Information on government sponsored training in the public school system is generally readily available. A description of the training can generally be obtained from the Ministry of Education, or in some situations from the Ministry of Labor. A description of this training would include information on a whole range of items such as programs, facilities, teachers, students, administration, etc. To obtain all information, it may be necessary to visit a small sample of schools.

4.23 b) Private schools: In some countries training programs are offered to the public by private, for profit, schools. Information on such schools frequently can be obtained from the Ministry of Education since most countries require that private schools be registered with the Ministry of Education. If a list of such schools is available, a sample could be visited to obtain data similar to that listed above. If a list of such schools is not available, the names of a sample may be obtained by telephone books and by talking to a few large firms who might hire graduates of such schools.

4.24 c) Training in the enterprise: In addition to training in schools, there is always the likelihood that employers, especially the large ones, have developed some type of training in their plants. There is not likely to exist a list of firms that offer training in their plants and it will be necessary to search out this information. Some such training efforts are more likely to be taken by large firms, and a brief list of large firms can be put together quickly based upon conversations with knowledgeable persons in the government or in industry associations.

4.25 d) Training centers: Vocational training may also be offered in a specially designed training center administered by a government agency, an employer association or some industry federation. In most situations, training centers offer training in a limited number of semi-skilled or skilled occupations, with special emphasis on the vocational (or shop) aspects of the work. Where it is part of the job, theoretical, mathematical, and blueprint reading courses are also offered. If training centers are run by government agencies, there is no problem in locating the facilities. If the training centers are run by private organizations, it becomes necessary to contact the various employer associations or industry federations to locate the centers. The availability of a training center facility with good programs may make it relatively easy to expand training in that center, especially if its location and equipment fit into the needs of the growth industries.
4.26 e) Apprenticeship programs: Another type of training that is likely to be found in many countries is apprenticeship programs. Such programs may be sponsored by an employer or an industry group, possibly in cooperation with a government agency or with a union. Those programs sponsored by an industry group, a governmental agency or a union, are readily located; those sponsored by individual employers, especially small employers, will not be readily located. However, by interviewing a few key leaders in major industries and in major unions, one cannot only locate most apprenticeship programs but also learn the general characteristics of the programs. A number of employers also would have to be interviewed in order to get some feel of individual employer reactions to apprenticeship.

4.27 In addition to obtaining general types of descriptive information about the operation of apprenticeship programs, it also is necessary to get information on the following:

- What are the government laws affecting apprenticeship (e.g., minimum age, minimum wage, ratio of apprentice to journeyman, benefits to firms employing apprentices)?
- How are apprenticeship programs financed?
- How much related instruction is required of apprentices and who provides the facilities and administers the courses?
- Who finances and provides the related instruction?
- Do the apprentices attend the related instruction courses on their own time or on Company time? Is it mandatory?
- What are the requirements to enter an apprenticeship program?
- What is the length of the program?
- What is the pay scale for apprentices?
- How are the apprentices recruited?
- What is the retention rate?
- Do the completers receive a special certificate that is recognized nationwide?
- Is the apprenticeship system operating at capacity? If not, how many additional apprentices can it absorb?

4.28 In most situations, much of this information will be obtained through interviews with key individuals in industry, unions, and the government. In some cases, information will be readily obtained from general officers of organizations; in other cases, there may be specialized personnel whose responsibilities are the administration of apprenticeship programs. While it may vary from industry to industry, or from occupation to occupation, apprenticeship
does offer a mode of training that normally can be expanded rather easily, within certain limits.

4.29 f) Other training modes: Another means for training personnel is foreign firms. It is rather common that foreign firms will bring in their key skilled personnel who have the responsibility for training nationals. Depending on how long the firms have been operating in the country, the establishment may be a significant source of newly-trained workers. Such foreign firms are easily identified and located, and an interview would readily provide the desired information about any training programs.

4.30 In some nations, the military offers training courses to their new recruits. Often such training cuts across into civilian occupations. Again, by one or two interviews information on such training could readily be obtained.

4.31 It is not very likely that one can obtain all the information about the various training systems and programs of a country in a short period of time. Locating sources of information will undoubtedly be a problem; and even when sources are located, obtaining the needed information can also delay the situation considerably. In order to keep the time delays at a minimum, key persons should be interviewed at the initial stage of any investigation. The following is a check-list of organizations or persons who should be contacted for information about training programs:

(1) Ministry of Education
(2) Ministry of Labor
(3) Military leaders
(4) Trade Union leaders
(5) Officials of Industry Federations
(6) Officials of employer associations
(7) Officers of major firms
(8) Training directors in school programs
(9) Training directors in skill centers
(10) Training directors in company-run programs.

Calculate present cost/graduate of this mode (Block 10)

4.32 The calculation of costs of any mode of training offered in any institutional setting is similar to that of a regular vocational school. In the case of training offered, partly or totally, in a non-institutional setting (apprenticeship, on-the-job training, etc.). The non-institutional segment of training has to be calculated separately. When different programs share the same resources in the non-institutional setting the allocation of costs can be
made on the basis of hours of instruction or hours equipment usage. The major part of the cost of training in non-institutional settings is the opportunity costs of skilled workers and supervisors engaged in teaching, opportunity costs of machinery and equipment, and costs of breakdown of equipment. There is no data available to allow an analysis of these types of costs. Data will have to be developed on site and even then the best observations will be only gross approximations of reality.

Determine the capacity of the training mode for absorbing extra trainees (Block 11)

4.33 The present cost per trainee or graduate is no indication of the costs of absorbing an increased number of trainees. This is especially true for systems of training that use idle capacity of equipment and personnel of other systems or institutions. For example, in many countries a rapid retraining system uses the facilities of vocational schools and the equipment of factories at night or during other non-working hours. The analysis of costs of these systems shows indeed a low cost per trainee. However, once the available "free" capacity is totally taken up the marginal costs of training goes up considerably. The same can be argued about on-the-job training. As long as the number of trainees or apprentices is small it is possible to take advantage of the "excess teaching capacity" of skilled workers and supervisors. When the numbers to the trained increase substantially, there may be a need to hire extra personnel with the result that costs of training may differ considerably to the costs before the enlargement of the program.

Determine if the training would be profitable to the firm (Block 12)

4.34 \[ \sum_{t=1}^{m} \frac{C_t + W_{at} - Q_{at}}{(1+r)^t} < \sum_{t=m+1}^{n} \frac{Q_{st} - W_{st}}{(1+r)^t} \]

\( C_t \) = cost of training
\( W_{at} \) = apprentice wages during training
\( Q_{at} \) = value of apprentice production
\( Q_{st} \) = value of production of skilled worker
\( W_{st} \) = wages of skilled worker
\( t \) = time subscript
\( r \) = rate of discount

Costs of training can be calculated as in page 89 (Block 10) above.
Consider different policies to make training attractive to the firm.

4.35 Policies to encourage training in the enterprise are:

1. provision of administrative machinery for cooperative training efforts by small enterprises to lower costs/trainee.
2. subsidization of training (grant per trainee)
3. subsidization of trainee's wages
4. preferential (lower) interest rates for building and purchase of machinery and equipment for training.
5. provision of support personnel and materials to lower costs of training to the enterprise

Calculate explicit and implicit costs of policies (Block 14)

4.36 Explicit costs of the policies are easily calculated. For example, a flat grant per trainee multiplied by the number of trainees gives the total cost of subsidization of training; likewise, the administrative set up for helping and overseeing training as well as the subsidy of lower interest rates can also be calculated. The implicit costs of policies are most difficult to determine: a strong in-plant training at the expense of formal vocational schools may alienate the formal bureaucracy of a Ministry of Education or Labor, if these policies are financed with taxes affecting a particular sector of the economy there might be adverse political reactions. A sounding of local industrial and political leaders is the only way of gauging the impact of these policies.

Explore the possibilities for developing new modes of training (Block 15)

4.37 If a decision is reached that modes of training in existence in the country are inadequate, a search must be made for new modes. There are numerous possibilities based on the different combinations of on- and off-the-job training. The following is an example of lists of information needed for evaluation of two modes of training, in school and in the enterprise.

List of Information for Schools and Training Centers

I. Facilities

1. Possible location of each facility
2. Size of each facility
3. Maximum number of trainees that can be handled in a facility.

II. Programs

1. Availability of course and program materials
2. Sources of materials for programs and courses
III. Administration
1. Who will select, and on what basis, the courses and programs to be offered
2. Administrative size and its organization
3. Job placement activities

IV. Students
1. Qualifications and standards for admission
2. How will the students be recruited
3. Qualifications for graduation

V. Teachers
1. Training and experience required for instructors
2. How will teachers receive their training and what is the duration of that training
3. How will vocational instructors be recruited
4. What will instructors be paid compared to wages paid to comparable craftsmen in industry.

VI. Output Factors
1. Expected dropout and completion rates for this mode of training
2. Estimated cost of a graduate trainee of a program
3. Reputation of graduates
4. Employability of graduates

List of Information for Training in the Enterprise

I. Facilities
1. Possible location of the training by industry
2. Number and location of plants
3. Training capacity per occupation

II. Programs
1. Courses and programs available
2. Description of possible methods of training
3. Duration of training program

III. Administration
1. Who will select the courses and programs to be offered
2. Who will select the trainees and on what basis
3. Who will supervise training
IV. Trainees

1. What are requirements to enter program
2. What incentives will be used to induce workers to enter training program

V. Instructors

1. Who will be the instructors
2. What special training will be given to the instructors
3. What will be the ratio of instructors to trainees
4. Will instructors also have production or supervisory responsibility in plant.

VI. Output Factors

1. Estimated cost of graduate trainee
2. Retention rate of trainees
3. Reputation of trainees

The list is by no means all-inclusive and there are numerous combinations of school and enterprise training.

4.38 Other major questions for which answers must be sought are:

What are the attitudes of the parties that have to participate in the training towards a new mode of training?

What reactions can be expected from the existing modes of training with which the new mode is going to compete?

What measures are necessary to overcome possible opposition on the one hand, and encourage the cooperation of needed parties on the other?

4.39 In the final analysis the possibility of establishing a new form of vocational training depends on a variety of circumstances that can only be evaluated in toto. Only a "gestalt" approach combining all the economic, educational, and institutional variables can provide a guideline for action.
Appendix 1-1

BIBLIOGRAPHY

Evaluation Studies of Vocational Education

Group I


Group II


Group III


Group IV


44. Lees, Dennis, Chiplin Brian. The Economics of Industrial Training.

45. La Formation Professionnelle des Adultes. Loi #71-575 du 16 Juillet 1971 portant organisation de la formation professionnelle. (Act No. 71-575 of July 16, 1971 concerning the organization of continuing vocational training as a part of lifelong education.)


AN ANALYTIC FRAMEWORK FOR RENEWING LITERATURE ON THE EVALUATION OF VOCATIONAL TRAINING

1. The review of selected literature used a comparative analytical approach. This approach was made possible by the development of a general framework, broad enough to encompass a variety of variables used in evaluations and different situations.

Description of the Framework

2. The analytical framework consisted of a systematic listing of the following variables: purpose of the study; coverage of the study; type of evaluation—process evaluation, output evaluation; characteristics of the trainee; costs—costs to the individual in a formal vocational school setting; costs of training to vocational schools; costs of training to an enterprise or to a program outside formal vocational schools; methods for determining special types of costs; outputs—benefits to the individual, benefits to society, choice of unit for outputs and costs; criterion for cost-benefit or cost-effectiveness analyses.

3. Purpose of an Evaluation Study: Evaluation studies are made for three basic purposes: to provide suggestions for improving the system; to indicate success or failure for the system; and to compare one system with another or with some standard of excellence, to provide a rational basis for choice between systems.

4. Coverage of the Study: This problem is especially important when conclusions are used for decisions to expand a system beyond some marginal changes, or to introduce an altogether new system of vocational training.

5. Economies and diseconomies of scale are very important in determining the costs and size of an enterprise or labor market when dealing with the value of output. If a comparative study of formal vocational schooling and apprenticeship programs shows that both the costs of vocational schooling and the chances of getting a job through apprenticeship programs are higher, this does not prove conclusively that it is more cost-effective to provide all training in apprenticeship programs. The vocational school may have marginal costs lower than average costs, that is, show economies of scale, and the apprenticeship programs may share diseconomies of scale with marginal costs higher than average costs. Here, expanding the vocational school program may lower costs, and increasing the apprenticeship programs will increase costs.

6. Where the ease with which apprentices get good jobs depends on the number of apprentices, program expansion—more training of apprentices—may make it harder to get good jobs for everybody.

7. A distinction also has to be made between studies that cover the whole "universe" of the training system under evaluation or just a part of it, or even one single enterprise. Reliability and extrapolation of the results will be different for each of these cases.
8. **Process Evaluation:** This evaluates what goes on in a specific training system or school. It includes: the type of administration managing the system; curriculum; kind of teachers; teaching aids and equipment used; type of building, etc.

9. The purpose of the process evaluation is to improve the ongoing system. But the results of these studies can also be used profitably to discover advantages and disadvantages of types of training, the training most commonly provided in different institutions, requirements for equipment and personnel, and comparisons between occupational requirements and curriculum offered. The greatest number of existing evaluation studies deal with process evaluation.

10. **Output Evaluation:** This evaluates the outcome of the process. It includes what happens to the person who goes through the process. When evaluations of the output are compared to the costs of the process, they become cost-benefit and cost-effectiveness studies.

11. **Cost-benefit analysis** can be **a priori** or **a posteriori**. A **a priori** cost-benefit analysis is done to ascertain the feasibility of a program not in operation. In the public sector, a **a priori** cost-benefit analysis is mostly used to make decisions on future investments such as water use, resource development and, especially, on defense expenditures. A **a posteriori** studies are used to evaluate existing or past programs. In a **a posteriori** evaluation of outputs, there are two basic approaches: the before-and-after studies, where the control is the individual before he enters the training system; and the control-group studies, where the individuals trained are assessed against similar groups of untrained individuals.

12. The literature on output evaluation is sparse, and cost-benefit and cost-effectiveness studies are comparatively recent. Most studies are on developed nations. There are very few for developing nations (see selected bibliography). There are almost no **a priori** studies of vocational training that include evaluation of outputs.

13. **Characteristics of the Trainee:** We can view vocational training as a process that receives an input—an individual with certain characteristics—and produces an output—the benefits that accrue to the individual, society, or the training institution because the individual has gone through the training process.

14. It is important to specify what kind of input goes into the process when evaluating two separate processes, formal vocational schools and training systems outside the school. If the entrant in one process comes from a better environment, has a higher level of natural abilities, and is better motivated, then it will cost less to achieve the same proficiency level with this candidate than with a student with lower intelligence and poor motivation.

15. Specifying the input means to particularize the following: age; background; previous education and experience; and measures of intelligence and motivation. Many of these characteristics are considered in the selection procedure which institutions use for admission if direct measurements are unavailable.
16. Characteristics of the students, or criteria for eligibility into the program are especially important in the before-and-after studies where the subject is his own control.

17. Costs: Costs have to be assessed for the individual and for the institution or firm providing the training.

18. Costs for the individual in a vocational school include: fees--when charged at the school; books and materials; travel expenses in connection with the training; opportunity costs of time spent in school while training minus scholarships, board and room when provided in the school free, and other monetary support for travel and books.

19. Costs for the individual in an enterprise are the difference between the value of his contribution to production (marginal revenue product) and the wages he receives plus other fringe benefits. If the trainee in the enterprise is not employed there, his costs are the same as those of an individual in a vocational school.

20. Costs for a vocational school include: salaries of teachers; administration; maintenance; materials; buildings and equipment; board and room (when offered); scholarships; minus fees and other charges; and revenue from the sale of school production.

21. Costs for an enterprise providing training include: direct costs such as wages and salaries of instructors directly connected with the training; direct wages and salaries of administrators of the training program; cost of buildings and equipment used only for training; and maintenance of buildings and equipment related only to training; indirect costs such as opportunity costs of existing production facilities and equipment used in the training and also for production; imputed value (opportunity costs) of supervisory personnel not directly involved in training; loss of production due to errors, spoilage, etc.; incidental expenses due to training programs such as travel, extra insurance payments because apprentices or trainees are on the premises, board and meals, wages and fringe benefits; minus increased value of production accrued to trainees.

Some Controversial Issues in the Analysis of Costs

22. These issues include: costs of new processes versus old processes; joint costs; and value of production by the trainee in an enterprise.

23. New vs. Old Processes: The age of a training program is an important variable when determining the actual costs of a process because of set-up costs and valuation of buildings and equipment.

24. Set-up costs of training are not very important in an older program because in all probability the costs have been amortized. But they may become crucial because of their lumpiness for a new program. Development of curricula, training instructors, setting up an administrative structure takes time and money.
25. Evaluation of equipment costs is also easier in a new program. The value is then the market value of the machinery, and depreciation criteria are easier to determine. With old machinery the book depreciated value usually does not reflect market prices of the used machinery, and in countries with high rates of inflation even a correct value has to be adjusted by a price index for the type of equipment.

26. Joint Costs: When the same expenditure produces two different products, say, the same class is given for general education and vocational students, or the same equipment applies to different cohorts of students, it is important to decide on what basis to prorate costs.

27. There is no fast rule for cost proration. When dealing only with marginal costs, consideration of joint costs may be unnecessary. But when dealing with average costs—and this is the case when comparing different programs—the marginal revenue product of the output can be used as a basis for distribution of these types of costs. Where courses are given for different occupations jointly, the cost of the joint course would be allocated in accordance to their relative wages. But this method implies that for a production technique joint costs will be allocated differently according to changing demands for the output.

28. Determination of the Value of Production of Trainees: This can be done by timing the production process using regular workers. The same specific item is costed, using time spent by trainees. A rate of substitution of trainees' time to normal workers' time can be calculated which gives the relative wages. The relative wages can now be applied to the total time spent by the trainee minus instruction time, holidays, travel time, etc. If the trainee works as part of a team, only gross approximations are possible.

29. Outputs: Specifying the output means to determine the net benefits from the training received by the individual, society, and, in the case when training is done in an enterprise, the firm.

30. Net benefits accrued to training are total benefits observed minus benefits that would accrue without the training, plus or minus changes unrelated to the person trained or the process of training.

\[ B_N = B_T + e \]

- \( B_N \) = Net benefits due to training
- \( B_T \) = Total observed benefits
- \( B_{WT} \) = Benefits that occur because of changes outside the training system and/or the individual.

31. Examples of \( B_{WT} \) are automatic upgrading, gains in seniority. Examples of \( e \) are economic fluctuations, windfall profits, structural changes in industries, etc. Net benefits are in money and intangibles. To the individual, money benefits include: probability of initial employment, time elapsed between the training completion and the first job, career ladder and earnings progression (after taxes), and employment stability. Intangible benefits include: job satisfaction, satisfaction derived from having more
training, lower probability for accidents on the job, and options for choosing occupations if training is for broader groups of skills.

32. For society, the benefits consist of the increased productivity due to training reflected presumably by increased earnings (before taxes) of the trainee, and all other external benefits generally attributed to general education, if this type of education is included in the training.

33. Net benefits for the enterprise consist of lower turnover rates, better socialization of workers, less supervisory burdens, and increases in productivity and production due to training rather than to new equipment and technological change, say, lower rates of rejects and accidents.

The Choice of a Unit of Output on Which to Base the Benefits or Costs:

34. The output of a vocational school or training program in an enterprise is mixed. Courses are varied in content, cost, and length of training. There are also dropouts.

35. Cost per student, cost per student hour, cost per graduate and cost per graduate hour are averages of outputs of a system. Comparisons of averages of two programs give a reliable answer when the weights of the components of the averages are similar. If they are not, it may be necessary to deal with costs and outputs at a more detailed level of aggregation.

36. Cost-Benefit and Cost-Effectiveness Analyses: A comparison of costs and outputs of a training system becomes a cost-benefit analysis when the output can be expressed in monetary value, or a cost-effectiveness analysis when major components of benefits are non-monetary. In this latter case, for a comparison of two programs, two measures are needed for each program. While the ratio of benefits to costs can be used as a criterion of choice for cost-benefit analysis because the choice will also depend on the marginal utility of the extra benefits compared with the marginal costs of one program as compared with another.

37. Each study in the five major groups in the review was analyzed in the framework presented above. Description of each variable of the framework corresponding to each evaluation study are placed side by side to allow ready comparison. The matrix of evaluation studies by characteristics of the analytical framework also provides a sense of completeness and thoroughness of the studies and, hence, a yardstick for measuring the validity of generalizing their conclusions.
CHECKLIST OF VARIABLES FOR THE ANALYSIS OF EVALUATION STUDIES OF VOCATIONAL TRAINING

A. Purpose
1. Indication of success or failure
2. Basis for improving the program
3. For comparison

B. Coverage of Study
1. Whole systems
2. Groups of schools or enterprises
   a. Representative of training system (large sample)
   b. Representative of training system (small sample)
3. Single school or enterprise
   a. Representative of training system (large sample)
   b. Representative of training system (small sample)

C. Process Evaluation
a. Quantitative
b. Qualitative
   1. Type of teacher
   2. Type of curriculum
   3. Teaching methods
   4. Size of classes
   5. Equipment and materials
   6. Buildings
   7. Administration
   8. Related services (job counselling, guidance, placement)

D. Output Evaluation
1. A priori studies
   → Cost-Benefit Analysis
2. A posteriori studies
   a. Cost-Benefit Analysis
   b. Cost-Effectiveness Analysis
   c. Subjective evaluation by peers and superiors

E. Specification of Inputs (trainee)
1. Age
2. Background
3. Previous education
4. Previous experience
5. Measures of intelligence
6. Measures of motivation
7. Aptitude
8. Sex
9. Race
10. Location
11. Other
Appendix 2-7

F. Selection Procedures

G. Costs to Individual in Vocational School
   1. Fees
   2. Books and materials
   3. Travel and other incidental expenditures
   4. Opportunity costs of time in school
   5. Minus scholarships, board and room, monetary support, stipends, and other

H. Costs of Training to Vocational School
   a. New Program
   b. Established Program
      1. Salaries of teachers
      2. Salaries of administration and maintenance
      3. Buildings and equipment
      4. Materials
      5. Board and room
      6. Scholarships
      7. Other incidental expenses
      8. Minus fees and other charges, and revenue from sold finished products
      9. Marginal costs, average costs
     10. Other

I. Costs of Training to an Enterprise
   a. New Program
   b. Established Program
      1. Direct Costs of Training Program
         a. Costs for setting up new program
         b. Salaries of instructors
         c. Cost of administering the program
         d. Consultants to program
         e. Buildings and equipment specifically used in training
         f. Maintenance of buildings and equipment specifically used in training
         g. Materials and books specifically used in training
         h. Other (travel, board and meals)
         i. Marginal costs, average costs
      2. Indirect Costs of Training
         a. Imputed value of opportunity cost of lost time by personnel not involved directly in training
         b. Opportunity cost of production facilities and equipment
         c. Loss of production due to errors, spoilage, etc.
         d. Extra insurance costs
         e. Other
      3. Wages of Trainee Minus Increased Value of Production Accrued to Trainees

J. Methods for Evaluating Special Types of Cost
   1. Method used for allocation of joint costs
   2. Method used for evaluating buildings and equipment
   3. Method used for evaluating trainees' production
K. Benefits for the Individual
   1. Monetary
      a. Probability of getting the first job
      b. Time to get the first job
      c. After-tax earnings progression
      d. Employment stability
      e. Lower accident rate
   2. Intangible
      a. Job satisfaction
      b. Satisfaction from more education
      c. Increase of occupational options
      d. Other

L. Benefits to Society
   1. Increased earnings before tax (a proxy for productivity)
   2. External benefits of general education
   3. Per cent of time employed.

M. Benefits to Enterprise of Training Programs
   1. Less supervisory burden—more disciplined work force
   2. Lower turnover rates
   3. Better socialization of workers
   4. Increases of productivity due to training rather than to new equipment, i.e., lower rates of rejects or accidents
   5. Other

N. The Choice of Unit of Output
   1. Student
   2. Graduate
   3. Student hour
   4. Graduate hour
   5. Occupation
   6. Employed graduate

O. Criterion for Cost-Benefit or Cost Effectiveness Analyses
   1. Benefits > Costs
   2. Benefit/costs
   3. Rate of return

P. General Conclusions
## Comparative Analysis of Evaluation Studies of Vocational Education

<table>
<thead>
<tr>
<th></th>
<th>MINCER</th>
<th>MERENDA</th>
<th>SANDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. Coverage of Study</strong></td>
<td>1. Whole system: U.S.A. (using census data.)</td>
<td>1. Whole system: Navy system; random samples drawn from two groups applying for promotion in 1954 and 1955, according to whether they had received their job training in school or OJT.</td>
<td>1. Whole system: Springfield Illinois public school system graduates, 1961-65.</td>
</tr>
<tr>
<td><strong>C. Process Evaluation</strong></td>
<td>No process evaluation.</td>
<td>No process evaluation.</td>
<td>No process evaluation.</td>
</tr>
<tr>
<td><strong>D. Output Evaluation</strong></td>
<td>2a. A posteriori: C/B Analysis.</td>
<td>2b. A posteriori: Effectiveness only (no costs) measured by performance on test for promotion.</td>
<td>2a. A posteriori: Costs were looked at; also various monetary and non-monetary benefits.</td>
</tr>
<tr>
<td><strong>E. Specification of Inputs (trainee)</strong></td>
<td>1. Age considered. 3. Previous education: years of schooling.</td>
<td>7. Aptitude: The abilities of the two groups were the same before training.</td>
<td>1. Age considered. 2. Background considered. 5. Intelligence considered; there were no significant differences. 8. Sex considered. 9. Race considered.</td>
</tr>
<tr>
<td><strong>G. Costs to Individual in Vocational School</strong></td>
<td>Total costs were imputed from income, different levels of formal schooling, and different ages. Earnings data from Census.</td>
<td>Not specified.</td>
<td>Not specified.</td>
</tr>
<tr>
<td>H. Costs of Training to Vocational School</td>
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<td>-----------------------------------------</td>
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<tr>
<td>1. MINCER (continued)</td>
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<td>Not specified.</td>
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<tr>
<td>2. MERENDA (continued)</td>
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<td>Not specified.</td>
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<td>3. SANDERS (continued)</td>
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<tr>
<td>(Established program)</td>
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<tr>
<td>1. Teacher's salaries considered.</td>
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<tr>
<td>2. Administration and maintenance</td>
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<td></td>
<td></td>
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<tr>
<td>salaries considered.</td>
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<tr>
<td>3. Buildings and equipment</td>
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<tr>
<td>considered.</td>
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<tr>
<td>4. Materials considered.</td>
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<td>Not specified.</td>
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</table>

<table>
<thead>
<tr>
<th>I. Costs of Training to an Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs were assumed to</td>
</tr>
<tr>
<td>have been passed on to individuals</td>
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<tr>
<td>in the form of lower starting salaries</td>
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<tr>
<td>for jobs where significant OJT was</td>
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<tr>
<td>expected.</td>
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<tr>
<td>Not specified.</td>
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</table>

<p>| J. Methods for Training to an          |</p>
<table>
<thead>
<tr>
<th>Enterprise</th>
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<tbody>
<tr>
<td>Not specified.</td>
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<td>Not specified.</td>
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<table>
<thead>
<tr>
<th>K. Benefits for the Individual</th>
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<tbody>
<tr>
<td>1c. Earnings considered.</td>
</tr>
<tr>
<td>1d. Employment stability:</td>
</tr>
<tr>
<td>considered in separate analysis.</td>
</tr>
<tr>
<td>Not specified.</td>
</tr>
<tr>
<td>1e. Earnings considered.</td>
</tr>
<tr>
<td>1d. Employment stability considered.</td>
</tr>
<tr>
<td>2a. Job satisfaction considered.</td>
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<tr>
<td>2d. Other: attitudes considered.</td>
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<tr>
<td>Not specified.</td>
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</table>

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<thead>
<tr>
<th>L. Benefits to Society</th>
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<tbody>
<tr>
<td>L. Earnings before tax considered.</td>
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<tr>
<td>Not specified.</td>
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<td>Not specified.</td>
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</tbody>
</table>

<p>| M. Benefits to Enterprise of Training |</p>
<table>
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<tr>
<th>Program</th>
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<td>Not specified.</td>
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<td>Not specified.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>N. The Choice of Unit of Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>All persons.</td>
</tr>
<tr>
<td>2. Graduates.</td>
</tr>
<tr>
<td>1. Student: costs-only total costs</td>
</tr>
<tr>
<td>were considered.</td>
</tr>
<tr>
<td>2. Graduate: benefits-wages per</td>
</tr>
<tr>
<td>graduate.</td>
</tr>
<tr>
<td>Not specified.</td>
</tr>
<tr>
<td>No quantitative relationship</td>
</tr>
<tr>
<td>between costs and wages was used.</td>
</tr>
</tbody>
</table>

<p>| O. Criterion for Cost-Benefit or      |</p>
<table>
<thead>
<tr>
<th>Cost-Effectiveness Analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Rate of Return</td>
</tr>
<tr>
<td>Not specified.</td>
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</tbody>
</table>

Appendix 3-2
### 1. MINCER (continued)

**P. General Conclusions**

1. Investment in OJT is a large part of total U.S. investment in education; it equals over half of expenditures on school education.
2. The total rate of return is nearly the same for OJT and formal education; the private rate of return is higher for formal education.

### 2. MERENDA (continued)

1. Formal school graduates did significantly better on the promotion test than workers trained on the job. Therefore, it is a superior method of training.

### 3. SANDERS (continued)

1. Student backgrounds were similar in both programs.
2. Both groups participate to the same extent in exposure to non-vocational education.
3. Vocational technical programs are better than occupational programs at improving attitudes towards school.
4. Both groups are likely to be satisfied with their jobs.
5. The cost of the vocational-technical program is much greater.
<table>
<thead>
<tr>
<th>Purpose</th>
<th>4. JAGODKIN</th>
<th>5. KREVNEVICH</th>
<th>6. STEPAKOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Academic vocational training versus on-the-job training, and the relative use of trained workers by different firms.</td>
<td>3. Compares efficiency of school-based and industry-based training for setters and fitter-repairmen for automatic production lines.</td>
<td>3. Compares school-based with in-plant training of lathe operators</td>
<td></td>
</tr>
</tbody>
</table>

| Coverage of Study | Groups representative of training system (small sample): 385 machine operators and metal fitters from 2 factories, a truck plant and an agricultural machinery plant. 1964. | 2a. Group representative of training system (large sample): 4200 workers in a group of factories in 6 cities. | 2b. Group representative of training system (small sample): lathe operators in two Leningrad factories |

| Process Evaluation | No process evaluation. | No process evaluation. | 2a. Curriculum: School graduates receive better theoretical training; as a result, setters in the 6th rank receiving bonuses for their efficiency suggestions averaged 45 rubles for school-trained workers and 38 rubles for factory-trained workers. |

| Output Evaluation | A posteriori C/B analysis, quantitative for the machine operators, qualitative for the metal fitters. Also, a subjective evaluation by superiors. | 2a. A posteriori C/B analysis. | 2a. A posteriori C/B analysis. |

| Specification of Inputs (trainee) | 1. All in sample aged under 30 years. 3. Two categories of previous education specified; less than 7th grade, 7th grade or more. | 3. Three categories of previous education: 7 years, 8 years, 10 years of general education (before vocational). | 3 and 4. Previous education and experience: both groups (school-trained and in-factory-trained) had much the same level of general education and experience (differences were less than one year and two years, respectively.) |

### Costs to Individual in Vocational School

<table>
<thead>
<tr>
<th>Number</th>
<th>Full Name</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>JAGODKIN</td>
<td>(continued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not specified.</td>
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<tr>
<td>5.</td>
<td>KREVNEVICH</td>
<td>(continued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not specified.</td>
</tr>
<tr>
<td>6.</td>
<td>STEPANOV</td>
<td>Not specified.</td>
</tr>
</tbody>
</table>

#### Costs of Training to Vocational School

- **2-year vocational school:**
  1. and 2. Teachers' and administration salaries = 357 rubles.
  5. Board and room 687 rubles.
  7. Other expenses = 154 rubles.
  9. Average cost per pupil for the two years = 1229 rubles.

#### Costs of Training to an Enterprise

- **Established Program:**
  b. Instructors' salaries, 46 rubles.
  c. Administration, 17 rubles.
  h. Stipends, 79 rubles.
  i. Average cost per trainee, 143 rubles.

#### Methods for Evaluating Special Types of Costs

2. Suggests using capital costs = 4.2% of operating costs, the proportion in the national budget.

3. Method used for evaluating trainees' production: school trainees are only paid 33% of the prevailing rates for their production, while factory trainees are paid the prevailing rates.

#### Benefits for the Individual

1c. Earnings estimated over a ten-year period, given a hypothetical progression through 4 salary stages; progression is faster for school grads. Current wages also given in table.
2b. Satisfaction from more education is slightly greater among school grads.

1c. Earnings: average time for school-trained worker to reach the 6th category of wage rates is less (between 50% and 60%) than for factory-trained.
4. JAGODKIÂN (continued)  

L. Benefits to Society  
1. Increased earnings: with age held constant, school grads averaged 25% higher wage.

M. Benefits to Enterprise of Training Program  
2. Lower turnover rates for school grads (4.7% vs. 12.6% for others).

N. Choice of Unit of Output and Costs  
6. Per employed graduate (no mention is made of unemployment).

O. Criterion for Cost-Benefit or Cost-Effectiveness Analysis  
2. B/C ratios and payback period.

P. General Conclusions  
1. The author does not judge explicitly the relative cost-effectiveness of school training; he assumes that it is obviously better and wishes to lay the groundwork for future comparisons of the effectiveness of different firms in using workers with school training.

5. KREVNEVICH (continued)  

4. Increases of productivity due to training: Theoretical training by school-trained workers leads to more valuable efficiency suggestions.

6. STEPANOV (continued)  

1. Earnings before tax: the output of school-trained workers was from 3% to 17% higher than for plant-trained workers.

3. Rate of return: payback period for extra costs of school training is 5 to 6 years for lathe operators.

1. Vocational schools should be expanded because workers become more productive more quickly if they have had school training.

1. School training is economically superior to in-factory training.

2. The next step is to compare vocational schools to see which ones' programs give a shorter payback period.
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>3. Compares briefly vocational school graduates with those trained in the firms.</td>
<td>In-factory training vs. academic training of industrial workers.</td>
<td>4 countries' systems of training skilled metal workers: Belgium, in school; W. Germany, a highly organized apprenticeship program; the Netherlands, a combination of these two; and the U.K., a loosely controlled apprenticeship.</td>
</tr>
<tr>
<td>Coverage of Study</td>
<td>2b. Group representative of training system (small sample): cites studies at 3 mechanical engineering plants in Moscow and chemical plants in Lisichansk.</td>
<td>Whole system of training in the USSR (size of sample unknown).</td>
<td>Groups representative of training system (small sample): school and employer records from 1 town in each country known for its skilled metal trades. Persons completing training in 1958. There were problems of imprecise comparisons, e.g., different definitions of &quot;skilled&quot;.</td>
</tr>
<tr>
<td>Process Evaluation</td>
<td>(Qualitative) 2. Curriculum must be expanded to increase the time spent in practical exercises and the principles of organization and production economics.</td>
<td>(Qualitative) Type of curriculum: in academic programs, the curriculum is keeping up with growing automation, and technological advancement while on-the-job apprenticeship programs are not.</td>
<td>(Qualitative) 3. The four teaching methods mentioned above under B are evaluated for their progress and developing trends.</td>
</tr>
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<td></td>
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<td>4. Previous experience specified.</td>
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<td>5. Results on examinations specified.</td>
</tr>
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<td>6. Previous efforts to get further training (a measure of motivation) specified.</td>
</tr>
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<td>7. Position attained (i.e. supervisor, skilled worker, or left job) specified, as a measure of aptitude.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>11. Geographic mobility specified.</td>
</tr>
<tr>
<td>7. BELKIN (continued)</td>
<td>8. BELKIN (continued)</td>
<td>9. C.I.R.F.</td>
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<tr>
<td>Costs to Individual</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td></td>
</tr>
<tr>
<td>in Vocational School</td>
<td></td>
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<tr>
<td>Costs of Training to</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td></td>
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<tr>
<td>Vocational School</td>
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<tr>
<td>Costs of Training to</td>
<td>Not specified.</td>
<td>Not specified.</td>
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<tr>
<td>an Enterprise</td>
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<tr>
<td>Special Types of Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits for the</td>
<td>1c. Earnings: school-trained workers take only one-half as long to get promoted</td>
<td>Not specified.</td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefits to Society</td>
<td>1. Earnings before tax: productivity of school-trained workers is 15% higher than for factory-trained workers</td>
<td>1. Increased productivity because school-training enables workers to take full advantage of automation</td>
<td></td>
</tr>
<tr>
<td>Benefits to Enterprise</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td></td>
</tr>
<tr>
<td>of Training Program</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Choice of Unit of Output and Costs

<table>
<thead>
<tr>
<th>6. Employed graduate: per employed worker, benefits only.</th>
</tr>
</thead>
</table>

### Criterion for Cost-Benefit or Cost-Effectiveness Analyses

|----------------|----------------|----------------|

### General Conclusions

1. Vocational-technical schools should be expanded to meet the increasing needs of industry for skilled workers.

2. Academic (3 years after high school) is better than on-the-job (6 months' study plus apprenticeship) training for society.

3. Academic vocational programs must be drastically increased to keep up with the increasing complexity and automation of industry.

4. "Speculative" conclusions:
   1. All 4 systems have a high dropout rate.
   2. There is a common trend towards enterprise-owned vocational training.
   3. There is a common trend towards this sequence: a. orientation in school workshops; b. then, formative training in a school or production department; c. then, specialization.
   4. There is a wastage of skilled workers to too-narrow specialization.
   5. Many skilled workers fail to gain qualification because of wage classifications and formal training requirements.
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Coverage of Study</th>
<th>Process Evaluation</th>
<th>Output Evaluation</th>
<th>Specification of Inputs (Trainee)</th>
<th>Selection Procedures</th>
<th>Costs to Individual in Vocational School</th>
<th>Costs of Training to Vocational School</th>
<th>Costs of Training to an Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Kullmer</td>
<td>3. Compares different levels of education by the salaries reached at certain age levels.</td>
<td>1. Whole systems: 1% sample from a general census in 1964. 30% of the sample were excluded because their training was not related to their work.</td>
<td>No process evaluation.</td>
<td></td>
<td>1. Age: 4 groups from 14 to 64. 3. Previous education: 4 categories: 1) university and teachers' colleges 2) school vocational training plus practical training 3) practical on-the-job training only 4) no training.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>Not specified.</td>
</tr>
<tr>
<td>12. Blaug.</td>
<td>3. Comparison of costs and benefits for six educational levels and three types: academic, technical, professional.</td>
<td>2b. Group representative of trainees at 5 electrical engineering firms that had data available.</td>
<td>No process evaluation.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

1. Costs to Individual in Vocational School: All costs to the enterprise are considered: instructors' salaries, administration, consultants, buildings and equipment, maintenance.
10. KULLMER (continued)  

Methods for Evaluating Special Types of Costs  
Not specified.  

Benefits for the Individual  
1a. Earnings: income differences between the 4 levels of education increase with age.  
Not specified.  

Benefits to Society  
Not specified.  

Benefits to Enterprise of Training Program  
Not specified.  

Choice of Unit of Output and Costs  
2. Per graduate, benefits.  
1. Costs per student.  
2. Costs per student were adjusted by a dropout ratio, to give approximate costs per graduate.  
3. Social and private rates of return for six educational levels  

Criterion for Cost-Benefit or Cost-Effectiveness Analyses  
Not specified.  

General Conclusions  
1. Generally, more education increases wages in the order: no training, in-plant training, practical training, teacher training college (except in the 14-29 age group), technical college, universities.  
2. The trend noted in the U.S. for wage differentials between men and women to rise with higher standards of training has not been substan-

11. WINTERHAGER (continued)  

1. In general, it was found that training of a trainee in the firm is more costly than training in school because of low student-teacher ratio, high cost of teaching equipment, and student financial aid.  
2. There was no clear relationship between cost of training and turnover rate of trainees.  

12. BLAUG (continued)  

1c. Lifetime after-tax earnings.  
1c. Earnings before tax considered.  
1. The major conclusion from this pilot study was that more detailed and disaggregated data are needed for manpower research.

materials and books, travel, board, and meals, and indirect costs: opportunity cost of time lost by persons not directly involved in training, opportunity cost of facilities, loss due to errors and spoilage, extra insurance costs, wages of trainees minus production of trainees.
### Purpose

1. **HU**
   - 3. Comparison of vocational with non-vocational education in high schools to determine investment policies for the U.S.A.

2. **SCHRIVER**
   - 3. Compares Area Vocational Technical School (AVTS) graduates with high school graduates for wage differences and labor market experiences.

3. **CORRAZZINI**
   - 3. Comparison of vocational high schools with regular high schools.

### Coverage of Study

1. **HU**
   - 2a. Group representative of training system (large sample: vocational and non-vocational schools in 3 cities; some data incomplete and not used. Benefits derived from a sample of graduates, mailed questionnaire; one-third response rate; response bias considered.

2. **SCHRIVER**
   - 2a. Group representative of training system (small sample): wage and non-vocational schools in differences and labor market experiences.

3. **CORRAZZINI**
   - 2b. Group representative of training system (small sample): the three types of high schools in the Worcester, Mass. public school system: one boys' vocational, one girls' vocational, 4 regular high schools; sample of 12 firms employing graduates.

### Process Evaluation

1. **HU**
   - No process evaluation.

2. **SCHRIVER**
   - No process evaluation.

3. **CORRAZZINI**
   - No process evaluation.

### Output Evaluation

1. **HU**
   - 2b. A posteriori C/E analysis: Quarterly income. Also, C/E analysis-labor market experience.

2. **SCHRIVER**
   - 2a. A posteriori C/B analysis.

3. **CORRAZZINI**
   - 2b. A posteriori C/B analysis.

### Specification of Inputs (Trainee)

1. **HU**
   - 1. Age considered.
   - 2. Father's educational background (socio-economic status) considered.
   - 5. Intelligence considered.
   - 8. Sex considered.
   - 9. Race considered.
   - 10. Geographic location considered.

2. **SCHRIVER**
   - The following criteria were used in the rigorous matching of pairs:
   - 1. Age.
   - 3. Years of schooling, rank in class.
   - 5. I.Q., high school rank.
   - 8. Sex.
   - 10. Geographic location: urban or rural residence.
   - 11. Other: marital status.

3. **CORRAZZINI**
   - Not specified.

### Selection Procedures

1. **HU**
   - Not specified.

2. **SCHRIVER**
   - Not specified.

3. **CORRAZZINI**
   - Not specified.
13. HU (continued)

Costs to Individual in Vocational School

Not specified.

14. SCHRIVER (continued)

Cost of Training to

Vocational School

1. Fees considered.

2. Books and materials considered.

3. Travel and other incidental expenditures: omitted--considered equal to going to work.

4. Opportunity costs: considered from wages for matched control group member.

5. Stipends considered, e.g., veteran's benefits.

Cost of Training to an Enterprise

Not specified.

15. CORRAZZINI (continued)

Costs of Training to

1. Teacher's salaries considered.

2. Administration and maintenance salaries considered.


4. Materials considered.

9. Used marginal cost (separately shown).

Cost of Training to

Vocational and regular schools have different percent of total assets in land, buildings, and equipment respectively.

Method used for evaluating buildings and equipment: Schultz and Machlu methods: a) interest rate on land/buildings, equipment = 5.1%; b) depreciation = 2% of replacement cost (buildings); c) obsolescence 10% straightline (equipment).

1. Teacher's salaries considered.

2. Administration and maintenance salaries considered.


4. Materials considered.

10. Other: property tax foregone by city.

Costs are not broken down, except as noted below. Costs per hour of instruction and per student were computed from total cost. Buildings and equipment were built from 1965-1967; cost converted to '63 dollars. Assumed 4 4% borrowing rate; 20-year life--4 1/2 years of study give 9/40 of total cost.

Method used for evaluating buildings and equipment: Schultz and Machlu methods: a) interest rate on land/buildings, equipment = 5.1%; b) depreciation = 2% of replacement cost (buildings); c) obsolescence 10% straightline (equipment).

Vocational and regular schools have different percent of total assets in land, buildings, and equipment respectively.
Appendix 3-14

13. HU (continued)

K. Benefits for the Individual
1b. Job placement period considered.
1d. Percentage of time employed.
2d. Other: a) voting behavior; b) relation of curriculum to career interests; c) economic aspirations.

L. Benefits to Society
1. Before-tax monthly income.
3. Percentage of time employed.

M. Benefits to Enterprise of Training Program
Not specified.

N. Choice of Unit of Output and Costs
1. Student, for costs; marginal cost per Average Daily Attendance (ADA).
2. Graduates, for benefits.

J. Criterion for Cost-Benefit or Cost-Effectiveness Analyses
2. Benefit-Cost ratios: (four methods used) 1) MB-MB, divided by MC\textsubscript{1} - MC\textsubscript{2}; B/C ratio; not present value; rate of return.
3. Rates of return: number of years wage differentials (of vocational vs. regular graduates) would have to remain to make present value of extra costs equal to present value of extra benefits. 1) Different firms paid different differentials. 2) Alternative rates of discount were assumed: 5% and 10%.

P. General Conclusions
Additional funds should be spent on vocational-technical high school curricula rather than on non-vocational curricula, in senior high schools. How much is not specified.

14. SCHRIVER (continued)

1c. Earnings considered--AVTS graduates had average advantage of $7.02/week.
1d. Employment stability considered--higher for AVTS grads.
2c. Increase of occupational options considered.

15. CORRAZZINI (continued)

1c. Earnings: starting hourly wage.
2d. Other: number of dropouts; geographic mobility.

1. Earnings before tax: starting hourly wage.
4. Other: number of dropouts; geographic mobility.

1. Cost per student.
2. Benefits to graduates.

3. Rate of return calculated for wage-difference study.

1. AVTS training increased labor force participation, and increased occupational mobility.
2) Students with lowest education and aptitude had greatest rates of return.
3) AVTS is beneficial regardless of educational attainment.
4) The public rate of return is 6.5%. private rate 19.1%.

1. Vocational education program boys is at best only marginally profitable, whether conceived as alternative to general education as a dropout prevention program. Cheaper ways to prevent dropouts provide employment skills should be found.
16. TAUSSIG

**Purpose**

3. Comparison of vocational and academic high schools.

**Coverage of Study**

1. Whole system: New York-City school system. Benefits data from postcard survey; no follow-up, verification or correction for response bias.

**Process Evaluation**

No process evaluation.

**Output - Evaluation**

2a. A posteriori C/B analysis.
2b. A posteriori C/E analysis.

**Specification of Inputs (Trainee)**

1. Age considered.
3. Previous education considered.

**Selection Procedures**

Not specified.

17. PAULTER

3. Compares vocational secondary school graduates, vocational school dropouts, and general education high school graduates not continuing their education.

**Coverage of Study**

2a. Group representative training system (large sample): 300 subjects: 158 vocational school graduates, 60 control group graduates, 82 vocational school dropouts--85% response to mailed questionnaire. All were graduates or would-be graduates in 1964 (study done in 1966).

**Process Evaluation**

No process evaluation.

**Output - Evaluation**

2a. A posteriori C/B analysis.
2b. A posteriori C/E analysis.

**Specification of Inputs (Trainee)**

1. Age: high school age.

**Selection Procedures**

Not specified.

18. AL-BUKHAR

1. Evaluation of vocational training systems in Jordan.

**Coverage of Study**

1. Whole systems: public secondary (10th-12th year of school) industrial schools; 352 1964-66 graduates from 2 schools in Amman and Irbid. 90 finally interviewed, plus employers, teachers, non-graduate (Qualitative)

2. Present curriculum does not correspond to present and predict, industry needs. Only 27.7% are using learned skills.

8. Lack of coordination of guidance and placement.

**Process Evaluation**

No process evaluation.

**Output - Evaluation**

2a. A posteriori C/B analysis.

**Specification of Inputs (Trainee)**

1. Age: 15 years plus or minus.
3. Previous education: passed preparatory-school exam.

**Selection Procedures**

Must pass secondary entrance exam, usually lower third of passers go to vocational school.
16. TAUSSIG (continued)

Costs to Individual. Not specified.
In Vocational School

Costs of Training to Vocational School (Established program)
1. Teacher's salaries considered.
2. Administration and maintenance salaries considered.
4. Materials considered.
9. Average cost per average daily attendance is used.

Costs of Training to an Enterprise
Not applicable.

Methods for Evaluating Special Types of Costs
2. Method used for evaluating buildings and equipment: cites study by Theodore W. Schultz—uses capital costs equal to 22% of current costs.

Benefits for the Individual
1c. Earnings at first job considered.
1d. Employment stability: unemployment rates for period immediately after graduation considered.

17. PAULTER (continued)

Not specified.

18. AL-BUKHAR (continued)

Not specified.

Cost to government—not specified

Time to get the first job: Not specified.
Dropouts took longer than other two (vocational and non-vocational graduates), but the latter were the same.
1c. Earnings: no difference among 3 groups in present yearly salary (20 months after school).
1d. Employment stability: no difference among the groups in the number of job changes over a period of 20 months.
16. **TAUSSIG (continued)**

**Benefits to Society**

1. Earnings before tax considered. Not specified.
3. Other: number of dropouts. Not specified.

**Choice of Unit of Output and Costs**

1. Student: costs per average daily attendance. Not specified.
2. Graduate: benefits per graduate. Not specified.

**Criterion for Cost-Benefit or Cost-Effectiveness Analyses**

1. No numerical ratio used. Not specified.

**General Conclusions**

1) Although data were meager and not necessarily accurate, analysis suggests that investments in vocational schools have not rendered significantly greater benefits. The vocational school program has nothing to recommend itself. The schools' criteria for success may be irrelevant.

17. **PAULTER (continued)**

**Benefits to Society**

1. Earnings before tax considered. Not specified.

18. **AL-BUKHAR (continued)**

**Benefits to Enterprise or Training Program**

Not specified.

**Choice of Unit of Output and Costs**

1. Student: costs per average daily attendance. Not specified.
2. Graduate: benefits per graduate. Not specified.

2. Benefit-cost ratios are given: per pupil cost for secondary industrial versus secondary general equals 9.5 to 1; B/C for an industrial graduate is 1.6 to 1, general school graduate is 6.7 to 1, in initial time period.

**General Conclusions**

1) Manpower programs are a great success.
2) Recommends continuation of all 3 programs, with a few changes in clerical curriculum. The vocational school program has nothing to recommend itself. The schools' criteria for success may be irrelevant.

1) Establish coordinating organization for advising on curriculum, etc.
2) More emphasis on general training in the schools; specific training should be provided by employers.
3) Industrial schools should join with general schools and provide general and vocational training to all students.
4) OJT apprenticeship programs should be fostered.
5) Training center for adults should be established.
Appendix 3- 18

19. LOURDESANY

Purpose
3. To provide insight into effectiveness of vocational education as an alternative to academic secondary schools.

Coverage of Study
1. Full survey of the graduating class in 1969; 86% response.

Output Evaluation
2b. Comparison of effectiveness only.

20. SOMERS

Purpose
3. Compares 3 levels: high school, post-high school, and junior college and 6 program areas.

Coverage of Study

Output Evaluation
No output evaluation.

21. FIVE AND TEN YEAR FOLLOW-UP STUDY OF CONNECTICUT STATE VOCATIONAL-TECHNICAL SCHOOLS

Purpose
2. To improve state vocational-technical (voc-tech) schools.

Coverage of Study

Process Evaluation
(Qualitative questionnaire evaluation)
1. Teacher's skills should be improved.
2. Curriculum: courses were rated as not important, some value, or important. Tabulation shows better math, shop, and shop theory courses were recommended.
3. Teaching methods: respondents recommended more homework and on-the-job training.
4. Respondents recommended improvement and updating of equipment.
5. Respondents recommended more counseling, better job placement services, improvement of voc-tech school image.

Output Evaluation
No output evaluation.
<table>
<thead>
<tr>
<th>Specification of Inputs (trainee)</th>
<th>Selection Procedures</th>
<th>Costs to Individual in Vocational School</th>
<th>Costs of Training to Vocational School</th>
<th>Costs of Training to an Enterprise</th>
<th>Methods for Evaluating Special Types of Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unable to determine—the author used other studies.</td>
<td>Fees: (Peterson).</td>
<td>Books and materials considered (Swanson).</td>
<td>Extra costs considered (Taussig).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Opportunity costs considered (Taussing).</td>
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<td></td>
<td>Established Program</td>
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<td></td>
<td></td>
<td>Not applicable.</td>
<td></td>
</tr>
</tbody>
</table>

19. LOURDESAMY (continued)

20. SOMERS (continued)

21. CONNECTICUT FOLLOW-UP STUDY (continued)

1. Age considered.
2. Background: father's and mother's education and socio-economic status (SES).
8. Sex considered.
9. Race considered.
10. Geographic location considered (4 regions).
11. Other: marital status.

All graduates of classes of 1958 and 1963.
<table>
<thead>
<tr>
<th>Benefits for the Individual</th>
<th>Benefits to Society</th>
<th>Benefits to Enterprise of Training Program</th>
<th>The Choice of Unit of Output</th>
<th>Criterion for Cost-Benefit or Cost-Effectiveness Analyses</th>
<th>General Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a. Unemployment rates very high for vocational school graduates; 37% unemployment after two years in the labor market.</td>
<td>Same as for individuals.</td>
<td>Not applicable.</td>
<td>2. Graduate.</td>
<td>No cost-benefit calculated.</td>
<td>Income of vocational school graduates lower and unemployment rates higher than that of graduates from academic secondary schools.</td>
</tr>
<tr>
<td>1c. Earnings: magnitude of increase of the mean wages between first job and current job.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>2. Benefit cost ratio given.</td>
<td>1) Vocational education should be more generalized because many graduates take further education. 2) Variables determining job-relatedness of training are school level, program area, SES of job, and sex. 3) Job-relatedness and SES of job affect satisfaction, but not wages. 4) Junior college graduates, men, urban residents, those with higher grades enjoy labor-market advantages.</td>
</tr>
<tr>
<td>1d. Employment stability considered. 2a. Job satisfaction considered. 2b. Further education often followed. 2d. Other: socio-economic status of jobs for each level and program is shown.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td></td>
<td>1) Tables compare the ratings from questionnaire, earnings 5 and 10 years after graduation, and further education by schools and courses. 2) The number of persons with jobs unrelated to their vocational education suggests a re-direction of programs and broader guidance.</td>
</tr>
</tbody>
</table>
22. BINNINGER

1. Failure of French vocational training to educate generally enough to allow for technological change.

3. Coverage of Study

2. Process Evaluation
(Qualitative)
2. Present curriculum outdated.
3. Teaching methods: Audio-visual aids (TV) should be used more; also, encourage students to do personal research.
5. There is a lack of needed materials and equipment.
8. Guidance does not recognize effects of technological change.

4. Output Evaluation
No output evaluation.

5. Specification of Inputs (Trainee)
Not specified.

6. Selection Procedures
Not specified.

7. Costs to Individual in Vocational School
Not specified.

23. BELKIN

1. Evaluates the need for more vocational schools.

2. Present curriculum outdated.
3. Teaching methods: Audio-visual aids (TV) should be used more; also, encourage students to do personal research.
5. There is a lack of needed materials and equipment.
8. Guidance does not recognize effects of technological change.

2. By 1970 (2 years from now) industry will require 41% of workers to have had a school-based vocational education, based on an extrapolation of trends, 1948-65.

4. Type of curriculum. 68% of 20C graduates of a school combining vocational and secondary general education in a three-year program had been promoted within 4 years, while only 44% of 376 graduates c a regular 2-year vocational school had been promoted. Costs at the former were 58% higher. Other schools have added evening classes on general subjects at nearby non-vocational schools; but these must be separately organized.

5. Specification of Inputs (Trainee)
Not specified.

6. Selection Procedures
Not specified. Students have 8 years of primary schooling.

7. Costs to Individual in Vocational School
Not specified.

24. SOKOLOV

1. Describes and evaluates ways combining the training given in vocational schools with a general secondary education in the USSR.

2b. A few schools (number not specified).

4. Type of curriculum. 68% of 20C graduates of a school combining vocational and secondary general education in a three-year program had been promoted within 4 years, while only 44% of 376 graduates c a regular 2-year vocational school had been promoted. Costs at the former were 58% higher. Other schools have added evening classes on general subjects at nearby non-vocational schools; but these must be separately organized.
<table>
<thead>
<tr>
<th>Appendix 3-</th>
<th>22. BINNINGER (continued)</th>
<th>23. BELKIN (continued)</th>
<th>24. SOKOLOV (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Costs of Training to Vocational School</td>
<td>Not specified.</td>
<td>Not specified.</td>
<td>Costs per student for the 3-year school combining general and vocational education were 58% higher than for regular 2-year schools, due to the costs of the extra year's salaries and stipends.</td>
</tr>
<tr>
<td>4. Benefits for the Individual</td>
<td>Benefits of more general vocational training.</td>
<td>Not specified.</td>
<td>c. Promotion is faster (and earnings rise) for students with a general secondary education (see C above).</td>
</tr>
<tr>
<td></td>
<td>1c. Earnings mentioned.</td>
<td>1st. Employment stability mentioned.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2c. Increase of occupational options mentioned.</td>
<td>2d. Other: reduces boredom.</td>
<td></td>
</tr>
<tr>
<td>6. Benefits to Enterprise of Training Program</td>
<td>Benefits of more general vocational training.</td>
<td>4. Lower rates of rejects for workers with 10 years of general education than for workers with only 7 years.</td>
<td>Not specified.</td>
</tr>
<tr>
<td></td>
<td>5. Other: ease of upgrading workers into more demanding jobs with less additional training.</td>
<td>6. Employed graduate.</td>
<td>6. Benefits per employed graduate.</td>
</tr>
</tbody>
</table>
22. BINNINGER (continued)

O. Criterion for Cost-Effectiveness Analyses

Not specified.

P. General Conclusions

1) A more general training curriculum than the current one in France would be good.

23. BELKIN (continued)

Not done.

P. General Conclusions

1) The number of 3-year vocational schools with both general and vocational curricula should be increased.

24. SOKOLOV (continued)

No comparison of benefits and costs.

P. General Conclusions

1. The effort to give students a combined vocational and general secondary education is worthwhile. Further research should indicate the most effective way of doing it.
## Purpose
1. Evaluates the training given in the industrial vocational schools (BFS) to see how far it might justify the limitation or abolition of the apprenticeship system.

## Coverage of Study
2a. 240 firms questioned, 96 responded to subjective evaluations of (1) BFS's giving vocational training counting towards shortening the period of apprenticeship; (2) the limited number of schools giving training equivalent to a full apprenticeship.

## Process Evaluation
Category 1 (see B, above) schools, favorable opinions on the basic and theoretical training and maturity of graduates; unfavorable on the relevance of practical training, overestimation of skills by the graduates, lack of training in safety. Category 2 schools, favorable opinions on breadth of training and interest in their work; unfavorable on efficiency of work, and insufficient practical experience.

## Output Evaluation
3. Evaluation by employers (subjective).

## Specification of Inputs (Trainee)
Not specified.

## Process Evaluation
No process evaluation.

### 2a. A posteriori C/B Analysis
1. Age: 4 categories: 0-20, 20-30; 30-40; over 40.
2. Previous education: 3 categories: less than 10 years, less than 12 years, more than 12 years.
3. Employment and income history considered.

### 2a. A posteriori Evaluation of Benefits
1. Age considered.
2. Previous education considered.
3. Sex considered.
25. GRUNER (continued)

   6. Motivation: entry into the course is probably a sign of high motivation.

   11. Other: length of time unemployed before program:

       0 weeks, 0-5, 5-13, greater than 13, greater than 26 weeks.

Selection Procedures Not specified.

Costs to Individual Not specified.
In Vocational School

Costs of Training to Not specified.
Vocational School

Costs of Training to an Enterprise Not specified.

26. BORUS (continued)

   Unemployed and underemployed workers lacking skills in occupations offering employment, mostly from small towns.

   Not specified.

Costs to Individual Not specified.

1. Fees = 0.

2. Books and materials = 0.

3. Travel and other incidental expenditures: the average cost for the sample was $4 per week, $25 per course.

4. Opportunity costs: a. workers with no expectation of work, no opportunity costs; b. workers with expectations, wages foregone less allowance.

5. Stipends: retraining allowance.

   Not applicable.

27. MAIN (continued)

   9. Race considered.

   11. Other: whether head of household, family income before training, marital status, number of children, unemployment in year before training.

Costs of Training to Not specified.
Vocational School

Costs of Training to an Enterprise Not specified.

(New Program)

   Costs to Federal Government.

   1a. Costs for setting up: screening, counselling, testing, records processing, etc.

Not specified.
25. GRUNER (continued)

1b. Instructor's salaries: salaries a function of course duration.
1c. Administration: local costs plus state-wide costs for planning and evaluation.
1e. Buildings and equipment: no new buildings; equipment depends on subject matter.
1f. Maintenance: considered.
1h. Other: training allowance.

Methods for Evaluating Special Types of Costs

Not specified.

Benefits for the Individual

Not specified.

Benefits to Society

Not specified.

26. BORUS (continued)

3. Method used for evaluating trainees' production: mentioned not quantified; concludes that trainees produce less than marginal revenue product where wages are high and taxes on products are high.

1c. Earnings: considered.
1d. Employment stability: 5 week reduction in expected annual unemployment; alternatively, down 10 percentage points.
2c. Increase of occupational options: occupational mobility increased 18%.

27. MAIN (continued)

1c. Weekly earnings considered.
1d. Employment stability: number of months employed during first year after training.
1e. Weekly earnings considered.
4. Other: number of months employed during first year after training.
4. Other: improved labor market.
25. GRUNER (continued)

N. Benefits to Enterprise of Training Program
   Not specified.

O. Choice of Unit of Output and Costs
   Not specified.

P. Criterion for Cost-Effectiveness Analyses
   Not specified.

Q. General Conclusions
   1. Due to the apparent efficiency of vocational school training, the periods of apprenticeship which follow the schools could be shortened if: a) the BFS instructors have passed foreman or master examinations and have teacher training; b) the trade taught is the same as the apprenticeable trade; c) high standards of workshop equipment and practical training time are met.

26. BORUS (continued)

R. Benefits to graduates.

S. Benefit cost ratio: benefits discounted; three ratios offered: private, government and economy; different discount rates offered within each.

27. MAIN (continued)

T. Benefits to graduates.

U. General Conclusions
   1) Government should finance retraining.
   2) Aggregate demand should be creating job vacancies; only under this condition is unemployment decreased.
   3) B/C ratios are greatest for the economy.
   4) All three B/C ratios are greater than 1.

V. There was no significant difference in wages of "completers" and control group.

W. There was a better employment record for completers: the percent of full-time employment increased by an estimated 13-23% versus a 7-19% increase for dropouts.
<table>
<thead>
<tr>
<th></th>
<th>MANGUM</th>
<th>CAIN</th>
<th>BATEMAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. <strong>Purpose</strong></td>
<td>1. An evaluation of the Manpower Development and Training Act (MDTA), Title II.</td>
<td>An evaluation of the Job Corps.</td>
<td>1. An evaluation of the Work Experience and Training Program (WETP).</td>
</tr>
<tr>
<td>B. <strong>Coverage of Study</strong></td>
<td>1. Whole systems: entire program. Sample not specified.</td>
<td>2b. Group representative of training system (small sample); a small sample of white, Southern males with Job Corps (JC) experience. Control: no-show applicants to JC. Groups for wage comparison were while Southern males with &quot;similar personal characteristics.&quot; Low-response postcard survey. For education level comparison, selection based on years of school or level attained.</td>
<td>2a. Group representative of training system (large sample).</td>
</tr>
<tr>
<td>E. <strong>Specification of Inputs (trainee)</strong></td>
<td>1. Age considered. 3. Previous education considered. 8. Sex considered. 9. Race considered.</td>
<td>3. Previous education: 8-10 years of schooling, educational attainment of 6th-10th grade. 9. Race: white or non-white. 10. Geographic location: north or south.</td>
<td>1. Age categories: 25, 35, 45. 3. Years of schooling categories: 1) 0-7 elementary; 2) 8 elementary; 3) 1-3 high; 4) 4 high.</td>
</tr>
<tr>
<td>F. <strong>Selection Procedures</strong></td>
<td>Those referred to program by Employment Service, Community Action Programs, etc. Tends to leave out the unemployed with less than a basic education.</td>
<td>Not specified.</td>
<td>Not specified.</td>
</tr>
</tbody>
</table>
28. MANGUM (continued)

- Costs to Individual
  1. Fees considered, but details not in Vocational School given.

- Costs of Training to Vocational School
  Costs to the economy and the "taxpayer" considered; not specified.

- Costs of Training to Vocational School
  Costs to federal government.
  1h. Instructor's salaries considered. Fixed cost.
  1c. Administration: not charged to centers.
  1e. Buildings and equipment considered. Variable cost.
  1f. Maintenance considered. Fixed cost.
  1g. Materials and books considered. Variable cost.
  1h. Other: considered. Variable cost. Consumption expenditures deducted (considered transfer payments).

29. CAIN (continued)

- Costs to Individual
  4. Opportunity costs considered.
  5. Stipends considered.

- Costs of Training to Vocational School
  1c. Administration: marginal cost to the government.
  1h. Other: work related expenses--travel, clothing, etc. and public assistance payments.

30. BATEMAN (continued)

- Costs to Individual
  Not specified.

- Costs of Training to Vocational School
  Not applicable.

Methods for Evaluating Special Types of Costs

Not specified.

- Costs to Individual
  Method used for evaluating buildings and equipment: equipment depreciation and foregone interest earnings on construction and rehabilitation of buildings.

- Costs of Training to Vocational School
  Method used for evaluating trainees' production: value of product and work projects appraised at centers, deducted from costs.
28. MANGUN (continued)

K. Benefits for the Individual
Not specified.

L. Benefits to Society
1. Earnings before tax considered.
2. Percentage of time employed.

M. Benefits to Enterprise of Training Program
Not specified--any additional private costs were offset by the employer's private benefits in the on-the-job training parts of the program.

N. Choice of Unit of Output and Costs
Benefits per graduate--costs per student were adjusted by a percent dropout rate to give approximate costs per graduate.

O. Criterion for Cost-Benefit or Cost-Effectiveness Analyses
Benefit-cost ratio is greater than 1 overall; and the benefit-cost ratio for institutional training is compared with benefit-cost ratio for on-the-job training (OJT).

P. General Conclusions
1) Social benefits have exceeded costs by substantial margins. 2) Average net federal B/C ratio, all enrollees: 3.28 for OJT and 1.78 for institutional training.* 3) Above for graduates: 2.13 for OJT and 1.09 for institutional training.* Those ratios use only net additional earnings of first year after training.

29. CAIN (continued)

1c. Earnings considered; also, "educational gains which translate into increased earnings."
2d. Other: better socialization, increased family stability.

30. RATENAN (continued)

1. Lifetime earnings increase.

1. Student: per man/year, costs and benefits.
2. Graduate: benefits: increase earnings of those terminating enrollment.
3. Student: costs per participant.

2. Benefit-cost ratio: B/C calculation: B = present value of future earnings, calculated with discount rates of 3% and 5%: B/C for educational achievement calculated for linear and exponential rates of growth.

2. Benefit-cost ratio: criterion percent increase in lifetime earnings required to make C/B ratio = 1. This percentage was calculated for four age groups; four levels of schooling.

1) There was no significant increase in monthly earnings due to the program. 2) 64% were employed after participation vs. only 42% before. 3) The author recommends a much larger training component to increase effectiveness.
<table>
<thead>
<tr>
<th>31. KIRBY</th>
<th>32. KRAFT</th>
<th>33. SCOTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>1. Evaluates costs and utility of selected vocational-technical programs in Florida.</td>
<td>1. Evaluates the effectiveness of an on-the-job training (OJT) program administered by the Bureau of Indian Affairs (BIA) in Oklahoma, 1960-66.</td>
</tr>
<tr>
<td><strong>Coverage of Study</strong></td>
<td>2b. Groups representative of training system (small sample): two programs: electronics and TV-radio-repair, at two Florida education centers, all graduates in 1967 and 1968.</td>
<td>2b. Group representative of training system (small sample): nine firms, two of which had OJT programs already--226 entrants, 78 respondents in sample.</td>
</tr>
<tr>
<td><strong>Process Evaluation</strong></td>
<td>No process evaluation.</td>
<td>No process evaluation.</td>
</tr>
<tr>
<td><strong>Specification of Inputs (trainee)</strong></td>
<td>1. Age: no significant difference between trained group and control group.</td>
<td>1. Age: 5 categories.</td>
</tr>
<tr>
<td></td>
<td>3. Previous education: no significant difference between trained group and control group.</td>
<td>3. Previous education considered. (3 categories).</td>
</tr>
<tr>
<td></td>
<td>4. Previous experience: two categories--experienced or inexperienced.</td>
<td>9. Race considered.</td>
</tr>
<tr>
<td></td>
<td>6. Motivation: assumed to be the same for both groups.</td>
<td>11. Other: marital status, number of dependents.</td>
</tr>
</tbody>
</table>
### Selection Procedures
Not specified.

### Costs to Individual in Vocational School
4. Opportunity costs considered.
5. Stipends: minus government subsidies, and taxes not paid.

### Costs of Training to Vocational School
Not specified.

<table>
<thead>
<tr>
<th>Costs of Training to Vocational School</th>
<th>Not specified.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Established Program)</td>
<td></td>
</tr>
<tr>
<td>Costs to federal government:</td>
<td></td>
</tr>
<tr>
<td>1a. Instructor's salaries considered.</td>
<td></td>
</tr>
<tr>
<td>1b. Buildings and equipment considered.</td>
<td></td>
</tr>
<tr>
<td>1f. Maintenance and insurance considered.</td>
<td></td>
</tr>
<tr>
<td>1h. Other: 1) subsidies to individuals 2) taxes foregone.</td>
<td></td>
</tr>
</tbody>
</table>

### Methods for Evaluating Special Types of Costs
Not specified.

### 31. KIRBY (continued)

### 32. KRAFFT (continued)
Not specified.

1. Fees considered.
2. Books and materials considered.
3. Travel and other incidental expenditures: assumed to be the same as to a job.
4. Opportunity costs: mean hourly earnings in general manufacturing in the area of the school.

### 33. SCOTT (continued)
Not specified.

Indians desiring OJT were served by the Bureau of Indian Affairs and sent to firms.

1. Costs to government (including not cost to firms).
2a. Costs for setting up considered.
2c. Administration considered.
2i. Total cost equals $220,159 or $1,010 per trainee.
2e. Other: opportunity costs to society of foregone earnings.
3. Wages of trainee minus increase value of production accrued to trainees considered.

Not specified.

Opportunity costs considered.
1. Fees considered.
2. Books and materials considered.
(Zero here).
4. Opportunity costs considered.

Opportunity costs considered.
1. Fees considered.
2. Books and materials considered.
(Zero here).
4. Opportunity costs considered.

Opportunity costs considered.
1. Fees considered.
2. Books and materials considered.
(Zero here).
4. Opportunity costs considered.

Opportunity costs considered.
1. Fees considered.
2. Books and materials considered.
(Zero here).
4. Opportunity costs considered.

Opportunity costs considered.
1. Fees considered.
2. Books and materials considered.
(Zero here).
4. Opportunity costs considered.
31. KIRBY (continued)

- Benefits for the Individual
  1a. Probability of getting the first job considered.
  1b. Benefits for the Individual
  1c. Earnings considered.
  1d. Employment stability: training is considered; hedge against technological change.
  1e. Lower accident rate considered.

- Benefits to Society
  Except as in M, not specified.

- Benefits to Enterprise of Training Program
  5. Other: benefits to federal government: 1) expected value of additional tax payments.
  2) Reduction in welfare transfers.

32. KRAFT (continued)

- Benefits for the Individual
  1c. Earnings considered.
  1d. Employment stability: training is considered; hedge against technological change.
  2a. Job satisfaction considered.
  2c. Increase of occupational options considered.

33. SCOTT (continued)

- Total benefits for 226 trainees equal $465,220 per year (undiscounted):
  1c. Earnings considered. Before training, average equalled $186 per month; after, $312 per month.
  1d. Employment stability considered.

- Benefits to Society
  Except as in M, not specified.

- Benefits to Enterprise of Training Program
  1. Earnings before tax considered: marginal increases in Federal income, state sales, property taxes.
  3. Percentage of time employed considered. (See K, 1d. above.)

- Not specified.

- 1. Less supervisory burden: generally less disciplined, i.e., worse (punctuality, absenteeism).
  2. Lower turnover rates considered: no change or higher (i.e. worse.)
  3. Better socialization of workers: considered; generally, better (work attitudes).
N. Choice of Unit of Output and Costs
1. Student: Costs per trainee.
2. Graduate: benefits per trainee after training.

O. Criterion for Cost-Benefit or Cost-Effectiveness Analyses
2. B/C ratio, where B is the difference in expected income between trainees and non-trained control group. (See P. for discount rates.)

P. General Conclusions
1) B/C ratio was calculated for discount rates of 5, 10, 15, 20, 25, 50, 100, 150 and 200% and assumed income growth rates of 3% and 6%.
2) The government earned a real rate of return of 20% from investment in TAT, Phase I. Also, a more efficient allocation of labor has been achieved because needed skills were taught.
1) Vocational-technical training in Florida has a positive return, especially for more specialized programs. Therefore, it should be expanded.
2) Analysis allows the forecasting of future costs, but it must be computerized to handle the large amounts of data necessary.
1) Contracted training periods were much longer than necessary for learning a skill because employers believed Indians to have lower productivity than other workers. Since this is apparent, not true, training periods should be shortened.
2) High private and social B/C ratios.
3) Therefore, program is effect
<table>
<thead>
<tr>
<th>34. ROBERTS</th>
<th>35. DOYLE</th>
<th>36. GRELL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>1. Evaluates a pre-apprenticeship training program designed to bring more blacks into the building trades.</td>
<td>1. An evaluation of apprentice-ship programs.</td>
</tr>
<tr>
<td><strong>Coverage of Study</strong></td>
<td>3a. Enterprise representative of training system (large sample): One program: 143 graduates and 72 dropouts vs. 306 non-selected candidates as control. Of the 143, 124 went into apprenticeship and 72 were still in after a year. Project Build (1965).</td>
<td>1. Whole systems: all apprenticeship programs (union and corporation-sponsored). Sample not specified. 399 students from clerical, practical nursing, and dental assistant programs.</td>
</tr>
<tr>
<td><strong>Process Evaluation</strong></td>
<td>No process evaluation.</td>
<td>(Qualitative)</td>
</tr>
<tr>
<td>1. Instructors begrudge their apprentices and vice versa.</td>
<td>2. Curriculum: length of programs called satisfactory. Some revision proposed in clerical curriculum. Percent employed in training-related fields is larger than National MDT.</td>
<td>3. Teaching methods: 7 hours per week of study outside the classroom.</td>
</tr>
<tr>
<td><strong>Specification of Inputs (trainee)</strong></td>
<td>1. Age: about 20 (average).</td>
<td></td>
</tr>
<tr>
<td>2. Background: disadvantaged.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
G. Costs to Individual Not specified.  
   in Vocational School

H. Costs of Training  
   to Vocational School  
   Not specified.

I. Costs of Training  
   to an Enterprise  
   Costs to government--total cost  
   per trainee or graduate given.  
   Costs of apprenticeship programs are high to a firm; only large  
   ones with long-range objectives can afford it. However, a better  
   system of rewarding performance would eliminate many of the  
   indirect costs, such as loss of production, and opportunity  
   costs.

J. Methods for Evaluating Special Types of Costs  
   Not specified.  
   Not specified.  
   Not specified.

K. Benefits for the Individual  
   1c. Earnings considered.  
   1d. Employment stability considered.  
   Not specified.  
   Not specified.  
   Not specified.

L. Benefits to Society  
   1. Earnings before tax considered.  
   Not specified.  
   Not specified.  

M. Benefits to Enterprise of Training Program  
   Not specified.  
   Not specified.  
   Not specified.

N. The Choice of Unit of Output  
   Not specified.  
   Not specified.  
   Not specified.

O. Criterion for Cost-Benefit or Cost-Effectiveness Analyses  
   2. Actual benefit-cost ratio is not favorable.  
   Not specified.  
   Not specified.
34. ROBERTS (continued)

P. General Conclusions 1) The program is successful. The number of graduates still at work after one year compares favorably with other programs and their wages are up more than the control group's (55% compared to 25%).

35. DOYLE (continued)

1) Benefits to workers, firms, unions, and society would increase a great success. if apprenticeship programs were improved and expanded.

36. GRELL (continued)

1) Lincoln Manpower programs are

2) Recommends continuation of a 3 programs, with a few changes

clerical curriculum.
Appendix 3-

**37. PERLMAN**

**A. Purpose**

1. An evaluation of on-the-job training programs (OJT).
2. The author compares OJT with vocational school programs.
3. The author evaluates rapid retraining programs (OJT) cooperative training programs in Brazil.

**B. Coverage of Study**

2a. Groups representative of training system (large sample): firms with OJT programs in Milwaukee--150 out of 245 interviewed. Tended to be larger manufacturing companies.

**C. Process Evaluation (Qualitative)**

1. Foreman is teacher.
2. Curriculum; actual job skills.
3. Methods: trainee takes a place in the production line.

**D. Output Evaluation**

2b. A posteriori C/E analysis (no cost data).
3. Evaluation of proficiency by foreman.

**E. Specification of Inputs (trainee)**

3. Previous education: whether vocational schooling or not.
4. Previous experience: an average of 80% of entering trainees had prior experience with that company.
11. Other: trainees selected by (number): foreman (26); previous training record (9); union seniority (38); upon hiring (95); other (46).

---

**38. TUTTLE**

1. Qualitative evaluation of a cooperative training program.

2a. Group representative of training system (large sample): 238 graduates from cooperative education training program (1955-61) in Brazil. Over 5,000 persons interviewed out of 57,000.

Des Moines, Iowa area; 135 were interviewed; also, their employers in 1960-61 (30 employers).

(Qualitative)

1. Whole system: large sample of the Rapid Retraining System in Brazil.

2. Curriculum: graduates were satisfied with their core area training.
3. Teaching methods: both graduates counseling, guidance, placement, and employers wanted more production experience with more equipment.

2b. A posteriori C/E--non-qualitative.
3. Evaluation by peers and superiors (subjective) done.

---

**39. HOROWITZ AND ZYMELMAN**

1. Evaluates rapid retraining system in Brazil.

1. Whole system: large sample of the Rapid Retraining System in Brazil.

2a. Group representative of training system (large sample): 238 graduates from cooperative education training program (1955-61) in Brazil. Over 5,000 persons interviewed out of 57,000.

Des Moines, Iowa area; 135 were interviewed; also, their employers in 1960-61 (30 employers).

(Qualitative)

1. Evaluates rapid retraining system in Brazil.

2. A posteriori studies.
3. Evaluation by peers and superiors (subjective).

Not specified.

1. Age considered.
2. Background considered.
3. Previous education considered.
37. PERLMAN (continued)

Selection Procedures  Not specified.

Costs to Individual  Not specified.

in Vocational  

School.

Costs of Training  'Not specified.

to Vocational  

School.

Costs of Training  Direct costs--scarcely any.

to an Enterprise.

Methods for Evaluat-  Not specified.

ing Special Types  

of Costs.

Benefits for the  Only cited for basic educational

Individual  components of programs.

2b. Satisfaction from more  

education considered.

2c. Increase of occupational  

options considered.

38. TUTTLE (continued)

Not specified.

39. HOROWITZ AND ZYMELEMAN  

(continued)

Not specified.

1. Fees considered.

3. Travel and other incidental  

expenses considered.

4. Opportunity costs considered.

Costs of training to the program.  

Costs were analyzed over time.

The program was only three years  

old.

1b. Instructors' salaries.  

considered.

1c. Administration considered.  

1e. Buildings and equipment  

considered.

1f. Maintenance considered.  

1g. Materials considered.

Not specified.

Method for evaluating buildings  

and equipment was straightline  

depreciation.

1a. Probability of getting the  

first job considered.

1b. Time to get the first job  

considered.

1c. Earnings considered.

2a. Job satisfaction considered.  

2b. Satisfaction from more educa-  

tion considered.

2c. Increase of occupational op- 

tions considered.
37. PERLMAN (continued)

Benefits to Society
Not specified.

Benefits to Enterprise of Training Program
Response to question: Why do you have a training program?
(quantified).
1. Lower turnover rates: 46 said as an incentive to prospective employees; short-time period of training forces worker to stay to practice new skills; and they are not easily transmissible. Retention rates 83% (high).
2. Increases of productivity due to training: 122 said to provide more skilled manpower.
3. Per graduate hour.
4. Per graduate hour.

The Choice of Unit of Output
Not specified.

Criterion for Cost-Benefit or Cost-Effectiveness Analyses
Not specified.

General Conclusions
1) Few firms have formal OJT programs. They train for current needs at the worker is in production...
2) Because new equipment is expensive, vocational schools should concentrate on basic skills: math, drafting, mechanics, etc. Firms will concentrate on practical training as industrial patterns keep changing.

38. TUTTLE (continued)

Not specified.

Not specified.

1. Less supervisory burden: benefits to the enterprise were assumed to be the increase in productivity as reflected in higher wages.

39. HOROWITZ AND ZYMNELMAN (continued)

Not specified.

Not specified.

Not specified.
<table>
<thead>
<tr>
<th>Purpose</th>
<th>1. Evaluates 6-month courses of accelerated adult training in Portugal.</th>
<th>1. Evaluates the training of unskilled workers in public sector industrial projects. Applies the Little-Mireless method of evaluating industrial projects to educational establishments.</th>
<th>4. To recommend the expansion of a program.</th>
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</thead>
<tbody>
<tr>
<td>Coverage of Study</td>
<td>3a. 2 series of courses at one training center: 14 courses 161 workers, 8 occupations; and 20 courses, 254 workers, 11 occupations. (1964-67).</td>
<td>3b. Enterprise representative of training system (small system): training school of heavy electrical (industry), training apprentices, low-grade engineers and skilled artisans, 1770 workers, two-year program. (1963-64).</td>
<td>2b. Small sample of a group in a training system: special programs within INACAP, the National Training Institute of Chile.</td>
</tr>
<tr>
<td>Costs of Training to Vocational School</td>
<td>Not applicable.</td>
<td>Not specified.</td>
<td>Costs considered as recurrent and capital costs.</td>
</tr>
</tbody>
</table>
40. de CARVALHO (continued)

I. Costs of Training to an Enterprise
   Cost to the government, new program; only total investment given: 15.4 million escudos for 1st series, 16.5 million escudos for 2nd series. (A chart gives the costs per trainee by trade, and their old and new salaries.)

41. CHAKRAVARTI (continued)

   (New program)
   1b. Instructor's salaries considered.

42. Arrigazi (continued)

   Not specified.

I. Methods for Evaluating Special Types of Costs
   Not specified.

J. Benefits for the Individual
   1c. Wages rose by an average of 82.2% after the first series, and 62.5% after the second.

K. Benefits to Society
   1. Added value of trainees' productivity estimated to be 4 million escudos for 1st series, 5.8 million escudos for 2nd series (1 escudo = US $0.065).

L. Benefits to Enterprise of Training Program
   Not specified.

Not specified.

Not specified.

Amortization of new capital at several different interest rates.

Not specified.

Not specified.

1. Increased productivity considered.

2. External benefits: employment effect and increased tax income.
40. de CARVALHO (continued)  
41. CHAKRABARTI (continued)  
42. ARRIGAZZI (continued)

I. The Choice of Unit of Output

1. Total costs per student.
2. Benefits per graduate.

1. Student: training cost per trainee.
1. and 2. Per student and graduate

1. Criterion for Cost-Unit, or Cost-Effectiveness Analysis

3. Rate of return on capital invested in each year = 25% - 30%. 
Payback period = 328 working days.

3. Rate of return calculated: uses 6 sets of assumptions about shadow wages and training costs—domestic and world market prices included. Value of marginal product assumed equal to wage. Rate of return (30%-48%).

I. General Conclusions

1. There is a high rate of return on accelerated adult vocational training.

1) Great difference in profitability between private and social returns. Therefore, training should be done by public sector.
2) Shadow wage-rate assumptions affect rates of return more in educational projects than industrial, because in the latter the wage bill is a small proportion of costs.
3) No difference in rates of return with market vs. accounting price.
4) Rates of return are above marginal social rate of return of 6% better in the long run.

The rate of return is from 30% to 50% depending on assumptions. The expansion should be undertaken
<table>
<thead>
<tr>
<th>Appendix 3-44</th>
</tr>
</thead>
</table>

| Process Evaluation | No process evaluation. | (Qualitative) | (Qualitative) |

1. Number of instructors under each teacher: former industrial board (by industry) is increasing workers with teacher training rapidly.
2. Curriculum: quality of training courses, both theory and practice has improved since 1964 Act.
3. Teaching methods: increase (1964-68) in use of off-the-job training centers: 45% of shipbuilding apprentices were trained in centers in 1968 vs. 24% in 1965; employment in that industry is decreasing though.
5. Equipment and materials: it is better for trainees to use expensive equipment under trained supervision than to use it at factories and wreck it.

43. ZDERMAN (continued)

Costs to Individual
4. Opportunity costs considered; also, not specified. in Vocational School

foregone welfare payments not

payable at higher post-training

salary.

Costs of Training
to Vocational School

Not specified.

Costs of Training
in an Interactive

Not specified; see L. (below)

(Established Program) for difficulty small firms have

in getting grants for training under the Act.

Costs of Training
in an Interactive

1b. Instructor's salaries con-

sidered.

1c. Buildings and equipment con-

sidered.

1f. Maintenance considered.

1h. Other: training grant, loss

in taxes.

2a. Imputed value of opportunity

cost of lost time by personnel.

not involved directly in train-

ing considered (administrators).

2b. Opportunity cost of produc-

tion facilities and equipment

considered.

Methods for Evalu-

Not specified.

ating Special Types of Costs

Not specified.

Benefits for the

Not specified.

Individual

1c. Earnings considered;

including training grant.

1d. Employment stability

considered.

2a. Job satisfaction considered.

2d. Other: domestic happiness.

2c. Increase of occupational

options: Negative benefit

possible because Act subsi-
dizes firms to give very speci-

fic training programs in some

cases—their main value is to

keep the worker right there.

1d. Employment stability:

20% had been unemployed; after

training almost all became

employed.
43. Zinerman (continued)

1. Earnings before tax considered.
2. External benefits of general education considered: increase in number of skilled workers in short supply areas.

44. Lees (continued)

2. External benefits of general education: the subsidies under the Act should be used as incentives to firms to give more general training programs (otherwise, their interest is in specific ones.) This is not always enforced.
4. Other: the economies of scale are still operating because small firms are not able to attract the recognized instructor which is required by the boards for a training grant. The board system is financed by a levy on all payrolls. The money to be granted back for training programs is not always enforced.

45. LA FORMATION PROFESSIONNELLE DES ANGLES (continued)

Benefits to Society

1. Earnings before tax considered.
2. External benefits of general education considered: increase in number of skilled workers in short supply areas.

Benefits to Enterprise of Training Program

Not specified.

1. The Choice of Unit of Output

1. Trainee.

2. Criterion for Cost-benefit or Cost-effectiveness Analyses

3. Rate of return: 8% discount twice yearly, 3-year time horizon. Also, payback period for return of costs.

General Conclusions

1) Short payback periods and high rate of return indicate net benefits of program.
2) This survey was crude; follow-up surveys, control groups, specification of inputs, examination of indirect effects, and displacement effects are necessary.

1) The Industrial Training Boards are not designed logically.
2) The training preferences of individual firms have taken precedence over collective wisdom.
3) The levy/grant system is defective.
4) Reform of the Act is necessary.

1) ATU should be expanded (right now it is mostly for metal workers) logically.
2) Two-thirds of trainees are working at jobs for which they were trained.
3) The levy/grant system is defective.
4) Reform of the Act is necessary.
46. FENGEB

A. Purpose
1. Evaluates plant vocational schools giving theoretical instruction to young employees whose attendance to courses is compulsory.

5. Coverage of Study
2a. Twentv-three large firms with plant schools; 100 firms with apprenticeship programs but no theoretical schools. (1969).

C. Process Evaluation (Qualitative)
1. Teachers at the plant schools may be selected from among persons actually working with the techniques to be taught.
2. Plant schools can be more flexible in planning and scheduling production training than public vocational schools.
3. Teachers at the plant schools may be selected from among persons actually working with the techniques to be taught.

D. Output Evaluation. Not done (see P. below).

47. REINERMANN

1. Evaluates apprenticeship training in artisan trades. (West Germany and other Common Market countries.)

1. Whole system of artisan apprenticeship. (Sample not specified.)

1. Type of teacher: experienced workers were trained to teach by consultants in 1965.
2. Curriculum: the consultants studied the production line and set up a teaching manual.
3. Teaching methods: exercises on standards of achievement were set up. The length of time in training was determined by performance.
4. Equipment and materials: a special center was set up for the program.

48. THOMAS

A new training program using trained instructors and advanced methods vs. an older program.

A single firm representative of training system (large sample 92 employees entering over a four-year period; the sample was chosen to be homogeneous for certain characteristics (see E. below). A Yorkshire clothing factory.
46. FENGER (continued)

Specification of Inputs (trainee)
1. Age: youth with compulsory schooling required.

Selection Procedures
Not specified.

Costs to Individual in Vocational School
Costs of Training to Location
Costs of Training in Enterprise
Methods for Evaluating Special Types of Costs
Not specified.
Not specified.
Not specified.
Not specified.

47. REINERMANN (continued)

Not specified.

48. THOMAS (continued)

1. Average age: 15 and 1/4 years; all less than 20.
2. Working-class background.
3. High-school dropouts at age 15.
4. No previous experience.
5. Average to below average intelligence.
8. All female.

Costs to Individual in Vocational School
Costs of Training to Location
Costs of Training in Enterprise
Methods for Evaluating Special Types of Costs
Not specified.
Not specified.
Not specified.
Not specified.

(New Program)
Total additional costs:
c. Administration: in the third year a new personnel officer was hired £ 767.
d. Consultants, £ 1,486.
g. Materials £ 92.
3. Wages of trainee minus trainee production = -£287 (negative cost).
3. Value of trainees' production = total wages minus total production, a negative figure here.
<table>
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</thead>
</table>

### Benefits for the Individual
- Not specified.

### Benefits to Society
- Not specified.

### Benefits to Enterprise of Training Program
- Not specified.

### The Choice of Unit of Output
- Not specified.

### Criterion for Cost-Benefit or Cost-Effectiveness Analyses
- Not specified.

### General Conclusions
1. Plant schools are successful in training young employees to pass their skill exams.
2. Firms also expressed high satisfaction with the public vocational schools.
3. The number of plant schools is unlikely to increase in the future. Reasons: the cost of the schools; the reluctance of firms to train beyond their immediate needs.
4. Plant schools are needed for short and adult training courses.

### 46. FENGER (continued)
- Benefits for the Individual: Not specified.

### 47. REINERMAN (continued)
- Benefits for the Individual: Not specified.

### 48. THOMAS (continued)
- Benefits for the Individual: Not specified.
- 1c. d. Earnings and employment stability mentioned but not quantified.
- 2a. Increased job satisfaction mentioned but not quantified.

- 2. Lower turnover: 75% of net benefit was due to the longer average retention rates of the new trainees.
- 4. 25% of the net benefit was due to productivity increases due to training.

- 1. Costs per trainee.
- 6. Benefits = marginal product of employed graduate.
- 2. Ratio of additional benefits to additional costs is greater than 1.

- The criticism of artisan apprenticeship programs is rejected for these reasons: a) there are still excellent prospects in Common Market countries for artisan trades, such as automobile mechanics, plumbing, electricity installation, etc.
- b) the system is being modernized by allowing groups of small firms to join their training programs, and changing trade descriptions.

- 1. The B/C ratio for the new system is 8/1; discounted benefits, however, over 4 years at 10% give a ratio of 6.5/1.
- 2. The benefits assessment does not include: long-term effects on the firm's profitability, or short-term effects on human attributes.
- 3. Output drops back down after the new training system is stopped.
Appendix 3

49. CASTRO

**Purpose**
Comparison of costs of SENAI, PIPASO, and vocational schools in Brazil.

**Coverage of Study**
2b. Small sample of establishments and schools.

**Process Evaluation**
Not specified.

**Output Evaluation**
Not applicable.

**Specification of Inputs (trainee)**
Not applicable.

---

50. HARDIN

2. To recommend policy for improving Manpower Development Training Act (MDTA) institutional programs.
3. Compares different courses, trainee characteristics, and labor market characteristics.

**Coverage of Study**
2b. Groups representative of training system (small sample): groups of state or federal training courses--784 persons interviewed, 1962-66. Michigan selected for large variety of courses and labor market. Courses studied were selected for variety: length, service vs. manufacturing occupations, kind of labor market served--rural, urban Detroit. Individuals also selected for variety from all enrolled trainees.

**Process Evaluation**
Not specified.- No process evaluation. (Qualitative)
8. Job Corps counseling favorably affects earnings. MDTA-OJT gives automatic placement, but training is too specific. Other two programs lack counseling and placement services.

**Output Evaluation**
Not applicable.

**Specification of Inputs (trainee)**
Not applicable.

---

51. RAKLINS

2) Manpower Development Training Act (MDTA) institutional programs. 3) Neighborhood Youth Corps (NYC) for dropout prevention.
4) MDTA on-the-job training (OJT).

**Coverage of Study**
2b. Group representative of training system (small sample)--4 programs in Los Angeles: Job Corps, 239 persons; MDTA Institutional, 101 trainees; NYC and MDTA on-the-job training (OJT), no specific sample.

**Process Evaluation**
No process evaluation.

**Output Evaluation**
2a. A posteriori C/B analysis for society, Individuals, government. Weighted to get figures for whole state.

**Specification of Inputs (trainee)**
1. Age specified for 4 Job Corps programs.
2. Background: prior earnings, prior unemployment compensation or welfare receipts, health, household size, marital status.
3. Previous Education specified for Job Corps and MDTA's.
8. Sex specified.
49. CASTRO (continued)

50. HARDIN (continued)

51. RAMLINS (continued)

3. Previous education: years of schooling.
4. Previous experience: kind of job, length of employment.
8. Sex considered.
9. Race considered.
11. Other: training occupation.


Selection Procedures Not applicable.

Unemployed persons.

NYC: high-school dropouts or imminent dropouts; NDTA: disadvantaged persons and the hard-core unemployed are excluded.

Costs to Individual Not applicable.

in Vocational School

3. Travel and subsistence.
5. Stipends: net of unemployment compensation and welfare payments foregone and training allowances.

Not specified.

Costs to Individual Not applicable.

in Vocational School

3. Travel and subsistence.
5. Stipends: net of unemployment compensation and welfare payments foregone and training allowances.

Not specified.
49. **CASTRO (continued)**

| Methods for Evaluating Special Types of Costs | Specifies method for evaluation of buildings and equipment. |
| Benefits for the Individual | Not applicable. |
| Benefits to Society | Not applicable. |
| 1. Benefits to Enterprise of Training Program | Not applicable. |
| The Choice of Unit of Output | 3. Student hour. |
| Criterion for Cost-benefit or Cost-Effectiveness Analyses | Not applicable. |
| General Conclusions | There is no definite answer as to which mode of training has a lower cost/student hour. |

50. **HARDIN (continued)**

| 1. Methods used for allocation of joint costs: administration costs pro-rated per trainee per week (average cost). |
| Benefits for the Individual | 1c. Earnings: author prefers increase in disposable income (subtracting unemployment benefits and welfare). Multivariate analysis isolates gains due to training from other variables such as personal characteristics and labor market. |
| Benefits to Society | 1. Earnings before tax considered: Not specified. |
| 1. Benefits to Enterprise of Training Program | 5. Other: taxes, unemployment benefits, welfare. Regression analysis used. |
| The Choice of Unit of Output | 1. Student: per trainee. |
| Criterion for Cost-benefit or Cost-Effectiveness Analyses | 2. Cost-benefit ratio: 3 ratios: Not specified. |
| General Conclusions | 1. Government should operate and finance courses. |

51. **RABLINS (continued)**

<p>| 1c. Earnings considered. |
| Benefits for the Individual | 2c. Increase of occupational optic an N.Y.C. strong point is to help get academic credentials. |
| Benefits to Society | 1. Earnings before tax considered: Not specified. |
| 1. Benefits to Enterprise of Training Program | 5. Other: taxes, unemployment benefits, welfare. Regression analysis used. |
| The Choice of Unit of Output | 1. Student: per trainee. |
| Criterion for Cost-benefit or Cost-Effectiveness Analyses | 2. Cost-benefit ratio: 3 ratios: Not specified. |
| General Conclusions | 1. The type of program makes no difference in earnings, but the length of training period does (longer periods are better). Job placement efforts make a difference too. |
| | 2) N.Y.C.'s strong point is the importance of academic credential for the future. |
| | 3) The labor market is important—NIT is real when vacancies exist. |</p>
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<tr>
<th><strong>52. GUBINS</strong></th>
<th><strong>53. SCHRIVER</strong></th>
<th><strong>54. GREENBERG</strong></th>
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<tr>
<td><strong>Purpose</strong></td>
<td>3.1) To compare cost-benefit ratios for training of unemployed persons from an Eastern city ghetto with cost-benefit ratios for larger populations. 2) To compare cost-benefit ratios by age and educational attainment.</td>
<td>3. Compares 1) the effect of certain student characteristics and type and length of training on rate of return on investment in vocational training; 2) the effect on income distribution of educational groups.</td>
</tr>
<tr>
<td><strong>Coverage of Study</strong></td>
<td>3a. A single school representative of training system (large sample): 108 graduates of 1966 Manpower Development Training Act (MDTA) program in Baltimore (out of 319, 33.8% response); control group was all applicants to the program. Program graduates who had 12 months post-training employment and who were accessible (33% of graduates).</td>
<td>2b. Group representative of training system (small sample): rate of return study: 127 pairs from a previous study by the authors potential-income study—411 former students; income distribution study: 233 former students.</td>
</tr>
<tr>
<td><strong>Process Evaluation</strong></td>
<td>No process evaluation.</td>
<td>No process evaluation.</td>
</tr>
<tr>
<td>Specification of Inputs (trainee)</td>
<td>Selection Procedures</td>
<td>Costs to Individual in Vocational School</td>
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<td>----------------------------------------</td>
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<tr>
<td>3. Previous education considered.</td>
<td></td>
<td>5. Allowances considered.</td>
</tr>
<tr>
<td>8. Sex considered and rejected,</td>
<td></td>
<td></td>
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<tr>
<td>by multiple regression analysis.</td>
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</table>

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<th>Costs of Training to an Enterprise</th>
<th>Specified characteristics on rate of return:</th>
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<td>(New Program)</td>
<td>1. Age considered.</td>
</tr>
<tr>
<td></td>
<td>3. Previous education considered.</td>
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<tr>
<td></td>
<td>4. Previous experience considered.</td>
</tr>
<tr>
<td></td>
<td>8. Sex considered.</td>
</tr>
<tr>
<td></td>
<td>9. Race considered.</td>
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</table>

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<tr>
<th>Selection Procedure</th>
<th>Costs to Individual in Vocational School</th>
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<tr>
<td></td>
<td>Opportunity costs considered.</td>
</tr>
<tr>
<td></td>
<td>5. Allowances considered.</td>
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</table>

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<thead>
<tr>
<th>Costs of Training to an Enterprise</th>
<th>Costs to government and economy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(New Program)</td>
<td>1a. Costs for setting up considered.</td>
</tr>
<tr>
<td></td>
<td>1b. Instructor's salaries consid-</td>
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<td></td>
<td>ered.</td>
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<td></td>
<td>1c. Administration considered.</td>
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<td></td>
<td>1f. Maintenance considered.</td>
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<td>1g. Materials and books consid-</td>
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<tr>
<td>Special Types of Costs</td>
<td></td>
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<tr>
<td>Benefits for the Individual</td>
<td>1c. Earnings considered.</td>
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<tr>
<td>Benefits to Society</td>
<td>1. Earnings before tax considered.</td>
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<tr>
<td>The Choice of Unit of Output</td>
<td>6. Benefits per employed graduate.</td>
</tr>
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</tr>
</tbody>
</table>
52. GUBINS (continued)

Criterion for
Cost-Benefit or
Cost-Effectiveness
Analyses

2. Cost-benefit ratio: 3 ratios for individual, society, economy. Present value discount rates 5% and 10% for society and economy, 15% and 35% for individual. Duration of benefits, 10, 30, or 40 years. Grouped by age and educational attainment.

53. SCHRIEVER (continued)

3. Effect of 12 variables on rate of return.
2. Payback period discount.
3. Net benefit — present value.
4. Internal rate of return.

54. GREENBERG (continued)

Not specified.

General Conclusions

1. There are substantial payoffs to the economy and society from training hard-core ghetto unemployed.
2. C/B greater for age less than 22 than for age greater than 22 (greater than 22 costs are less for fewer dropouts).
3. C/B greater for less than 9 years of education than for greater than 9 years.
4. Programs are economically beneficial to trainees regardless of age, sex, education or discount rates.
5. Programs may be expanded by two or three times and C/B will still be greater than one.

1) Significant variables: job-relatedness of course, additional training, marital status, I.Q., hours of AVTS. Not significant: curriculum (type of program), residence, race, occupational mobility, age, geographic mobility.
2) a. Rate of return averaged 6.3%, highest for: low I.Q., married, additional training after AVTS, 15 months or less training at AVTS.
b. Income difference: average income highest for: females in health occupation, males (no difference for occupation), skilled or semi-skilled job, geographically mobile, married, high school graduates.
c. Income distribution: AVTS training increased expected income of dropouts and graduates.

1) Significant indication that the type of firm is the strongest variable in determining wage rates of first job.
2) Other indications: marriage, age, non-Negro, all have positive associations with wages; being female or Spanish surname has negative associations.
3) OJT programs are significantly better than others according to starting wage rates.
Appendix 3-57

55. LOEWE

Purpose
2. To recommend policy for improving the attitudes towards work of vocational school pupils.

Coverage of Study
2b. 50 good and 50 poor pupils (25 of each sex), from 4 different types of vocational school: craft, trades, horticulture, railways, graphic arts.

Process Evaluation
No process evaluation.

Output Evaluation
No output evaluation.

Specification of Inputs (trainee)
Characteristics of good and poor pupils listed.
2. Background: materials situation not important. More poor pupils (28% vs. 6%) had only one parent.
6. Motivation: many poor pupils were dissatisfied with the trade they were learning, and intended to change later; good pupils were satisfied.
7. Aptitudes: good pupils had chosen their trades according to a clear idea of their aptitudes and interests.

Selection Procedures
Not specified.

Costs to Individual in Vocational School
Not specified.

H. Costs of Training to Vocational School
Not specified.

I. Costs of Training to an Enterprise
Not specified.

J. Methods for Evaluating Special Types of Costs
Not specified.

K. Benefits for the Individual
Not specified.

L. Benefits to Society
Not specified.

M. Benefits to Enterprise of Training Program
Not specified.

N. The Choice of Unit of Output
Not specified.

O. Criterion for Cost-Benefit and Cost-Effectiveness Analyses
Not specified.

P. General Conclusions
1. Parents and teachers must give children many opportunities to explore interests and aptitudes and praise them for their efforts in order to develop self-confidence.
A NUMERICAL EXAMPLE OF THE CALCULATION OF THE COSTS OF A TRAINING PROGRAM

The following example computes the cost of training in a hypothetical welding program that is being offered in conjunction of other training programs. This example is also intended to demonstrate the use of the data in Tables 1 through 11 of Chapter III in this report. Since these sample calculations make several general assumptions about other programs offered in a hypothetical school, the results should not be used as a basis for evaluating welding programs in general.

1. Basic Assumptions.
   a. All operating costs, enrollment projections, instruction hours, etc. are based on single year figures. Also, the entire welding instruction is provided during the course of a year. This assumption is valid also in the case where the program is offered over a period of years if there is a steady inflow of students ('steady state').
   
   b. Average annual demand in the welding program is:
      - 25 gas (oxyacetelyne) welders
      - 10 arc welders
      - 15 combination welders
   
   c. Enrollments in other programs using the welding laboratory:
      - Sheet Metal: 35 students/year
      - Machine Shop: 30 students/year
   
   d. Characteristics of other facilities shared by welding students:
      
      Drafting Laboratory:
      - Equipment = $10,700
      - Facility Costs = $45,000
      - Hours of Instruction = 15,000 (not including welding)
      - Instruction Costs = $8,000/year

      Classrooms:
      - Facility Costs = $125,000
      - Hours of Instruction of "other programs" \( (\Sigma HRS_j) = 450,000 \)
        (not including welding). (300,000 hours laboratory; 150,000 hours class)
      - Instruction Costs = $105,000/year

   c. Total Administrative Costs (TAC) $35,000/year

   NOTE: The following subscripts will be used in this example:
   - \( d \) = drafting
   - \( t \) = total
   - \( w \) = welding
   - \( s \) = sheet metal
   - \( m \) = machine shop
   - \( k \) = laboratory index
   - \( i \) = equipment index
   - \( j \) = program index
Allocations of Administrative Costs

2. Administrative costs to be allocated to the welding program are computed using the following equation:

\[
\text{ADM}_w = \frac{TCA \times HRS_w}{\Sigma HRS_j}
\]

Where:
- \(\text{ADM}_w\) = administration costs allocated to welding program
- \(TCA_w\) = total costs of administration
- \(HRS_w\) = student hours of welding program
- \(\Sigma HRS_j\) = student hours of all programs

With \(TCA_w\) and \(HRS_w\) known, the first step in computing the allocated cost of administration is to determine \(HRS_w\). From Table 11, the total hours of instruction needed for gas, arc and combination welders are 530, 530 and 880 respectively. These hours are then multiplied by the number of students in each program (gas = 25; arc = 10; combination = 15) to compute the total hours of welding instruction.

\[
HRS_w = 530 \times 25 + 530 \times 10 + 800 \times 15 = 30,550 \text{ hours}
\]

Then, substituting into equation 1, the administrative costs to be allocated to the welding program are computed as follows:

\[
\text{ADM}_w = \frac{35,000 \times 30,550}{450,000 + 30,550} = $2,250/\text{year (rounded)}
\]

3. Allocation of Laboratory Instruction: Laboratory instruction costs to be allocated to the welding program are computed by using the following equation:

\[
\text{CLI}_w = \Sigma \text{CLI}_{kw}
\]

Where:
- \(\text{CLI}_{kw}\) = \(TCL_k \times \frac{HRS_{lwk}}{\Sigma HRS_{lk}}\)

Since, as shown in Table 11, welding students make use of both welding and drafting laboratories, it is necessary to compute the welding laboratory instruction costs allocated to the welding program (\(\text{CLI}_{w}^{w}\)) and the drafting laboratory instruction costs allocated to the welding program (\(\text{CLI}_{w}^{d}\)). From Table 11, the total hours of welding laboratory instruction for gas, arc, and combination welders are 420, 420 and 770 respectively. (These numbers are based on the assumption that the same teacher teaches both the laboratory and related theory components of the welding program.) These hours are then multiplied by the number of students in each program to compute the total hours of welding laboratory instruction.
Appendix 4 - 3

HRSL \_w = 420 \times 25 + 420 \times 10 + 770 \times 15 = 26,250 \text{ hours}

CLI\_w = \text{cost of laboratory instruction of welding program}
TCL\_w = \text{total cost of laboratory instruction of welding program}
HRSL\_w = \text{hours student of welding program spent in laboratory of welding program}
\sum HRSL\_w = \text{total hours student of all programs spent in laboratory of welding program}

Similarly, from tables 10 and 8, we find the total number of hours welding laboratory used by sheet metal (HRSL\_sw) and machine shop (HRSL\_wm) students equal 4,550 hours (35 \times 70 \times 30 \times 70). Thus, the total utilization is 30,800 hours (4,550 + 26,250). If we assume one welding instructor at a cost of $8,500 per year, equation (2) may be solved as follows:

\[
\text{CLI}\_w = \frac{8,500 \times 26,250}{30,800} = \text{rounded } $7,250
\]

A similar computation for the drafting laboratory results in the following allocation of drafting instruction costs:

\[
\text{CLI}\_d = \frac{8,000 \times 70 \times (25+10+15)}{1500 + 70 \times (25+10+15)} = \text{rounded } $1,500
\]

The sum of these figures gives a total laboratory cost allocated to the welding program of:

\[
\text{CLI}\_w = \text{CLI}\_d + \text{CLI}\_w = $1,500 + $7,250 = $8,750
\]

4. Allocated Cost of Class Instruction: Class instruction costs to be allocated to the welding program are computed using the following equation:

\[
\text{CCII}\_w = \frac{TCC1 \times \text{HRSC}\_w}{\sum \text{HRSC}\_j}
\]

where

\[
\text{CCII}\_w = \text{cost of class instruction of welding program}
TCC1 = \text{total cost of class instruction}
\text{HRSC}\_w = \text{hours student class of welding program}
\sum \text{HRSC}\_j = \text{hours student class of all programs}
\]

From table 11, the class hours associated with each welding program are 40. This number is then multiplied by the total number of students in each program to give HRSC\_w as:

\[
\text{HRSC}\_w = 40 \times 25 + 40 \times 10 + 40 \times 15 = 2,000 \text{ hours}
\]
Then, the total cost of class instruction allocated to the welding program becomes:

\[
CCII_w = \frac{105,000 \times 2,000}{2,000 + 150,000} = \text{rounded } 1,400
\]

5. **Allocation of Equipment Costs:** Equipment costs allocated to the welding program are computed in the following manner:

\[
TCL_w = k \cdot (EC_{wk} + FC_{wk})
\]

where

- \( TCL_w \) = total cost laboratory welding program
- \( EC_{wk} \) = equipment cost of laboratory \( K \) allocated to welding program
- \( FC_{wk} \) = fixed cost of laboratory \( K \) allocated to welding program

Since the welding students use both welding and drafting laboratories, equipment costs of these laboratories must be allocated to the welding program. These allocated costs are computed below.

6. **Fixed Costs of Welding Laboratory:**

\[
FC_w = (\text{From Table 22}) \quad \text{General Support Package } $3,000
\]

\[
\text{Major Support Equipment } 1,660
\]

\[
\text{Benches } 600 (1)
\]

\[
\text{Tools (etc.) } 1,500 (1)
\]

\[
\text{Total } $6,760
\]

(1) Assumes 20 students and laboratories with benches in a ratio of 1:5.

7. **Equipment Costs of Welding Laboratory:**

\[
EC_w = \sum_i r_i \cdot C_i
\]

where

- \( r_i \) = number of machines of type \( i \)
- \( C_i \) = cost of machine of type \( i \)

and

\[
r_i = \frac{\sum_{j} HRS_{ij} \cdot S_j / SS_{ij}}{HRSA_i \cdot U_i}
\]

where

- \( HRS_{ij} \) = hours instruction on machine \( i \) required by a student in program \( j \)
- \( S_j \) = number of students in program \( j \)
- \( SS_{ij} \) = student stations on equipment \( i \) in program \( j \)
- \( HRSA_i \) = hours available on equipment \( i \)
- \( U_i \) = utilization factor
Sample calculation of $r \times C$ for arc welding system (from Table 22):

1. For arc welders -- $HRS = 160$ to 200 hours (assume 180-second line, column 3 of Table 22)
2. For machine shop and sheet metal students, assume the instructional hours in welding are prorated according to the mix represented by the average combination student (column 5 of Table 22). (This assumption will probably be valid for most laboratory equipment computations.) Thus, for machine shop and sheet metal students, hours on arc welding equipment are:

$$HRS_{ws} = \frac{70 \times 180}{590} = 21.36$$

$$HRS_{wm} = \frac{50 \times 180}{590} = 15.08$$

Where 70 and 50 are the hours of welding instruction received by sheet metal and machine shop students respectively (Tables 10 and 8), and 180/590 is the factor used to assign the hours of instruction received by sheet metal and machine shop students in the welding laboratory to arc welding equipment. (180 are the average hours use of only arc welding equipment; 590 are the average number of hours instruction of a combination welding program using all equipment. See Table 22.)

If we assume one student per station (i.e., $S_{ij} = 1$), $r_i$ for arc welding stations is calculated as follows:

$$r = \frac{180 \times 15 + 180 \times 10 + 35 \times 21.36 + 30 \times 15.08}{1560(a) \times 0.75(b)}$$

$$= \frac{5697}{1170} \approx 5 \text{ arc welding machines}$$

(a) assumes 30 hours per week x 52 weeks/year
(b) assumes 75% machine utilization

Then, since the average cost of one arc welding booth and welder is $1,000, the total equipment cost for arc welding systems is:

$$EC = r \times C = 5 \times 1000 = $5,000$$

Applying similar computations to all other systems results approximately in an $\sum EC_{wi}$ of $12,400$.

Combining fixed and equipment costs for the welding laboratory, we derive a total cost of the welding laboratory as:

$$TLC_w = 12,400 + 6,760 = \text{Rounded } $19,000$$

The amount of this total cost borne by the welding program is then computed from the following equation.
Appendix 4-6.

\[ EC_{jk} = \frac{TLC_k \times H_{kj}}{\sum_j H_{kj}} \quad (6) \]

where

- \( EC_{jk} \) = equipment cost of laboratory K allocated to program j
- \( TLC_k \) = total cost of laboratory K
- \( H_{kj} \) = hours use of laboratory K by program j
- \( \sum_j H_{kj} \) = hours use of laboratory K by all programs

\[ EC_{ww} = (19,000 \times \frac{25 \times 350 + 10 \times 350 + 15 \times 700}{30 \times 50 + 35 \times 70 + 25 \times 350 + 10 \times 350 + 15 \times 700}) \]

= rounded = $16,000

To compute the total laboratory costs allocated to the welding program, we must also add the allocated costs of the drafting program. Therefore:

\[ EC_{wd} = 10,700 \times \frac{[(25 + 10 + 15) \times 70]}{15,000 + [(25 + 15 + 10) \times 70]} \] (c) = rounded $2,000

(c) \((25+10+15) \times 70\) represents the total course of drafting instruction received by students in each of the three welding courses.

The equipment costs to be allocated to the welding program is then the sum of costs allocated to welding from both the drafting and welding programs:

\[ EC_W = $2,000 + $16,000 = $18,000 \]

8. **Allocation of Facility Costs**: The total facility costs allocated to the welding program include:

- TLCC (drafting) = $45,000
- TLCC (class) = $125,000
- TLCC (welding) = $60,000 (assumed)

Using the cost allocation factors \([H_{kj} \times S_j]/(H_{kj} \times S_j)\) for the welding program computed in the above section, the total facility cost to be allocated to the welding program is:

\[ TCCP = \left[\frac{(45,000 \times 3500 \times 60,000 \times 22,750 + 125,000 \times 18500}{27,250}}\right] \left[1 + 0.4\right] \] (d) = rounded $89,000
(d) assumes a facility burden factor of 40%.

9. **Cost of Materials** ($C_m$): We shall assume an amount per student of $50 per year.

**COMPUTATION OF ANNUAL COSTS PER STUDENT**

10. **Annual Variable Costs**

\[ \text{OCPS}_w = \frac{\text{ADM}_w + \text{LP}_w + \text{CLI}_w + C_m}{\text{NOS}_w} \]  \hspace{1cm} (7)

where

- \(\text{OCPS}_w\) = total operating costs per student in welding program
- \(\text{ADM}_w\) = administrative costs of welding program
- \(\text{CLI}_w\) = cost of laboratory instruction of welding program
- \(\text{CCL}_w\) = cost of class instruction of welding program
- \(C_m\) = cost of materials
- \(\text{NOS}_w\) = number of welding students per year

\[
\text{OCPS}_w = \frac{2250 + 8750 + 1400 + 50}{50} = \text{rounded } $300.
\]

11. **Annual Fixed Costs**

\[
\text{AFCPS}_w = \frac{\text{TCCP}_w - \text{FRV} + \text{EC}_w}{\text{TNOS}_w}
\]

Where

- \(\text{AFCPS}_w\) = allocated fixed cost per student in welding
- \(\text{TNOS}_w\) = total number of students in the welding program over the life of the program. For this example, assume the program is planned for 7 years. Therefore, \(\text{TNOS}_w = 7 \times \text{NOS}_w = 350.\)
- \(\text{TCCP}_w\) = total construction cost for welding program
- \(\text{FRV}\) = facility recovery value (salvage value) after the welding program is discontinued. For this example, assume that this factor, after accounting for building depreciation, etc., represents 65% of the initial facility cost. Therefore, \(\text{FRV} = \text{TCCP}_w \times 0.65 = $57,800.\)
Then,
\[ \text{AFCPS}_w = \frac{89,000 - 57,800 + 18,000}{350} = \text{rounded} \$150 \]

Total annual average cost per student in welding (\(\text{ACPT}_w\)) then becomes:
\[ \text{ACPT}_w = \text{AFCPS}_w + \text{OCPS}_w = 300 + 150 = \$450 \]

In summary, the average cost of $450 per student for the welding program is obtained by determining total administrative costs, laboratory instruction, class instruction equipment costs of welding and other laboratories, and construction costs, and allocating them to the welding program. The bases for the allocation are the hours of the welding programs in class and laboratories compared with the time of instruction and use of facilities of all other programs.

For simplification's sake, we assume straight-line depreciation and we disregard the influence of interest charges.