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9. ABSTRACT
This study deals with the development of skilled industrial workers in the State of Sao Paulo, Brazil. Large numbers of skilled industrial workers recently have been developed rapidly in this area, and three broad questions concerning their origin, development and present situation are examined. First, what was the origin of the present skilled industrial laborers? The study attempts to determine if they were in fact drawn randomly from the total Brazilian population or if their geographic, socio-economic, and other characteristics of origin make them significantly different from the remainder of the population. Second, how did these individuals learn and develop their mental and manual skills? An examination is made of the institutional arrangements, content, duration, and sequence of their learning experiences. Third, and perhaps most important, do variations in the origins of individuals and in the types of learning experiences to which they were exposed influence the nature, quality, and market valuation of the work they perform on the job? A general model relating factors important in the development of skilled industrial workers is elaborated. This model serves as a basis for the development of several linear regression models which are used to "explain" variation in what is done on the job, wage rates, and the time taken to reach the skilled occupational level.

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# ALTERNATIVES FOR THE TRAINING OF SKILLED INDUSTRIAL LABOR IN SÃO PAULO, BRAZIL

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## FOREWORD

This monograph is the product of an intensive study over the course of a year conducted by Michael Lukomski with the collaboration of SENAI in São Paulo, Brazil. It stems from a developing interest in non-formal education activities and institutions as they relate to the processes of economic development.

It is of particular significance that the study could be done in Brazil which is attaining an enviable record of economic growth. São Paulo, of course, is the engine of the Brazilian train and the study acquires additional significance for that reason. Furthermore, SENAI has been the leader in Latin America in the establishment of vocational education, so it is particularly appropriate that this study was undertaken there.

One of the important lessons learned--or at least confirmed--in the conduct of this study is the very great amount of work that is required to produce definitive results. Initially a much broader objective was set than was ultimately possible to accomplish. Sights were successively reduced because of the demands of sample size, the cost of interviewing, and the significant differences between occupation groups. We finally thought it better to be able to say something solid about even one small group than to be superficial regarding a number of groups. In this connection the choice of lathe operators as a group for study proved to be very good, but the penalty of successive reduction of the target group increases the difficulties of "costing" enormously.

As the group becomes more specialized, problems associated with joint costs become more severe. Very little could be determined regarding cost effectiveness and cost benefits.

Methodologically, Lukomski has employed Professor Harbison's "tagging" technique, but in reverse. Rather than following the products of educational experiences to their "destinations," Lukomski has selected a carefully defined destination and then worked backward to find out the various routes followed by lathe operators in obtaining the skills they have and the positions they occupy. Some very useful data concerning institutions and their apparent effects emerged.

This study will provide additional insight into the evaluation of non-formal educational activities in the developing world. It is useful for the information it provides and for the questions it raises and leaves unanswered.

Lukomski and I are grateful for the gracious cooperation received from SENAI in São Paulo. Its president, Prof. Paulo Ernesto Tolle was receptive in the initial arrangements and then extended continued support. Prof. João Baptista Salles da Silva, likewise, provided constant support and encouragement. Collaboration of many others of the SENAI staff was critical in the execution of the study. We hope it will have proven a useful exercise for SENAI as well as for its broader audience.

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# INTRODUCTION

This study deals with the development of skilled industrial workers in the State of São Paulo, Brazil. Large numbers of skilled industrial workers recently have been developed rapidly in this area, and three broad questions concerning their origin, development and present situation are examined. First, what was the origin of the present skilled industrial laborers? The study attempts to determine if they were in fact drawn randomly from the total Brazilian population or if their geographic, socio-economic, and other characteristics of origin make them significantly different from the remainder of the population. Second, how did these individuals learn and develop their mental and manual skills? An examination is made of the institutional arrangements, content, duration, and sequence of their learning experiences. Third, and perhaps most important, do variations in the origins of individuals and in the types of learning experiences to which they were exposed influence the nature, quality, and market valuation of the work they perform on the job? A general model relating factors important in the development of skilled industrial workers is elaborated. This model serves as a basis for the development of several linear regression models which are used to "explain" variation in what is done on the job, wage rates, and the time taken to reach the skilled occupational level.

General considerations--Skilled manpower is important to industrialization. Once a nation selects and begins on

the course of industrialization as a primary path toward economic development, demand expands for new skills, and ever increasing numbers of workers. These human resources must somehow be developed if growth rates are not to be retarded.

At any time, an economy possesses a population pool from which those who are to become skilled industrial workers must be drawn. Two of the major factors leading to the differences between individuals in the population are: (1) the conditions at birth (when, where, and to whom an individual is born); and (2) past learning experiences (type and duration of formal education, work experience, and training). By some process, individuals (generally a small percentage of the total population) must be "chosen", and by some means they must be "transformed" into skilled industrial workers. As used here, transformation should be understood to mean the process by which an individual who is not a skilled industrial worker becomes one. The type of transformation required is directly related to the type of individual chosen and to the skills to be learned.

In some cases the transformation may consist of nothing more than one short course in which the skills associated with a specific skilled occupation are developed. A transformation such as this (generally called a program) can be successful only if the individual possesses some abilities prior to the program which allow him to complete his development rapidly. For example, he may have a high school education, several years of industrial work experience, and a previous course in some related occupational area. These past learning experiences give him a general foundation (set of

abilities) upon which the short course can quickly build. As his abilities prior to the program are similar to the abilities to be developed through the program, the required transformation can be rapid.

In other cases the transformation may be well beyond the capacities of a simple short course or program. There are cases in which the candidates for development into skilled industrial workers are individuals having little or no formal education, no industrial work experience, and no training experiences of any type. If such an individual were to be developed into a skilled industrial worker, the transformation required might include several years of formal education, some introductory industrial work experience, and finally, an industrial training program of relatively long duration.

In both hypothetical examples the transformation can be accomplished. That is, an individual who is not a skilled industrial worker can be transformed into one. The types of transformations required, however, are very different: the first consists of a single "program," the second, of what is generally thought to be a series of "programs."

Even if the final products (skilled industrial workers) of the two transformations are identical, a definitive comparative evaluation is still very difficult. Both the individuals who are transformed and the transformations differ. Each transformation is efficient in the sense that, given the characteristics of the individual to be transformed, the transformation can be accomplished.

When evaluation is undertaken it is generally only the first type of transformation which is considered. That

is, a specific, defined short-term program is identified and evaluated, taking the prior learning experiences of the individual, and thus his abilities prior to the program, as given in the analysis. From a short run point of view, treating past investments in formal education, work experience and training as irrelevant may be justified. From a manpower planning point of view (which should be long-run) it is not. Investments in formal education made today influence the "quality" of individuals who may be "chosen" to become skilled industrial workers in the future.

It is not legitimate to view the second type of transformations as a series of three independent "programs" i.e., formal education, work, and training. They are not independent as the output of one serves as an input to another. Any decision in one area will affect all other areas. Each individual "program" is in reality only a part of a total learning system. While the evaluation of programs in isolation may serve some purposes, this practice is likely to give misleading information to the educational planner. What is important is the system of learning, for it is only if the total system is known that individual programs can be viewed in their proper perspective as they relate to all other parts of the learning system. Given this type of information, the identification of alternatives (transformations capable of working on the same types of individual) is possible and, thus, comparative evaluation meaningful.

## BACKGROUND NOTES

This section provides general historical and institutional information on Brazilian industrial growth and the development of industrial labor. Many types of data commonly available in advanced countries simply do not exist in Brazil. Brazil's data collection systems have improved greatly in recent years, but reliable, long-term, time series data in almost all areas remain scarce. Cross-sectional data collected in different years are not always comparable due to variations in coverage and definitions. Even today, on some topics comprehensive data is non existent, especially in the case of the operations and output of private industrial training schools.

Growth, industry, and skilled labor--Real Gross Domestic Product in Brazil has increased over 500 percent since 1947. The average annual rate of increase has been over 6.8 percent (see Table 1). Since 1965, the average annual rate of increase has been over 8.3 percent. Per capita real Gross Domestic Product since 1947 has grown at an average annual rate of over 3.7 percent, and since 1965, over 5.1 percent. Presently Brazil is one of the fastest growing and most rapidly industrializing countries in the world.

The leading growth sector in Brazil has been the industrial sector. Since 1947, real industrial production has increased by over 800 percent (see Table 2). The average annual rate of growth in industrial production since 1947 has been over 8.8 percent, and since 1965, over 11.2 percent.

TABLE 1.--Domestic Product at Constant Prices--Total and Per Capita; Selected Years, 1947-1972.

| | Total Gross Domestic Product | | | Gross Domestic Product-Per Capita | | |
|---|---|---|---|---|---|---|
| | At 1949 Prices (CR$million) | Index (1965=100) | Annual Variation (%) | At 1949 Prices CR$1.00 | Index (1965=100) | Annual Variation (%) |
| 1947 | 200.7 | 34.0 | --- | 4.1 | 56.2 | --- |
| 1950 | 244.8 | 41.5 | 6.5 | 4.7 | 64.6 | 4.0 |
| 1955 | 340.0 | 57.7 | 6.9 | 5.6 | 69.9 | 3.7 |
| 1960 | 472.9 | 80.2 | 9.7 | 6.8 | 93.2 | 6.6 |
| 1965 | 589.5 | 100.0 | 2.7 | 7.3 | 100.0 | -0.1 |
| 1966 | 619.6 | 105.1 | 5.1 | 7.5 | 102.7 | 2.2 |
| 1967 | 649.2 | 110.1 | 4.8 | 7.6 | 104.1 | 1.8 |
| 1968 | 704.3 | 119.4 | 8.4 | 8.1 | 111.0 | 6.3 |
| 1969 | 773.6 | 130.1 | 9.8 | 8.6 | 117.8 | 6.3 |
| 1970 | 847.2 | 142.5 | 9.5 | 9.1 | 124.7 | 5.4 |
| 1971* | 942.9 | 158.6 | 11.3 | 9.9 | 134.2 | 8.2 |
| 1972* | 1,040.0 | 175.1 | 10.4 | --- | --- | --- |

*Estimated.

Source: A economia brasileira e suas perspectivas, PBE-APECAO 73 (Rio de Janeiro: APEC Editora, 1973), p. 15.

TABLE 2.--Real Product Index by Sectors; Selected Years, 1947-1972.

| | Agriculture | Industry | Commerce | Transp. and Communic. | Services | Total Product |
|---|---|---|---|---|---|---|
| 1947 | 43.4 | 26.0 | 41.2 | 25.4 | 34.6 | 34.0 |
| 1950 | 59.2 | 35.6 | 48.3 | 35.2 | 41.6 | 41.5 |
| 1955 | 62.9 | 51.9 | 62.2 | 51.8 | 53.2 | 59.[illegible] |
| 1960 | 75.7 | 83.5 | 85.9 | 80.1 | 81.3 | |
| 1965 | 100.00 | 100.0 | 100.00 | 100.00 | 100.00 | |
| 1966 | 96.8 | 111.7 | 107.7 | 106.6 | 103.5 | |
| 1967 | 102.3 | 115.0 | 112.4 | 114.9 | 10[illegible] | |
| 1968 | 103.7 | 132.8 | 125.5 | 125.1 | | [illegible] |
| 1969 | 109.9 | 147.1 | 136.6 | 139.7 | | [illegible] |
| 1970 | 116.1 | 163.5 | 148.8 | 160.5 | | [illegible] |
| 1971* | 129.3 | 181.8 | 168.1 | 170 | | [illegible] |
| 1972* | 135.8 | 209.1 | --- | [illegible] | | [illegible] |

*Estimated.

Source: A economia brasileira e suas perspectivas, [illegible] APEC Editôra, 1973), p. 74.

The State of São Paulo is by far the leading industrial center in Brazil. In 1949, 49 percent of all Brazilian industrial manufacturing originated there. Ten years later in 1959, São Paulo's share had increased to over 55 percent.[1] The Department of Statistics (Departamento de Estatística) for the State of São Paulo estimates that in 1967, São Paulo accounted for over 57 percent of all Brazilian manufacturing production.[2] It is generally assumed, though data are not available, that this trend is continuing. São Paulo's share of a rapidly expanding industrial product is also increasing.

The 1970 census (Censo Demográfico-Brasil) reported the total population of Brazil in 1970 as more than 93 million.[3] Approximately 66 million (71 percent) were ten years old or older. Of these 66 million, only 30 million (46 percent) were economically active, and of those economically active, 5.3 million (17.6 percent) were working in the industrial sector.[4] The National Department of Labor (Departamento Nacional de Mão-de-Obra) estimates that in 1970 over 51 percent of all Brazilian industrial employees were working in the State of São Paulo.[5] The data clearly indicate that São Paulo is the dominant and most dynamic industrial center in Brazil. SENAI estimates that in 1972 there were more than 1.5 million individuals employed in São Paulo's industrial sector (see Table 3).

TABLE 3.--Industrial Workers in the State of São Paulo, 1972.

| | Number | Percentage |
|---|---|---|
| Unskilled | 175,541 | 11.56 |
| Semi-skilled | 794,530 | 52.33 |
| Skilled | 266,913 | 17.58 |
| Foreman, etc. | 23,466 | 1.55 |
| Technicians | 18,820 | 1.24 |
| Engineers | 7,502 | .49 |
| Other | 237,633 | 15.65 |
| Total | 1,518,405 | 100.00 |

Source: Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Regional de São Paulo, "Levantamento Industrial 1972." Unpublished Internal Document.

Over 17.5 percent were classified as skilled industrial workers. According to the SENAI definition:

> A skilled industrial worker is a worker capable of performing all the operations required in a skilled industrial occupation. His work is varied and not subject to automation. A relatively long training period (3,000-4,000 hours) is required to develop the necessary skills. Two types of training are possible (1) for a 'new' worker apprenticeship training, or (2) for a semi-skilled worker rapid training courses. Knowledge of the technical aspects of the occupation is required.[6]

Time series data on the number of skilled industrial workers in the State of São Paulo are not available, but a good proxy is. SENAI has kept records on the number of "qualified" (qualificados) industrial workers in the state since 1946. The qualified category contains, in addition to skilled industrial workers, foremen, technicians, and engineers. In 1972, 20.9 percent of São Paulo's industrial workers were classified as

qualified. Within the qualified category, 84.3 percent were skilled industrial workers. The development of the industrial labor force in São Paulo since 1946 is illustrated in Table 4.

Since 1946, the number of industrial employees in the State of São Paulo has increased by over 274 percent. The number of qualified industrial workers has increased by at least 280 percent, and perhaps by as much as 350 percent.[7] The rapid development of the industrial sector in São Paulo has been "matched" by an impressive increase in the quantity of skilled industrial labor. The failure to develop skilled labor at these high rates would surely have resulted in significantly lower rates of industrial expansion. In the following sections, some of the major sources of industrial training are identified and briefly discussed.

The formal school system--There are four basic levels in the Brazilian formal school system:[8]

1. Primary School (primário)--4 years
2. Middle School (ginásio)--3 or 4 years
3. High School (colégio)--3 or 4 years
4. University (superior)--3 or 6 years

In 1970, approximately one-third of all Brazilian children between the ages of 7 (the legal age for starting primary school) and 14 were not enrolled in any formal school program.[9] For those who do begin the first year of primary school, the prospects for completing the required four-year program are not very good (see Table 5). Less than 27 percent of those who begin primary school graduate. Of those who do graduate from primary school, less than 36 percent begin a middle school program. This pattern is repeated at

TABLE 4.--Industrial Workers in the State of São Paulo; Selected Years, 1946-1972.

| Year | All Industrial Workers (000) | Qualified Industrial Workers (000) | Year | All Industrial Workers (000) | Qualified Industrial Workers (000) |
|---|---|---|---|---|---|
| 1946 | 552.5 | 109.8 | 1966 | 1,209.6 | 232.9 |
| 1950 | 672.9 | 196.7 | 1967 | 1,212.5 | 236.3 |
| 1955 | 856.5 | 209.0 | 1968 | 1,256.4 | 245.8 |
| 1955* | 856.5 | 168.3 | 1969 | 1,331.8 | 266.9 |
| 1960 | 969.1 | 194.3 | 1970 | 1,391.6 | 280.9 |
| 1965 | 1,187.7 | 227.9 | 1971 | 1,449.4 | 293.9 |
| | | | 1972 | 1,518.4 | 310.7 |

*In 1955 the definition of qualified was changed and a new series was initiated. Sufficient information was not available to make the pre-1955 and post-1955 series comparable.

Source: Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Regional de São Paulo, Relatório 1946--Relatório 1972 (São Paulo: SENAI/SP, 1946-1972).

TABLE 5.--Hypothetical Experience of 10,000 Students Who Began Primary School.

| Step | Enrollment | Percentage Loss from Preceding Step | Percentage Loss Accumulated |
|---|---|---|---|
| Beginning primary school | 10,000 | --- | --- |
| Completing primary school | 2,673 | 73.27 | 73.27 |
| Beginning middle school[a] | 952 | 64.39 | 90.48 |
| Completing middle school | 400 | 57.99 | 96.00 |
| Completing senior high[b] | 188 | 53.00 | 98.12 |
| Beginning university[c] | 76 | 59.58 | 99.24 |
| Completing university | 34 | 55.27 | 99.66 |

[a]ginásio

[b]colégio

[c]superior

Source: John M. Hunter, Economic Aspects of Higher Education in Brazil, Monograph No. 5, Latin American Studies Center, Michigan State University, p. 24.

all levels. Only 4 percent of those who start in the formal school system graduate from middle school. Less than .5 percent graduate from a university.

To help overcome this problem the government has instituted special equivalency examinations at both the middle and high school levels, giving adults who have dropped out of the formal school system an opportunity to further their educations. Both television and radio are used to aid individuals with their self-study programs. The United States Agency for International Development (AID) reports that very little data on the number of individuals preparing for the exams or on the number who have passed the exams are available.[10] AID does report, however, that in the State of São Paulo over 85,000 individuals presented themselves for the exams in 1970. The certificate granted upon passing the exam is recognized as a legal equivalent to the regular, formal school diploma. One notable effect has been increased pressure on the universities.

In 1970, there were over 17.3 million students enrolled in the Brazilian formal school system: 74.0 percent in primary school, 17.8 percent in middle school, 5.8 percent in high school, and 2.4 percent in universities.[11]

Almost 4 percent of all Brazilian secondary students (both the middle and high school levels) were enrolled in industrial vocational programs in 1971 (see Table 6). Over 43 percent of these industrial students were in the State of São Paulo.

Publicly financed industrial training in the State of São Paulo has a long history.[12] Prior to the 1900's the government generally felt that industrial training was only

TABLE 6.--Students Enrolled in Brazilian Secondary Educational Programs, 1971.

| Type | Enrollment | % of Total | Enrollment | % of Total | Enrollment | % of Total |
|---|---|---|---|---|---|---|
| Academic | 2,914,745 | 84.66 | 549,343 | 49.07 | 3,464,088 | 75.93 |
| Commercial | 233,174 | 6.77 | 244,770 | 21.86 | 477,944 | 10.48 |
| Normal | 51,753 | 1.51 | 248,798 | 22.23 | 300,551 | 6.59 |
| Industrial | 116,111 | 3.38 | 64,550 | 5.77 | 180,661 | 3.96 |
| Agricultural | 11,143 | .32 | 9,565 | .85 | 20,708 | .45 |
| Others: Art | 1,166 | .03 | 223 | .02 | 1,389 | .03 |
| Home Economics | 2,174 | .06 | 1,626 | .15 | 3,800 | .08 |
| Nursing | 2,590 | .08 | 546 | .05 | 3,136 | .07 |
| "Work Oriented Ginásios" | 109,849 | 3.19 | --- | --- | 109,849 | 2.41 |
| Total | 3,442,705 | 100.00 | 1,119,421 | 100.00 | 4,562,126 | 100.00 |

Source: USAID/Brazil, Human Resources Office, Brazil-Education Sector Analysis (Rio de Janeiro: Human Resources Office, November, 1972), p. 44.

appropriate for "(. . .) the poor (. . .) orphans, the miserable (. . .) the abandoned, the blind, the deaf and dumb."[13] This view changed slowly, and it was not until the pressures of a growing industrial sector were felt that the government actively entered the area of industrial training. The pressures developed rapidly. In 1907 there were only 314 industrial establishments in São Paulo, by 1912 there were 3,321. During this period São Paulo's share of the Brazilian total jumped from 10.5 percent to 35 percent.

The federal government was the first to respond to the need by establishing an industrial training school in 1910. The state established two schools in 1911 and two more in 1913. Until 1919 academic classes were not taught in the state schools. When they were introduced, "the reaction against the introduction of general cultural courses into the teaching of industrial skills was very strong."[14] The pressures of industrialization slowly overcame the traditional views and by 1931 there were nine state-sponsored industrial training schools. In 1936 the number was 28, and by 1940 the number had grown to 42.

> (. . .) industrial education in São Paulo progressed! It passed the phase of indifference and almost hostility on the part of the people. In 1940, all realized its advantages and applauded enthusiastically whatever new attempt to increase its realization (. . .) in 1911, 2 schools with 435 students (. . .) in 1940, 42 schools with 11,503 students.[15]

In 1942, there were two important laws passed which changed the character of Brazilian industrial education. The first was the Organic Law of Industrial Education (Lei Orgânica do Ensino Industrial) which legally recognized

industrial education as part of the formal school system. The second was the law which created the SENAI industrial training system. Industrial training within the formal school system still exists today. The peak of its importance, however, was in the early 1940's. Although there are no reliable time series data available, the relative importance of the formal school system in the preparation of skilled industrial labor has clearly declined.

The SENAI system--The SENAI industrial apprenticeship and training system was established by an act of the federal government (Decreto-Lei No. 4048) in January, 1942. It was created in response to the demands of industry for more and better trained qualified industrial workers. The objectives of SENAI are:[16]

1. To realize in schools installed and maintained by SENAI or in cooperation with industry, a system of industrial apprenticeship for youth between the ages of 14 and 18.

2. To assist firms in the elaboration and execution of general programs of training for workers at various skill levels, and to assist in the realization of apprenticeship programs within firms.

3. To give workers over 18 years of age the opportunity to complete their professional development in short courses given either in SENAI schools or in the firms where they are employed.

4. To give study scholarships for the purpose of upgrading to both SENAI personnel and to individuals employed in industry.

5. To cooperate in the development of technical research of interest to industry.

SENAI's initial efforts were mainly concentrated in the development of apprenticeship courses. Over time the range

of SENAI training has increased to the present variety of courses:[17]

1. Apprenticeship--These courses are for youth ages 14 to 18 who are either presently employed in industry or who are potential employees. By law, each industrial firm in Brazil must employ and enroll in SENAI schools the number of apprentices equivalent to 5 to 15 percent of its total skilled workers. (In practice this does not occur--the number enrolled in SENAI schools depends on SENAI's capacity.) A complete four-year primary education and entrance tests (general education and aptitude) are required to enter the program. The courses take between 1,600 and 3,000 hours and have a duration of between 18 and 36 months. Training is offered in over 40 occupational areas.

2. Industrial Preparation--Intended for those over 16 years old who do not have the qualifications for a skilled job. The courses are divided in three blocks of approximately 180 hours each. Most courses are offered at night.

3. Upgrading--Intended for individuals who are already working at the skilled level but who want to improve and update their technical skills and theoretical knowledge. The duration of the courses varies.

4. Specialization--Intended for individuals who are already working at the skilled level but who wish to specialize in a specific area within their field. The duration of the courses varies.

5. Technical--Intended for individuals with a complete middle school education who want to work at levels between the skilled workers and the engineer. Course generally takes over 1,200 hours.

6. Technical Assistant--Intended for individuals who wish to assist technicians. The course duration is approximately 300 hours.

7. Other--Many other types of training courses are also provided in response to industries' needs. Content and duration depend on the need.

SENAI is a national organization, subdivided into 19 administrative regions. There is a National Council controlled by the National Confederation of Industry (Confederação Nacional da Indústria) and a regional council, for each administrative region, which is controlled by the corresponding State Federation of Industries (Federação das Indústrias). Representatives of the Ministry of Education (Ministério da Educação) and the Ministry of Labor (Ministério do Trabalho) are part of the National Council. Every council has a department under its direction charged with implementing the policies adopted. Each region has a great deal of autonomy in establishing and directing its own programs.

The SENAI system is financed by a compulsory 1 percent tax on the payrolls of all Brazilian industrial establishments. The tax is collected through the National Social Security System (Instituto Nacional de Previdência Social) and is channeled to the National Department and dispensed as follows:

85 percent is returned to the state where it was collected

5 percent goes to the National Department

4 percent is used to assist less developed regions

4 percent goes to the north and northeast regions of the country

2 percent goes to the National Confederation of Industry

In addition to the regular 1 percent tax, firms having more than 500 employees are taxed an additional .2 percent which is collected by each regional department of SENAI and transferred directly to the National Department. Over US$34 million was collected by SENAI in 1971.

Because the State of São Paulo has the highest concentration of industry, the Regional Department of SENAI in São Paulo (Departamento Regional de São Paulo) is the largest in the country. In 1972, SENAI owned and operated 135 industrial training centers throughout Brazil.[18] Of these, 47 (34.8 percent) were in the State of São Paulo. Also in 1972, SENAI supervised 100 training centers which were owned and operated by large industrial firms. Twenty of the centers were located in the State of São Paulo. São Paulo's share of individuals enrolled in the various SENAI programs is even greater. The total for all Brazil in 1972 was 237,126; São Paulo has enrolled 114,484 (48.3 percent).

SENAI of São Paulo began operation in 1943, graduating 554 adults from its rapid training and upgrading courses (see Table 7). In 1972, 57,372 adults were graduated. The first class of apprenticeship trainees was graduated in 1943 and contained 176 individuals. The 1972 apprenticeship class contained 6,089 individuals. In its early years, SENAI owned no schools and "borrowed" the facilities of the public school system. Over the past 30 years the growth of the SENAI system has been impressive.

Other sources of industrial training--Private industrial training schools have existed for many decades in São Paulo. No study has been published on the origin and history of these schools, and data on their outputs are not collected by any central agency. All private schools which offer training (industrial or other) are required to register with the State Department of Technical Education (Departamento do Ensino Professional) in São Paulo. However, schools are not classified in the department's records by the type of training

TABLE 7.--Training Certificates Awarded by SENAI of São Paulo: Selected Years, 1943-1972.

| | Minors | Adults | | | | Minors Plus Adults (Total) | SENAI Schools in Firms (Total) | Grand Total |
|---|---|---|---|---|---|---|---|---|
| | Apprenticeship (Total) | Rapid Training | Up-Grading of Skills | Other | Total | | | |
| 1943 | --- | 323 | 211 | 20 | 544 | 544 | --- | 544 |
| 1944 | 176 | 456 | 344 | 114 | 946 | 1,122 | --- | 1,122 |
| 1945 | 421 | 621 | 365 | 186 | 1,172 | 1,593 | --- | 1,593 |
| 1950 | 1,376 | 817 | 290 | 298 | 1,405 | 2,781 | --- | 2,781 |
| 1955 | 2,489 | 626 | 72 | 651 | 1,349 | 3,838 | --- | 3,838 |
| 1960 | 2,486 | 1,041 | 307 | 1,927 | 3,275 | 5,761 | --- | 5,761 |
| 1965 | 3,307 | 5,[illegible]94 | 1,445 | 1,932 | 8,981 | [illegible] | --- | [illegible] |
| 1970 | 5,235 | 10,189 | 5,006 | 23,720 | 38,915 | 44,153 | 12,896 | 57,[illegible] |
| 1971 | 5,050 | 11,8[illegible] | 5 044 | 30,767 | 47,685 | 53,735 | 27,214 | 8[illegible],549 |
| 1972 | 6,089 | 15,707 | 4,037 | 38,128 | 57,372 | 63,461 | 22,440 | 85,901 |
| Total | 73,554 | 96,455 | 28,308 | 132,515 | 257,478 | 331,032 | 78,576 | 409,606 |

Source: Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Regional de São Paulo, Relatórios 1972 (São Paulo: SENAI/SP, 1972).

they provide, nor are data collected on the number of students enrolled or graduated. All that is known is that a large system of tuition-charging, profit-oriented private industrial training exists and that it has made some contribution to the development of skilled industrial manpower.

Other sources of industrial training are (1) the industrial firms themselves, (2) religious organizations, (3) trade organizations, and (4) correspondence courses. There are no data available on any of these, and it is quite possible that other "unknown" sources of training also exist.

## THE IMPORTANCE OF THE STUDY

As Myint has noted in The Economics of Developing Countries:

> It is increasingly recognized that many underdeveloped countries are held back by (. . .) a shortage of skills and knowledge (. . .) attention has shifted from capital to education (. . .) to investment in human capital.[19]

The importance of education, and particularly industrial education, has long been appreciated in São Paulo. The high rates of industrial expansion which have been noted would not have been possible without large investments in the development of skilled labor. For the past 30 years, at least 1 percent of all industrial wages and salaries paid in São Paulo have been channeled to SENAI for the purpose of developing skilled industrial workers. The magnitude of other investments for similar purposes is not known.

São Paulo's industrial expansion is impressive as an example of highly successful rapid industrial development. Much can be learned from the means by which this was accomplished, in particular by the study of the development of the necessary skilled industrial manpower. New educational laws presently being implemented in São Paulo were developed without complete knowledge of either the past or the present system of industrial skill development. Other parts of Brazil, as well as other countries, are presently in the stage of industrial development that São Paulo was in 30 or 40 years ago. Many of the problems they will encounter as they

industrialize will probably be the same problems that were solved in São Paulo many years ago.

A major problem is the lack of knowledge regarding the solution of manpower problems in São Paulo. The SENAI program is the only part of the industrial training system that is well known. The contribution of SENAI, or any other source of industrial training, cannot be evaluated without knowledge of the total skill development system. One objective of this study is to provide this type of information.

## THE MODEL

The general model used in the study is represented in Figure 1. At the highest level of abstraction the model contains three basic elements: the conditions at birth, learning which takes place over time, and the present situation. The conditions at birth are represented by the block labeled initial conditions. Learning is represented by the three blocks labeled formal education, work experience and training. The positions of these three blocks is not intended to suggest ordering in time or that the different types of learning take place during separate periods of time. The present situation is represented by the two blocks present work situation and present work situation control. The model suggests that: (1) the initial conditions (when, where, and to whom an individual is born) may influence not only the present work situation of the individual (occupation and pay received) but also the type and duration of his learning experiences (formal education, work experience, and training); (2) the combination of both factors, initial conditions and learning experiences, may influence the present work situation; and (3) other factors not related to initial conditions and learning may also influence the present work situation--these other factors are represented by the block labeled present work situation control.

The model contains six blocks of variables and serves three purposes: first, it is used to identify factors which may be important in the development of skilled industrial

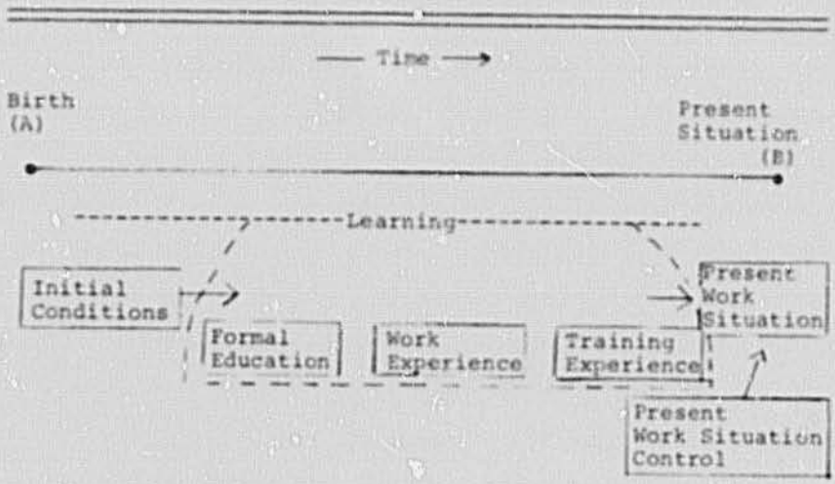


Figure 1.--The General Model.

workers; second, it facilitates the organization of relevant information to describe meaningfully what has happened in the Brazilian case; and third, it allows for the analysis of different types of learning to determine if some have had more favorable results than others.

Initial conditions--It is reasonable to assume that the situation in which an individual is born (when, where, and to whom) would have an influence on: (1) the occupations known to him; (2) what occupations are considered as acceptable; and (3) what occupations are actually attainable.

An occupation that is not known to exist cannot be an occupational goal. For example, individuals born in backward areas to uneducated parents may not even know that a particular skilled industrial occupation exists. Such an occupation, thus, lies outside of the set of occupations defined by the individual's or his parents knowledge. In some cases an occupation may be known and yet it may not be an acceptable occupational goal.

The son of a doctor living in the Greater São Paulo area would almost certainly know that skilled industrial occupations exist. However, due to the high socio-economic position of the father, this probably would not be an acceptable occupacion for the son. In some cases an occupation is both known and acceptable, but it is not attainable. Again, an individual born in a backward area of uneducated parents may know that skilled industrial occupations exist and regard such an occupation as acceptable. Yet, if some form of education is required, and if the costs associated are judged to be too high, the occupation is not attainable.

Even when an occupation falls within the sets of what is known, what is acceptable, and what is attainable, the particular path taken toward the realization of the occupational goal may be influenced by the resources at the disposal of the individual and his family. An individual with few resources, might become a skilled industrial worker through work experience only, while an individual with greater resources might pay for a special industrial training course.

It is possible that the initial conditions of the individual may influence the occupational goal chosen and the path taken toward the realization of that goal. Consequently, the following variables are entered in the initial conditions block:

1. age
2. place of birth
3. place of primary education

4. educational levels of parents
5. occupational area of father
6. occupational level of father

Formal education--Generally, an individual learns to read and write, acquires the knowledge of basic science, and learns the basic use of mathematical tools in the formal school system. As the individual moves through the higher levels of the system the objectives and the specific content of learning change. The lower levels may be viewed as foundation building for the higher levels. Entry into skilled industrial occupations may require some critical minimum of formal education. On the other hand, there may be a point beyond which more formal education is not required for the satisfactory performance of the tasks of a skilled industrial worker. There also may be a strong relationship between the level of formal education and what is viewed as an acceptable occupation. Probably few high school graduates work in blue collar positions in Brazil. On the other hand, more formal education might facilitate specific skill development. In sum, formal education may be important in the development of skilled industrial labor, so the following variables are entered in the formal education block:

1. age started school
2. highest grade completed
3. program of highest grade completed
4. age when highest grade completed

Work experience--Through informal demonstration, imitation, and experimentation an individual may learn by simply working in any occupational area. The importance or relevance of

what was learned depends on the final occupational objective, i.e., the skilled industrial occupation in which the individual is eventually employed. Three factors should be considered: (1) the relationship of the work experience to the eventual skilled industrial occupation; (2) the duration of the experience; and (3) the time sequence of all different work experiences.

There are four points in the individual's work history which are well defined:

1. the first job ever (the beginning of the work history)
2. the first job in the occupational area of the present occupation (generally less than skilled)
3. the first job as skilled in the present occupation
4. the present job (all individuals in this study are presently working as skilled industrial workers)

In some cases two or more points may coincide, but, in the general case the four points are distinctly separated by time. Any given work experience can be related to the present skilled occupation using the following scale:

1. in the area of the present occupation
2. related to the present occupation
3. some other industrial occupation
4. agricultural occupation
5. other (neither industrial nor agricultural)

Given that the four points can be established and fixed in time, and given knowledge of the time sequence of all work experiences between these points, it is possible, using the relevance scale, to construct the following variables which are entered into the work experience block:

1. age at time of: (a) first job ever; (b) first job in area of present occupation; and (c) first job as skilled in present occupation
2. position on relevance scale for first job ever
3. entry level (learning, semi-skilled, or skilled) into area of present occupation
4. relevance and duration of work experience between: (a) first job ever and first job in area of present occupation; (b) first job in area of present occupation and first job as skilled; and (c) first job as skilled and present job as skilled

Training--Training is defined as job-oriented learning which takes place under various forms of sponsorship, for various periods of time, but is oriented toward a specific occupation. It differs from work experience (learning by doing on the job) because it generally has some type of defined structure. That is, it is scheduled for a certain number of hours during a certain period of time, and generally both classroom instruction and supervised shop work are included. In the Brazilian context, training is represented by the many and varied types of courses available from a wide range of sources. The SENAI apprenticeship programs are an excellent example of the type of long-term training available. Shorter-term industrial training courses are offered by various public and private entities, as well as by SENAI.

A wide range of courses is available from a great variety of sources, but no central clearing house for information on these courses exists. SENAI keeps its own records, and although private schools generally are registered

with the state government, no records are kept on the number of individuals who have taken private school courses. Courses given by the factories are recorded only by the factories themselves. Even in the case of the courses given through the public school system, no time series data are available. In short, a training system exists, but there is no way to estimate its total magnitude or to place its components in perspective.

Training courses may be extremely important to the development of skilled industrial labor, and the following variables are entered in the training block:

1. number of courses taken
2. for each course:
   a. sponsor
   b. occupational area
   c. content (classroom/shop)
   d. total hours planned
   e. duration in months
   f. percentage of courses completed
   g. year course started
   h. geographic location

Present work situation--Two factors in the individual's present work situation are of interest:

1. what is actually done on the job
2. the pay received

Within limits determined by the occupation, differences among individual workers are expected. Specifically, some individuals may do more varied types of work, some may do more difficult work, and these differences may be reflected in labor market prices.

With respect to what is done on the job previous research by SENAI can be used. Some of the most interesting and useful products of this research are the analytical tables (quadros analíticos) of tasks and operations that are generally associated with specific skilled industrial occupations.[20] In the analytical table a task is defined as the turning out of some specific intermediate product (e.g. a gear) in the firms' productive process. The completion of a task requires one or more distinct, physical operations. As the complexity of the task increases, the number and complexity of the required operations also increase. The specific operations associated with an occupation are finite in number and arranged in order of increasing difficulty. Using the operations table as a bases, two types of information can be developed. First, the number of specific operations performed on the job can be established, and second, an index reflecting the degree of difficulty can be constructed.

Given what is done on the job, it is assumed that, other things equal, differences in the quality of work are reflected in differences in the market valuation of the individual's work. Gross monthly earnings adjusted for hours of work is used as a measure of market valuation.

In sum, the present work situation block contains three variables:

1. number of operations performed
2. an index of the difficulty of operations performed
3. pay rate

Present work situation control--It is possible that factors not related to initial conditions or learning (formal education, work experience, and training) may influence the present work situation, i.e., what is done on the job and the pay received. The type of final product produced by the firm can influence the types of operations performed on the job. SENAI has developed and uses an industrial classification system for firms based on the type of final product. Using this code it is possible to introduce into the model variables which control for differences in the present work situation which are caused by differences in the final product.

Somewhat related are differences in factory size. Individuals working in small job shops which concentrate on specialized, small-scale contract work might be expected to perform different operations than individuals working in large establishments employing mass production techniques. Even within the larger factories, variations might be expected between individuals working in production and others working in maintenance. Differences in the specific type of machine used might also be expected to lead to differences in operations performed.

Given that these factors might be expected to influence the number and types of operations performed, four specific variables are placed in the present work situation control block:

1. factory industrial group
2. factory size
3. sector of work in factory
4. type of machine used

In addition to the number and types of operations performed, wage rates may be influenced by the occupational level at which an individual was first employed in the factory and by the number of years that he has been employed. For example, an individual who entered a factory at the apprentice level and worked his way up to the skilled level without ever entering the outside labor market might, because of his lack of labor market knowledge, offer his services to the factory at a relatively low rate. Other things equal, however, a positive correlation between the wage rate and the number of years of service might be expected. Accordingly, two more variables are added to the block:

5. factory entry level
6. number of years working in the factory

Summary of model--The general model developed has six major blocks of variables. Variable blocks and the specific variables within each block are reviewed below:

I. present work situation (PWS)

1. gross hourly earnings
2. number of operations performed
3. index of the difficulty of operations performed

II. present work situation control (PWSC)

1. size of factory
2. industrial group of factory
3. sector of factory
4. type of machine used
5. factory entry level
6. years working in factory

III. initial conditions (IC)

1. age
2. place of birth
3. place of primary education

4. educational level of parents
5. occupational area of father
6. occupational status of father

IV. formal education (FED)

1. age
   a. started school
   b. finished school
2. highest grade completed
3. program of highest grade completed

V. work experience (WEX)

1. age
   a. first job
   b. first job in present occupational area
   c. first job as skilled in present occupational area
2. occupational area of first job
3. entry level in area of present occupation
4. work experience
   a. after first job, but before entry into present occupational area
   b. after entry into present occupational area, but before reaching the skilled level
   c. after reaching the skilled level

VI. training (TR)

1. number of courses taken
2. for each course taken
   a. occupational area
   b. sponsor
   c. total hours completed
   d. duration of course in months
   e. age course began

The specific variables used in each block, and their associated codes, vary with the type of analysis being conducted. The analysis is conducted at two levels. First, the model is used to organize and describe relevant information. Second, the model serves as a basis for the development of several regression models. The most comprehensive regression model has the general forms (PWS) = f (PWSC, IC, FED, WEX, TR).

The regression analysis is used to determine (1) which blocks of variables, and (2) which specific variables are

significant in explaining variations in the present work situation.

## RESTRICTIONS AND METHODOLOGY

Because of time and other resource constraints the study was restricted to one important skilled industrial occupation, metal lathe setter-operators (torneiros mecânicos). This occupation is coded 8-33.20 in the 1968 edition of the International Standard Classification of Occupations. The occupational description is:

> 8-33.20 Lathe Setter-Operator.
>
> Sets up and operates a power-driven metalworking lathe:
>
> examines drawings and specifications of part to be made; fastens metal and tools in position on lathe using chucks, jigs and other fixtures as required; adjusts guides and stops; sets rotation speed of metal and starts machine; manipulates hand wheels, or sets and starts automatic controls, to guide cutting tool into or along metal; controls flow of lubricant on edges of tools; checks progress of cutting with measuring instruments and makes necessary adjustments to machine setting.
>
> May specialise in a particular type of lathe and be designated accordingly.[21]

The occupation of skilled lathe setter-operator was chosen because it is basic to the production of modern machines and machine parts. According to the 1970 Demographic Census, 19 of every 1,000 workers in São Paulo's industrial sector were employed in the area of lathe operation.[22] Since 1956, SENAI of São Paulo has trained 9,225 lathe setter-operators through its apprenticeship program. This represents 18.5 percent of all industrial apprentices trained by SENAI since 1956.[23]

The study was also restricted to the three highly industrialized counties of Santo André, São Bernardo do Campo, and São Caetano do Sul, commonly known as the "ABC" area of Greater São Paulo. The ABC area is slightly more than 600 square kilometers, yet in 1967 it accounted for approximately 10.8 percent of the total value of Brazilian manufacturing production.[24] SENAI of São Paulo estimates that in 1972 approximately 12.7 percent of the qualified industrial workers in the state were employed in these three counties.[25]

Finally the study was restricted to the machinery industrial sub-group. Metal lathe setter-operators can be found in all types of industrial establishments. Wherever there are machines to be repaired and maintained a lathe setter-operator may be employed. However, the highest concentration of lathe setter-operators is in industries which specialize in the production and repair of machines and machine parts. It is in this type of establishment that the lathe setter-operator works in both production and maintenance capacities.

Data was obtained using the "reverse tracer" technique. A sample of lathe setter-operators from the "ABC" area was selected using SENAI industrial census data as a sample frame. Workers were interviewed on the job and detailed information was obtained on their present work situations, origins, and past learning experiences (formal education, work experience, and training).

Interviews were conducted in 74 different firms, and 546 skilled lathe setter-operators were interviewed. Six questionnaires were not usable and discarded. A total of

540 questionnaires were usable and coded for computer analysis.

## THE FINDINGS

In this section the more important simple descriptive findings of the study are presented and discussed. The format of presentation is based on the general model previously developed. Reviewing briefly, the six areas of concern, or blocks of variables, are: (1) present work situation, (2) present work situation control, (3) initial conditions, (4) formal education, (5) work experience, and (6) training. The objective here is to describe and document within sample variation, and where possible, to make comparisons with the total industrial labor force of the state of Sao Paulo. It is important to note that the factors described in this section are used as both dependent (to be explained) and independent (explanatory) variables in the linear regression analysis which is presented in a later section. The four variables in this section for which the observed variation is to be explained are: (1) hourly wage rates, (2) number of operations performed, (3) difficulty of operations performed (all drawn from the present work situation block), and (4) time taken to reach the skilled occupational level (drawn from the work experience block). All other variables are used to explain the observed variation in the four independent variables. The specific explanatory variables in each of the four regression models are discussed later.

TABLE 8.--Gross Monetary Earnings (In Cruzeiros*).

| Monthly | | | Hourly | | |
|---|---|---|---|---|---|
| Cruzeiros | Number | Percentage | Cruzeiros | Number | Percentage |
| Less than 300 | 1 | .18 | Less than 2 | 7 | 1.30 |
| 300 to 599 | 14 | 2.59 | 2 to 2.99 | 20 | 3.70 |
| 600 to 899 | 53 | 9.81 | 3 to 3.99 | 46 | 8.52 |
| 900 to 1,199 | 92 | 17.04 | 4 to 4.99 | 77 | 14.26 |
| 1,200 to 1,499 | 154 | 28.52 | 5 to 5.99 | 119 | 22.04 |
| 1,500 to 1,799 | 114 | 21.11 | 6 to 6.99 | 114 | 21.11 |
| 1,800 to 2,099 | 63 | 11.67 | 7 to 7.99 | 100 | 18.52 |
| 2,100 to 2,399 | 34 | 6.30 | 8 to 8.99 | 46 | 8.52 |
| 2,400 to 2,699 | 12 | 2.22 | 9 to 9.99 | 7 | 1.30 |
| 2,700 or more | 3 | .56 | 10 or more | 3 | .56 |
| Total | 540 | 100.00 | Total | 540 | 100.00 |

*In 1973 U.S. $1.00 equaled approximately Cr$6.30.

## Present Work Situation

Earnings--The gross monthly earnings of the 540 skilled lathe setter-operators studied ranged from a low of Cr$780 to a high of Cr$12,442 (see Table [illegible]). A majority (77 percent) earned between Cr$990 and Cr$1,800. As the occupation studied is generally well defined and the labor market area from which the sample was drawn is small geographically, such large variation in earnings was unexpected. Some of the variation is eliminated by adjusting for hours of work. Even hourly earnings ranged, however, from Cr$1.47 to Cr$11.16 with a mean of Cr$[illegible] and a standard deviation of Cr$1.69. All individuals studied are classified as skilled lathe setter-operators, yet many have earnings three or four times greater than others. One of the major objectives of the study is to explain this phenomenon. At this stage, however, the intent is only to establish that differences in market valuation do exist.

In general the earnings levels of those in the sample with respect to all industrial employees in the State of Sao Paulo were very high. The Departamento Nacional do Trabalho reports that in 1970 only 20.4 percent of all industrial employees earned more than three minimum salaries.[24] The minimum salary is fixed by law and is the minimum amount a full time employee can be paid per month. As the cost of living increases the minimum salary is adjusted. This form of "indexing" permits the comparison of salaries in different years as most salaries in Brazil are expressed as multiples of the minimum salary. The percentage of the sample which earned more than three minimum salaries was approximately 91

percent. At the top end of the earnings scale about 4.1 percent of all industrial employees earned more than eight minimum salaries; no one in the sample had earnings in this class.

Though the large degree of within sample variation in earnings was unexpected, the generally high position in the total income distribution was not. The largest portion of the total industrial labor force consists of unskilled and semi-skilled blue-collar workers, as well as, low and medium level white-collar workers. One would expect these types of workers to be paid relatively less. The small percentage which had earnings in excess of 8 minimum salaries, consists mainly of higher level professionals and administrative personnel. Again, one would expect such high level white collar workers to earn relatively more.

<u>Number and difficulty of operations performed</u>--GTMAI developed and used in the questionnaire a list of 41 different physical operations which skilled lathe-setter operators generally perform on the job. Each worker was instructed to indicate which operations he actually used in his daily work.

The number of different operations performed ranged from 1 to 41, the mean was 33.5, and the associated standard deviation was 4.6. The majority (67.1 percent) performed 30 or more different operations (see Table 9). Over 13.8 percent performed 40 or 41 operations. Only 5.7 percent performed less than 11 operations. There is a relatively high degree of within sample variation in the number of different operations performed. However, there is no exact number of operations performed which separates the specialized

TABLE 9.--Number of 41 Different Operations Performed

| Operations | Individuals | | | Individuals | |
|---|---|---|---|---|---|
| | Number | Percentage | Operations | Number | Percentage |
| Less than 4 | 6 | 1.11 | 25 to 29 | 61 | 11.30 |
| 5 to 9 | 21 | 3.89 | 30 to 34 | 113 | 20.93 |
| 10 to 14 | 20 | 3.70 | 35 to 39 | 164 | 30.37 |
| 15 to 19 | 34 | 6.30 | 40 or 41 | [illegible] | 13.89 |
| 20 to 24 | 46 | 8.52 | | | |
| | | | Total | 540 | 100.01 |

worker from the non-specialized. It is safe to say that most were not highly specialized i.e. most performed a relatively large number of different operations.

As the operations in SFAAI's analytical table were arranged in order of increasing difficulty, it was possible to construct an index which reflected differences in the degree of difficulty of the operation performed on the job. The operations were numbered consecutively from 1 to 41, one corresponding to the least difficult operation and 41 to the most difficult. The number of the most difficult operation performed determined the rank on the difficulty scale. Regardless of differences in the number of operations performed, over 93 percent performed at least one of the four most difficult operations. No one ranked lower than 14 on the scale.

Summary-present work situation--The large variation in the present work situation of the skilled lathe setter-operators was not expected. Particularly unexpected was the large variation in hourly wage rates. Two specific questions

concerning the present work situation are dealt with later; first, what explains the variation in wage rates, and second, what explains the variation in what is done on the job (especially the number of operations performed).

Present Work Situation Control

Factory size--The factories from which the individuals in the sample were drawn ranged in size from small job shops employing 1 or 2 workers to large scale modern enterprises employing well over 2,000 workers. For convenience the factories can be divided into three categories--small (less than 50 employees), medium (50 to 349 employees), and large (350 employees or more). As shown in Table 10, the majority (62 percent) were employed in large factories. Most of the large factories were as modern as any in the world. They produced not only for the domestic market but also for export. The smaller job shops, on the other hand, generally either did repair work for other small-scale businesses, or specialized contract work for larger factories.

Table 10.--Factory Size.

| Size Class | Number of Employees | Individuals in Sample | |
|---|---|---|---|
| | | Number | Percentage |
| Small | Less than 20 | [illegible] | 13.19 |
| | 20 to 49 | 36 | 6.67 |
| Medium | 50 to 99 | 33 | 6.11 |
| | 100 to 349 | 81 | 15.00 |
| Large | 350 to 399 | 67 | 12.41 |
| | More than 1,000 | 268 | 49.63 |
| Total | | 540 | 100.00 |

**Type of lathe used**--Basically three different types of power metal lathes were used; modern, old, and specialized. The modern power lathe is distinguished by an external gearbox which allows almost instantaneous changes in the speed of rotation and movement of the carriage. The old lathe is capable of performing the same basic operations as the modern lathe, however, the external gearbox is missing. Any changes in the speed of rotation or movement of the carriage are accomplished by manually withdrawing one gear and replacing it with another. The final class of specialized lathes included several vertical and hydraulic electric machines. These lathes are used for very specialized work and in some cases require two operators.

The most common type of lathe used was modern (almost 89 percent). Old and specialized lathes account for about 7 and 3 percent, respectively.

It is interesting to note that the modern lathes were not concentrated in the large factories. Using the small, medium, large factory size class scheme previously defined, the respective percentages of modern lathes in each class were 87 percent, 96 percent, and 85 percent. The special lathes, however, were concentrated in the large factories.

**Sector of work**--Over 69 percent of those in the sample were employed in the production sector of their firms. The remaining 31 percent performed maintenance work. Again using the factory size classes of small, medium, and large: the respective percentages working in maintenance were 21 percent, 18 percent, and 28 percent. In the larger factories (over 25 employees), the distinction between maintenance and production work was generally quite clear. In

the smaller factories, however, there was some shifting between sectors. When this was the case, the primary sector of work was indicated.

Entry level and years working in factory--Over 74 percent of the workers in the sample entered their present employment already classified as skilled lathe setter-operators (see Table 11). Of the remaining 114 individuals, 93 entered as lathe operators but at a less than a skilled level, and 21 entered in occupations outside the area of lathe operation. It is rare that an individual is hired in his first job as a skilled worker, thus most of the individuals in the sample were not employed in the factories where they received their first work experience in lathe operation. Over 75 percent of those in the sample have been employed in their present firm less than four full years. Two points are indicated: (1) the labor market for lathe setter-operators is very active and (2) firms tend to place a higher value on lathe setter-operators who have gained work experience in other firms.

Summary--present work situation control--The physical conditions under which the lathe setter-operators worked varied greatly. They worked in different sizes and types of factories, used different types of lathes, and worked in different sectors. Their histories with the firms also varied. They entered at different skill levels and were employed for different periods of time. It is reasonable to assume that such differences would influence both what is done on the job and the pay received.

TABLE 11.--Entry Level and Years Working in Factory.

| Years | Lathe Setter-Operator: Skilled # | Skilled % | Lathe Setter-Operator: Less than Skilled # | Less than Skilled % | Other Occupational Area # | Other Occupational Area % | Total # | Total % |
|---|---|---|---|---|---|---|---|---|
| Less than 1 | 105 | 24.88 | 1 | [illegible] | 1 | 4.[illegible] | 15[illegible] | 19.[illegible] |
| 1 to 3 | 169 | 40.0[illegible] | 24 | 25.41 | 2 | 8.00 | 195 | 36.11 |
| 4 to 6 | 93 | 22.04 | 31 | 33.33 | 6 | 24.00 | 13[illegible] | 24.[illegible] |
| 7 to 9 | 23 | 5.45 | 9 | 9.68 | 3 | 12.0[illegible] | 3[illegible] | 6.30 |
| 10 to 12 | 21 | 4.97 | 14 | 15.05 | 6 | 24.00 | 41 | 7.59 |
| 13 to 15 | 7 | 1.66 | 3 | 3.23 | 3 | 12.00 | 13 | 2.41 |
| 16 or more | 4 | .95 | 13 | 13.9[illegible] | 4 | 16.00 | 2[illegible] | 3.69 |
| Total | 422 | 100.00 | 93 | 100.00 | 25 | 100.00 | 54[illegible] | 100.00 |

Initial Conditions

Age--The mean age for the sample was 3[illegible].7 years. Approximately 87 percent (47[illegible] individuals) were less than 40 years old. Only 5.4 percent (3[illegible] individuals) were less than 20 years old. The total industrial labor force in the State of Sao Paulo has significantly high percentages in both the under 20 (15 percent) and over 40 (13 percent) age classes.[27] The low percentage of individuals in the sample under 20 years of age may be explained by the time it takes to reach the skilled occupational level. On the other hand, the older skilled workers with many years of work experience might be found in supervisory positions and, thus, were not included in the sample. A definitive answer to the second

question is beyond the scope of this study, but the first will be dealt with later.

Place of birth and place of primary education--Over 78 percent of those in the sample were born in the State of Sao Paulo. The comparable figure for all employees (industrial and commercial) is just under 69 percent.[28] It was expected the sample would contain a higher percentage of individuals who were born and educated outside the State of Sao Paulo and immigrated to Sao Paulo due to the lack of job opportunities in their home states. This does not prove to be the case with those who reach the skilled occupational level (see Table 12). Although only 78 percent of those in the sample were born in the State of Sao Paulo, over 87 percent received their primary education there. In fact of those born outside the state, almost 44 percent were educated in Sao Paulo. On the other hand, only four individuals (less than 1 percent of the sample) were born in Sao Paulo and educated elsewhere. It is also interesting that only 197 individuals (36.5 percent) were born in the greater Sao Paulo area, however, 337 individuals (62.4 percent) received their education there. There is little doubt that for many years the greater Sao Paulo area has offered both great educational and employment opportunities to those who have immigrated from the interior of the state, as well as from other states.

TABLE 12.--Place of Birth and Place of Primary Education.

| Birth \ Primary School | Greater São Paulo (city) | Interior of São Paulo (rest of state) | Other State | Other Country | Total |
|---|---|---|---|---|---|
| Greater São Paulo (city) | 197 | | | | 197 |
| Interior of São Paulo (rest of state) | 96 | 127 | 4 | | 227 |
| Other State | 36 | 4 | 55 | | 95 |
| Other Country | 8 | 3 | 1 | 9 | 21 |
| Total | 337 | 134 | 60 | 9 | 540 |

Educational level of parents--Over 61 percent of those in the sample had at least one parent with a complete four-year primary education. For Brazil this is an extremely high figure. According to data published in the 1970 Demographic Census, less than 27 percent of the total population of 30 years of age and older had a complete primary education. The parents of those in the sample would come from this part of the population. On the other hand, approximately 14 percent of the sample had parents who had no formal education. In general, however, the educational levels of the parents must be considered to be relatively high.

Occupation of Father: Area and Level

Over 51 percent of the sample had fathers who had industrial occupations (see Table 13). Less than 18 percent had fathers who worked in agricultural occupations. According to 1970 census results, about 17 percent of the economically active population is employed in the industrial

TABLE 13.--Occupational Area of Father.

| | Individual | |
|---|---|---|
| | Number | Percentage |
| Lathe Operation | 15 | 2.78 |
| Related to lathe operation | 20 | 3.70 |
| Other industrial (not construction) | 172 | 31.85 |
| Construction | 71 | 13.15 |
| Agriculture | 93 | 17.22 |
| Other | 141 | 26.11 |
| Unknown | 28 | 5.19 |
| Total | 540 | 100.00 |

sector. Some 20 or 30 years ago this percentage was certainly less. The data suggest that having a father who worked in an industrial occupation gives an individual a higher probability of becoming an industrial worker. The lowest level of occupational status is associated with unskilled manual workers. Over 63 percent of the sample had fathers who had occupations which ranked above the unskilled level (see Table 14). Further, over 39 percent had fathers at or above the skilled worker level. Few, however, had fathers who were employed in white collar occupations.

Summary-initial conditions--In general the skilled industrial workers studied had relatively high socio-economic starting points. Their parents were well educated in comparison to the general population. Most are second generation industrial

TABLE 14.--Occupational Status of Father.

| Status Scale | Number | Percentage |
|---|---|---|
| 1. White collar and higher | 51 | 9.44 |
| 2. Supervision of manual workers | 36 | 6.67 |
| 3. Skilled worker | 124 | 22.96 |
| 4. Semi-skilled worker | 130 | 24.07 |
| 5. Unskilled worker | 171 | 31.67 |
| Unknown | 28 | 5.19 |
| Total | 540 | 100.00 |

workers (only 17 percent have fathers who worked in the agricultural sector). Also, most had fathers who worked at least at the semi-skilled level.

Formal Education

In the total sample of 540, only 32 individuals (5.9 percent) did not have at least a complete four-year primary education (see Table 15). A majority (59.6 percent) had completed, but not studied beyond the primary level. Of those who did have some secondary education, 66.7 percent were enrolled in standard academic programs, and 6.4 percent were enrolled in job-oriented business or commercial programs. The remaining 26.9 percent (50 individuals) were enrolled in industrial middle and high school programs. In the total sample 9.3 percent received industrial training within the formal school system.

When compared to all employees (industrial and commercial) in the State of São Paulo, the sample differs in two respects (see Table 16). First, the sample has a

TABLE 15.--Formal Education, Grade and Program.

| Highest Grade Completed | Primary | Secondary | | | Number | Percentage |
|---|---|---|---|---|---|---|
| | | Academic | Industrial | Commercial | | |
| 1. | 1 | | | | 1 | .19 |
| 2. | 5 | | | | 5 | .93 |
| 3. | 26 | | | | 26 | 4.81 |
| 4. | 322 | | | | 322 | 59.63 |
| 5. | | 54 | 4 | 3 | 60 | 11.11 |
| 6. | | 25 | 8 | 4 | 37 | 6.85 |
| 7. | | 24 | 13 | 2 | 39 | 7.22 |
| 8. | | 13 | 18 | 1 | 32 | 5.93 |
| 9. | | 2 | 3 | 1 | 6 | 1.11 |
| 10. | | 4 | 4 | 0 | 8 | 1.48 |
| 11. | | 3 | 0 | 0 | 3 | .56 |
| 12. | | | 0 | 1 | 1 | .19 |
| Total | 354 | 124 | 50 | 12 | 540 | |
| Percentage | 65.56 | 22.96 | 9.26 | 2.22 | | 100.00 |

TABLE 16.--Formal Education Levels.

| | Sample | | All Employees (State of São Paulo-1970) | |
|---|---|---|---|---|
| | Number | Percentage | Number* (Thousands) | Percentage |
| No formal education | --- | --- | 25.8 | 1.4 |
| Primary School | | | | |
| Incomplete | 32 | 5.92 | 295.3 | 16.0 |
| Complete | 322 | 59.63 | 954.1 | 51.7 |
| Middle School | | | | |
| Incomplete | 123 | 22.97 | 208.5 | 11.3 |
| Complete | 45 | 8.33 | 118.1 | 6.4 |
| High School | | | | |
| Incomplete | 14 | 2.59 | 66.4 | 3.6 |
| Complete | 4 | .74 | 108.9 | 5.1 |
| University | 0 | 0.00 | 68.3 | 3.7 |
| Total | 540 | 100.00 | 1,845.4 | 100.00 |

*Estimated.

Source: Data for all employees is from: Brazil, Ministério do Trabalho e Previdência Social, Departamento Nacional de Mão de Obra, Composição e distribuição de mão de obra--São Paulo (Rio de Janeiro: Departamento Nacional de Mão de Obra, 1972), p. 92.

lower percentage of individuals with less than a complete primary education. In the general labor force there are many individuals who work at the un-skilled level. It is expected that a large percentage of such individuals would not have a complete primary education. Second, the general labor force has a higher percentage of individuals with more than a complete middle school education. If the individuals in the sample had such high levels of formal education, they probably would be working in white collar occupations and not as skilled blue collar workers.

Only 37 percent of the sample completed their formal educations in the "normal" time of one calendar year for each grade. About 39 percent took one or two extra years, while over 24 percent took three or four. Thirty-seven (about 7 percent) actually took more than five extra years. Regardless of the highest grade completed, the pattern was the same. Few completed their formal educations in the "normal" time. This problem, generally called "evasion," is not uncommon and has troubled educational planners in Brazil for many years. It was not possible, due to the nature of the questionnaire used, to separate those individuals who were not passed at various levels from those who simply dropped out of school and then later returned. It is known, however, that about 24 percent finished their formal educations after they had already taken regular, full-time employment.

As noted, a special program (madureza) has offered adults the opportunity to complete a four-year academic middle school program or three-year high school program

in one year. Based on the effort expended to obtain a regular formal school degree, it was expected that many in the sample would have completed such special programs or be in the process of doing so. This did not prove to be the case (see Table 17). Over 92.5 percent of those in the sample have had no contact with these special programs. Of the 14 who completed the middle school program, four were enrolled in the high school program. A total of 25 were enrolled in the middle school program, and one individual was enrolled in the high school program who did not complete the middle school program. No one had completed the high school program.

TABLE 17.--Special Program Equivalents for Middle and High School (madureza).

| Middle School \ High School | Completed Program | Completing Program | Never Enrolled | Total |
|---|---|---|---|---|
| Completed Program | 0 | 4 | 10 | 14 |
| Completing Program | 0 | 0 | 25 | 25 |
| Never Enrolled | 0 | 1 | 500 | 501 |
| Total | 0 | 5 | 535 | 540 |

Summary-formal education--The high percentage of individuals with at least a complete primary education suggests that such a level of formal education is necessary for the development of specific industrial skills. In general, the educational levels of those in the sample did not differ greatly from the educational levels of the general labor force. Certainly, the level of formal education cannot explain the sample's high position in the total income distribution.

Work Experience

The mean age at which those in the sample first started working in regular, full time jobs was 14.3 years. The associated standard deviation was 2.1 years. About 21 percent had started their work lives before the age of 14; and by the age of 18, over 95 percent had started working.

The majority (about 83 percent) started their work lives directly in industrial occupations (see Table 18). Few started in agricultural or other (not industrial or agricultural) occupations. A large percentage (almost 40 percent) started directly in the area of lathe operation.

TABLE 18.--Occupational Area of First Job.

| Area of First Job | Individuals | |
|---|---|---|
| | Number | Percentage |
| Lathe Operation (LO) | 214 | 39.63 |
| Related to Lathe Operation (RLO) | 85 | 15.74 |
| Other Industrial Occupation (OTHIND) | 152 | 28.15 |
| Agriculture (AG) | 44 | 8.15 |
| Other (OTH) | 45 | 8.33 |
| Total | 540 | 100.00 |

Of the 326 individuals who started working outside the area of lathe operation, about 41 percent either started in an area related to lathe operation or had work experience related to lathe operation before they actually entered the area of lathe operation (see Table 19). Another 47 percent either started in other industrial occupations or had other industrial experience. In total, only 37 individuals

(about 7 percent of the total sample) entered the area of lathe operation without some type of prior industrial work experience.

TABLE 19.--Occupational Area of First Job and Work Experience Before Entering Area of Lathe Operation*

| First Job | Number | Work Experience Before Entering Area of Lathe Operation | | | |
|---|---|---|---|---|---|
| | | RLO | OTH IND | AG | OTH |
| RLO | 85 | 85 | | | |
| OTH IND | 152 | 24 | (128) | | |
| AG | 44 | 14 | 14 | (16) | |
| OTH | 45 | 11 | 13 | 0 | (21) |
| TOTAL | 326 | 134 | 155 | 16 | 21 |
| PERCENTAGE | 100.00 | 41.10 | 47.11 | 4.9 | 6.44 |

*214 started directly in area of lathe operation.

Note: RLO--related to lathe operation; OTH IND--other industrial occupation; AG--agricultural; OTH--other occupation (not industrial and not agricultural).

The time span (duration of the work experience) between the first job and the first job in the area of lathe operation varied greatly (see Table 20). Over 10 percent had more than nine years of work experience before they entered the area of lathe operation. Some worked the entire time in occupations related to lathe operation, others were not even working in industrial occupations. The combinations of types and durations of work are extremely varied and

TABLE 20.--Type of Years of Work Experience Before Entering Area of Lathe Operation.

| Type of Work Experience | Years of Work Experience | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 1-2 | 3-4 | 5-6 | 7-8 | 9 or more | Total |
| LO | 214 | | | | | | 214 |
| RLO | | 47 | 25 | 6 | 1 | 6 | 85 |
| OTH IND → RLO | | 3 | 4 | 6 | 6 | 5 | 24 |
| OTH → RLO | | 0 | 8 | 1 | 2 | 14 | 25 |
| OTH IND | | 67 | 26 | 18 | 8 | 9 | 128 |
| OTH → OTH IND | | 3 | 5 | 3 | 2 | 14 | 27 |
| OTH | | 13 | 5 | 3 | 5 | 11 | 37 |
| Total | 214 | 133 | 73 | 37 | 24 | 59 | 540 |

Note: LO--started in lathe operation; RLO--started in area related to lathe operation; OTH IND → RLO--started in other industrial occupation but had experience related to lathe operation; OTH → RLO--started in other occupation but had experience related to lathe operation; OTH IND--started in other industrial occupation and went directly to lathe operation; OTH → OTH IND--started in other occupation, had other industrial experience, then entered lathe operation; OTH--started in other occupation and went directly to lathe operation.

there are no readily visible patterns. It is reasonable to assume, however, that the type and duration of work experience prior to entering the area of lathe operation, would have an influence on the individual after he enters the area.

The mean age at which the first job in the area of lathe operation was taken was 17.3 years. The associated standard deviation, however, was quite large (almost 4 years). Less than 3.6 percent entered before the age of 14. The majority (almost 61 percent) entered between the ages of 14 and 17. By age 21, over 86 percent of the total had entered the area of lathe operation.

There are three possible levels at which an individual may enter the area of lathe operation; learning, semi-skilled, and skilled. The use of the word "learning" to designate the lowest entry level is not intended to imply that learning (the improvement of skills) does not take place at the other levels. It surely does. The first level (learning) consists primarily of apprentices and helpers i.e. workers who are just beginning to learn the trade. The second level (semi-skilled) consists of workers who are able to do some operations on the lathe, but who generally must have a skilled worker do the set up work for the job. They usually do repetitive work using automatic lathes. The final level consists of fully skilled lathe setter-operators. Such workers are capable of reading and interpreting designs, setting up the lathe, and executing any type of job for which the lathe is suited. Only 36 individuals in the sample (about 6.7 percent) entered the area of lathe operation at the skilled level (see Table 21).

TABLE 21.--Entry Level Into Area of Lathe Operation

| Level | Individuals | |
|---|---|---|
| | Number | Percentage |
| Learning | 401 | 74.26 |
| Semi-skilled | 103 | 19.07 |
| Skilled | 36 | 6.67 |
| Total | 540 | 100.00 |

The great majority (almost 75 percent) entered at the learning level. About 19 percent entered as semi-skilled workers.

The mean number of years from the first entry into the area of lathe operation until the skilled level was reached was 3.9 years. The associated standard deviation, however, was very large (almost 2.9 years). Leaving the area of the lathe operation was not a significant factor in explaining the great variation, since only 1.1 percent ever left the area. The data clearly show that there is great variation in the time taken to reach the skilled occupational level. The primary objective in a later section is to explain this variation.

The mean age at which the skilled level was reached was 21.2 years. Again, however, the standard deviation was great (about 4.2 years). After the skilled occupational level was reached only 2.4 percent left the area of lathe operation.

The number of years those in the sample have worked as skilled lathe setter-operators ranged from less than one year to over 41 years. The mean was 9.5 years and the standard deviation 7.6 years. About 42 percent worked at the skilled level for six or less years, and about 38 percent for between seven and fifteen years. About 8.5 percent have worked at the skilled level for over 21 years.

Summary-work experience--Though most of those in the sample started working in industrial occupations, there was great variation in both the specific types of work experiences and in the durations of the experiences. There was also great variation in the time taken to reach the skilled occupational level. The effectiveness of any given training experience would certainly be affected by the prior work experiences (prior abilities) that an individual brought with him.

Given the potential for such great variation in prior abilities, the evaluation of any given program cannot be properly undertaken without taking such factors into consideration.

Training

SENAI apprentice program--Prior to the study it was expected that over 60 percent of the skilled metal lathe operators in the ABC area would have gone through a three-year SENAI apprenticeship program. In the sample drawn for this study, the percentage was just under 27.6 percent (see Table 22). There is no readily available standard by which to judge if this figure is high or low. Certainly it shows that the SENAI apprenticeship program has made a significant contribution to the development of this occupation. SENAI officials thought it had done more. Almost 92 percent of

Table 22.--SENAI Apprenticeship.

| SENAI Apprenticeship | Individuals | |
|---|---|---|
| | Number | Percentage |
| None | 391 | 72.41 |
| Lathe Operation | | |
| Complete | 125 | 23.15 |
| Incomplete | 13 | 2.41 |
| Other | | |
| Complete | 9 | 1.66 |
| Incomplete | 2 | .37 |
| Total | 540 | 100.00 |

the 149 apprenticeship courses were taken in the Greater São Paulo area. Only 4 were taken in the interior of the state and 8 were taken in other states. The SENAI apprenticeship program was started in 1942, and one individual in the sample was part of that first group of students. Ten individuals completed the program prior to 1950. During the 1950-1970 period the sample contained at least three graduates for each year. Only one 1971 graduate was encountered, and no 1972 or 1973 graduates were found in the sample.

Courses--Training through special courses was numerically an important component in the development of the skilled lathe setter-operators in the sample. Over 68 percent had taken at least one special training course (see Table 23). Almost 30 percent had taken two or three. Of those without

TABLE 23.--Number of Special Courses Taken.

| Number of Courses Taken | Individuals | | Courses | |
|---|---|---|---|---|
| | Number | Percentage | Number | Percentage |
| None | 171 | 31.67 | | |
| One | 219 | 40.56 | 219 | 38.69 |
| Two | 103 | 19.07 | 206 | 36.40 |
| Three | 47 | 8.70 | 141 | 24.91 |
| Total | 540 | 100.00 | 566 | 100.00 |

special courses (171 individuals), 86 had SENAI apprenticeship training and 23 had been enrolled in industrial middle school programs. As the result, only 62 individuals, 11.5 percent of the sample, became skilled lathe setter-operators purely on the basis of work experience. All of the remaining

88.5 percent had their work experience supplemented by some form of special industrial training.

The types of courses taken can be divided into four categories. First, there are courses specifically designed for teaching the operation of lathes. There are generally two parts to the course--theory and practice. The theoretical or classroom portion deals with such things as mathematics, design reading, and the use of precision instruments. The practical or shop work part is concerned directly with the development of lathe use skills. Though the division of time between classroom and shop varies, all courses in lathe operation had both components. Over 35 percent of those in the sample had at least one course in lathe operation (see Table 24).

The second category is courses in mechanical design. The emphasis is placed on reading and interpretation. To some degree these courses are like the theoretical parts of the lathe operation courses. They differ because they are not restricted directly to the area of lathe operation and cover the area of design in more depth. Over 34 percent of the sample had at least one course specifically devoted to the study of mechanical design.

The third category consists of courses related to lathe operation. Any course on the cutting, grinding, or shaping of precision metal tools or parts is included. Examples are courses in the use of power saws, power drills, shapers, milling machines, and grinding machines. The structure of these courses is similar to that of the courses in lathe operation.

TABLE 24.--Types of Courses Taken.

| Types of Courses Taken | Individuals | |
|---|---|---|
| | Number | Percentage |
| Lathe Operation (only) | 99 | 26.83 |
| Lathe Operation + Design | 39 | 10.57 |
| Lathe Operation + Design + (Related to Lathe Operation or Other) | 20 | 5.42 |
| Lathe Operation + (Related to Lathe Operation or Other) | 35 | 9.49 |
| Design (only) | 99 | 26.83 |
| Design + (Related to Lathe Operation or Other) | 30 | 8.13 |
| Related to Lathe Operation + Other | 3 | .81 |
| Related to Lathe Operation (only) | 23 | 6.23 |
| Other (only) | 21 | 5.69 |
| Total | 369 | 100.00 |

The final category is labeled "other" and includes industrial courses not related to lathe operations, as well as small numbers of courses not specifically industrial.

The percentage of courses which originated from SENAI, was 31.6 percent (see Table 25). As with the SENAI apprenticeship program, this figure was much lower than expected. Most unexpected of all was the high percentage of courses which originated from the private, tuition charging, industrial training schools, almost 55 percent. Though it was known before the study that the private schools existed, there simply was no indication or expectation that the private schools would be providing almost 1.7 times as many courses as SENAI. Public schools, the industrial middle schools,

TABLE 25.--Courses, By Sponsor and Type.

| Sponsor | Total | | Type (Number) | | | |
|---|---|---|---|---|---|---|
| | Nº | % | LO | DES | RLO | OTH |
| SENAI | 179 | 31.6 | 77 | 43 | 35 | 24 |
| Private | 310 | 54.8 | 102 | 143 | 34 | 31 |
| Public | 43 | 7.6 | 21 | 12 | 9 | 1 |
| Other | 34 | 6.0 | 7 | 7 | 0 | 20 |
| Total | 566 | 100.0 | 207 | 205 | 78 | 76 |
| (Percentage) | (100.0) | | (36.6) | (36.2) | (13.8) | (13.4) |

Note: LO--Lathe Operation; DES--Design; RLO--Related to Lathe Operation; OTH--Other

sponsored 7.6 percent of the training courses. Within the "other" category, 13 courses were sponsored by factories and the remaining 21 were sponsored by various religious groups and a few unidentified organizations.

It is interesting to note that the private school courses are not a recent phenomenon. The first private school course taken by an individual in the sample was in 1942, the same year SENAI was founded. Most, however, were taken after 1960, although, about 24 percent were taken in the 1942-1960 period. The existence of such a relatively large, long historied, private industrial training "system" was one of the most interesting and perhaps most important findings of the study.

The time variation (number of hours scheduled) among courses was extremely great. Some were scheduled for as little as 48 hours while others were scheduled for over

5,000 hours. The time span over which the courses were taught ranged from 1 month to over 5 years. Even cross classification by sponsor and type of courses did not reduce the time variation. For example, over 49 percent of the private school courses in design were scheduled for over 1,000 hours. At the same time, over 30 percent were scheduled for less than 600 hours. Several were scheduled for less than 100 hours. The determination as to whether or not such differences are significant in explaining the variation in the quality of work is left to a future section. Here, it is only noted that the variation is extremely great.

About 83 percent of those who have taken courses took them from only one sponsor (see Table 26). It is interesting to note that of those who have taken more than one course, almost 43 percent took their courses from different sponsors. The remaining 57 percent took their second (and third) course

TABLE 26.--Sponsors of Courses Taken.

| Sponsors of Courses Taken | Individuals | |
|---|---|---|
| | Number | Percentage |
| SENAI (only) | 74 | 20.05 |
| SENAI + Private | 37 | 10.03 |
| SENAI + Private + (Public or Other) | 6 | 1.63 |
| SENAI + (Public or other) | 5 | 1.36 |
| Private (only) | 190 | 51.49 |
| Private + (Public or other) | 16 | 4.34 |
| Public (only) | 25 | 6.78 |
| Other (only) | 16 | 4.34 |
| Total | 369 | 100.00 |

from the same sponsor as the first. Particularly interesting is the SENAI (only) case (again see Table 26); the number of individuals who had more than one SENAI course (36) is almost as great as the number who had one SENAI course (38). In other words, almost 50 percent of those who had taken a SENAI course had taken more than one. This tendency for individuals to take more than one course from SENAI reduces the relative number of different individuals that SENAI courses reach. Thus, though SENAI sponsored about 32 percent of the courses taken, these courses only reached 33 percent of those who had at least one course. On the other hand, private schools sponsored about 55 percent of the courses, but over 67 percent of those who had at least one course, had at least one private school course. Viewed in this manner, the relative importance of private schools is even greater.

Summary-Training--Two findings are particularly significant. First only 11.5 percent reached the skilled occupational level without some form of special industrial training, and second, the private schools have trained many more of the workers than SENAI. Private schools sponsored over 54 percent of the training courses, while SENAI sponsored only 31 percent. Further, of those who have taken at least one course, 66 percent have taken at least one private school course, while only 33 percent have taken at least one course from SENAI.

## LEARNING PATHS

At a highly aggregated level, four basic learning paths have been taken to reach the skilled occupational level. A complete four-year primary education seems to be a necessary base for the development of specific industrial skills and this level of formal education is common to all four paths. The distinguishing feature of each path is the major type of industrial learning experience after primary school is completed. The four paths are:

1. SENAI--those who have been enrolled in a SENAI apprenticeship program.

2. Industrial School--those who have not been enrolled in a SENAI apprenticeship program but have attended a formal industrial middle school.

3. Courses--those who have neither been enrolled in a SENAI apprenticeship program nor attended a formal industrial middle school, but who have taken part-time industrial training courses.

4. Work--those who have no specific industrial training (neither SENAI, industrial middle school, nor training courses) and developed their industrial skills through work experience only.

In the sample of 540 individuals, 149 (27.6 percent) have taken the SENAI apprenticeship training path, and 41 (7.6 percent) have taken the industrial school path. The majority, 288 (53.3 percent) have taken the courses path. Only 62 (11.5 percent) have reached the skilled occupational level without some form of special industrial training.

Those who have taken the SENAI path tend to be younger than those who have taken other paths. The mean age for

the SENAI class is 28.48 years (see Table 27). On the other hand, those who attended industrial middle schools tend to be older than the others; the mean age is 35.20. Within each path, however, there is a great deal of variation and, thus, the differences between cell means should be interpreted with care.

TABLE 27.--The Four Major Learning Paths

| Path | Individuals | | Age | |
|---|---|---|---|---|
| | Number | Percentage | Mean | Standard Deviation |
| (1) SENAI | 149 | 27.6 | 28.48 | 7.10 |
| (2) Industrial School | 41 | 7.6 | 35.20 | 9.79 |
| (3) Courses | 288 | 53.3 | 30.40 | 7.50 |
| (4) Work | 62 | 11.5 | 34.77 | 11.34 |
| Total | 540 | 100.0 | 30.74 | 8.39 |

The formal educational levels of the parents of those who followed different paths did not differ greatly. In each case there was a small percentage with no formal education and a small percentage with more than a complete primary education. The majority in each path had at least one parent with a complete four year primary education. In general there was a tendency for the fathers to have slightly more education than the mothers. The only exception was the Industrial School path where there were more mothers with a complete primary education.

With respect to both the occupational area and the occupational level of the father, the SENAI path differed significantly from the other three paths. About 57 percent

of the SENAI path fathers worked in industrial occupations (see Table 28). The next highest percentage was in the

TABLE 28.--Occupational Area of Father by Learning Path (percentage distribution).

| Occupational Area | Path | | | | Total |
|---|---|---|---|---|---|
| | SENAI | Industrial School | Courses | Work | |
| Industrial (not construction) | 57.1 | 35.0 | 34.8 | 30.7 | 40.4 |
| Construction | 12.2 | 17.5 | 13.3 | 17.7 | 13.9 |
| Agriculture | 3.6 | 27.5 | 22.6 | 25.8 | 18.2 |
| Other | 27.1 | 20.0 | 29.3 | 25.8 | 27.5 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Industrial School path where 35 percent of the fathers had industrial occupations. Very few in the SENAI path had fathers who worked in agricultural occupations (3.6 percent). Each of the other paths, on the other hand, had over 22 percent. Less than 20 percent of the SENAI path fathers worked at the unskilled level (see Table 29). The other paths all had over 35 percent of the fathers working at this level. All four paths had about the same percentages at the white collar level. The SENAI path thus had a relatively high percentage of fathers (70.7 percent) who worked either at the semi-skilled, skilled, or supervision of manual workers levels. The other paths all had about 50 percent who worked at these levels.

Though the evidence is not conclusive, the data indicate that having had a father who worked in an industrial occupation at a semi-skilled or higher level may have given

TABLE 29.--Occupational Level of Father by Learning Path (percentage distribution).

| Occupational Level | Path | | | | Total |
|---|---|---|---|---|---|
| | SENAI | Industrial School | Courses | Work | |
| Unskilled | 19.3 | 37.5 | 39.6 | 35.5 | 33.4 |
| Semi-skilled | 32.1 | 10.0 | 23.7 | 27.4 | 25.4 |
| Skilled | 30.7 | 30.0 | 20.4 | 22.6 | 24.2 |
| Supervision of manual workers | 7.9 | 10.0 | 6.7 | 4.8 | 7.0 |
| White collar | 10.0 | 12.5 | 9.6 | 9.7 | 10.0 |
| Total | 100.0 | 100.00 | 100.0 | 100.00 | 100.0 |

the individual a greater probability of entering a SENAI apprenticeship program. It is reasonable to assume that those fathers who worked in industrial occupations would have had both greater knowledge of the training opportunities available to their sons and, perhaps, more personal contacts within different firms. Both "advantages" could have been used to put their sons "in contact" with the apprenticeship program.

As was noted, the four major learning paths all have as a common base a complete four year primary education. The distinguishing feature is the major type of industrial learning experience after primary school is completed. When other types of learning (more formal education, work experience, and other industrial training courses) are added to the basic paths, the paths become much more difficult to distinguish. For example, though only a complete four-year primary education is required to enter the SENAI apprenticeship program, about 44 percent of those who had SENAI

apprenticeship training (the SENAI path) also had more than just a complete primary education (see Table 30).

TABLE 30.--Educational Level by Learning Path (percentage distribution).

| Educational Level | Path | | | | |
|---|---|---|---|---|---|
| | SENAI | Industrial School | Courses | Work | Total |
| Primary Incomplete | --- | --- | 7.3 | 14.5 | 5.9 |
| Primary Complete | 55.7 | --- | 69.1 | 67.7 | 59.6 |
| More than Complete Primary | 44.3 | 100.0 | 23.6 | 17.8 | 34.5 |
| Total | 100.00 | 100.0 | 100.0 | 100.0 | 100.0 |

The same is true of the courses and work paths. Though lower than in the SENAI path, significant percentages had more than just a complete primary education. Also in the courses and work paths there were significant percentages who did not have a complete primary education.

The paths become even more complicated when other training courses are added. Over 42 percent who had SENAI apprenticeship also had one or more industrial training courses (see Table 31). The same is true for the Industrial School path. Over 43 percent had at least one training course. Even within the courses path there are about 42 percent who took more than one course.

It is interesting that of those in the SENAI path who had at least one course, over 71 percent took at least

TABLE 31.--Number of Courses Taken by Learning Path (percentage distribution).

| Number of Courses | Path | | | | |
|---|---|---|---|---|---|
| | SENAI | Industrial School | Courses | Work | Total |
| None | 57.7 | 56.1 | --- | --- | 31.7 |
| One | 27.5 | 29.3 | 57.6 | --- | 40.5 |
| Two | 11.4 | 14.6 | 27.8 | --- | 19.1 |
| Three | 3.4 | --- | 14.6 | --- | 8.7 |
| Total | 100.00 | 100.00 | 100.00 | --- | 100.0 |

one course from a private industrial school (see Table 32). Over 30 percent also took at least one course from SENAI. That is, SENAI apprenticeship was followed by SENAI training courses. Those in the Industrial School path have also taken courses from SENAI as well as from private schools. This is also true for the Courses path. Regardless of which path was followed, about twice as many of the courses taken were sponsored by private schools as were by SENAI.

If the different types and durations of work experience were also added to the paths and the great variation in the duration of the courses were taken into account, it quickly becomes obvious that "pure" learning paths do not exist. The number of possible combinations of different types and durations of formal education, work experience, and training is great. Simple cross tabulations are not suited to the type of analysis that is required to evaluate the effects of different types of learning. There are simply too many

TABLE 32.--Percentage Having at Least One Course From a Given Sponsor by Learning Path.

| Sponsor of Course | Path: SENAI | Industrial School | Courses | Work | Total |
|---|---|---|---|---|---|
| SENAI | 30.2 | 38.9 | 33.3 | --- | 33.1 |
| Private | 71.4 | 72.2 | 66.3 | --- | 67.5 |
| Public | 6.3 | 5.6 | 11.5 | --- | 10.3 |
| Other | 9.5 | --- | 8.3 | --- | 8.1 |

Note: The table is interpreted as follows: For the first path (SENAI)--of those who have had at least one training course, 30.2 percent have had at least one course sponsored by SENAI, 71 percent have at least one course from a private school, etc.

variables to be taken into account. Under such conditions linear regression techniques are appropriate. In the following sections several linear regression models are developed and used to evaluate the effects of different types of learning experiences.

## ANALYSIS OF THE FINDINGS

The purpose of this section is to "explain" the observed variation in four important variables, each of which has been discussed in the previous sections. The four variables are:

1. wage per hour (WA H)
2. number of operations performed (OP DO)
3. difficulty of operations performed (TOP OP)
4. time taken to reach the skilled occupational level (YRS AR LO-SLO)

In the section which explained the general model used in this study, it was suggested that variation in what was done on the job and the pay received (present work situation) might be explained in terms of when, where, and to whom an individual was born (initial conditions), the types and durations of different learning experiences to which the individual was exposed (formal education, work experience, and training), and by the physical situation in which work took place (present work situation control). To establish which of the above mentioned factors actually did have a significant influence, standard linear regression techniques were employed.[29]

In its most general form the linear regression model contained six blocks of variables, each of which corresponded directly to one of the six blocks suggested in the general model. The six blocks of variables were:

1. (PWS) present work situation
2. (PWSC) present work situation control

3. (IC) initial conditions

4. (FED) formal education

5. (WEX) work experience

6. (TR) training

The variables in each block and their respective codes are presented in Table 33.

A specific regression model for each of the four dependent variables was constructed using elements contained in the six variable blocks of the general model. The general form of each model may be represented as:

WA H (PWS, PWSC, IC, FED, WEX, TEX)

OP DO (PWSC, IC, FED, WEX, TEX)

TOP OP (PWSC, IC, FED, WEX, TEX)

YRS AR LO-SLO (IC, FED, WEX, TEX)

where: WA H, OP DO, TOP OP, and YRS AR LO-SLO refer to the four specific dependent variables, and PWS, PWSC, IC, FED, WEX, and TEX refer to the variable blocks used in the construction of each specific regression model.

EXPLANATION OF THE VARIATION OF WAGE PER HOUR

It was shown that there was great variation in the hourly wage rates of the skilled lathe setter-operators studied. Specifically, hourly wage rates ranged from less than Cr $2 to more than CR $10. The mean was Cr $6.30 and the associated standard deviation was Cr $1.69. The basic interest is in finding out why there was such great variation. That is, what factors are significant in "explaining" the observed variation?

The general form of the linear regression model used to explain the variation was:

TABLE 33.--General Form of the Basic Regression Model

| Variable Block | Variable Description | Variable Name Code | Variable Code (c) continuous (b) binary |
|---|---|---|---|
| PWS | Present Work Situation | | |
| | wage per hour | WA H** | c |
| | number of different operations performed | OP DO** | c |
| | index of difficulty of operations | TOP OP** | c |
| PWSC | Present Work Situation Control | | |
| | years working in factory | YRS F | c |
| | level of entry into factory (ENT LVL F) | | |
| | a. skilled lathe setter-operator | SKL LSO* | b |
| | b. in area of lathe operation | AR LO | b |
| | c. other area | OTH | b |
| | sector of work in factory (SECTOR F) | | |
| | a. production | P* | b |
| | b. maintenance | M | b |
| | type of lathe used (LATHE F) | | |
| | a. modern & don't know | MOD* | b |
| | b. other | OTH | b |
| | industrial group and size of factory (IND GP & SZ F) | | |
| | a. 03 - small | 03-S | b |
| | b. 03 - medium | 03-M | b |
| | c. 03 - large | 03-L | b |
| | d. 05 or 07 - small | 05,7-S* | b |
| | e. 05 or 07 - medium | 05,7-M | b |
| | f. 01, 11, or 13 - medium | OT-M | b |
| | g. 01, 11, or 13 - large | OT-L | b |
| IC | Initial Conditions | | |
| | age | AGE | c |
| | place of birth (PL BIRTH) | | |
| | a. greater São Paulo | GSP | b |
| | b. interior of state of São Paulo | SPI | b |
| | c. other state | OTH ST | b |
| | d. other country | OTH C* | b |

TABLE 33.--continued

| Variable Block | Variable Description | Variable Name Code | Variable Code (c) continuous (b) binary |
|---|---|---|---|
| | place of primary education (PL PRI ED) | | |
| | a. greater São Paulo | GSP | b |
| | b. interior of state of São Paulo | SPI | b |
| | c. other state or other country | OTH ST or C* | b |
| | educational level of Father (ED FATHER) | | |
| | a. no formal education | NONE* | b |
| | b. primary incomplete | PR INC | b |
| | c. primary complete | PR CPLT | b |
| | d. middle school incomplete or higher | MID+ | b |
| | e. don't know | DN | b |
| | educational level of Mother (ED MOTHER) | | |
| | a. no formal education | NONE* | b |
| | b. primary incomplete | PR INC | b |
| | c. primary complete | PR CPLT | b |
| | d. middle school incomplete or higher | MID+ | b |
| | e. don't know | DN | b |
| | occupational level of Father (OC LVL FTHR) | | |
| | a. white collar and above | WC+ | b |
| | b. supervisor of manual workers | SUPR MN | b |
| | c. skilled | SKLD | b |
| | d. semi-skilled | S-SKLD | b |
| | e. unskilled or don't know | N-SKLD* | b |
| | occupational area of Father (OC AR FTHR) | | |
| | a. industrial | IND | b |
| | b. agricultural | AG* | b |
| | c. other | OTH | b |
| | d. don't know | DN | b |
| FED | Formal Education | | |
| | level and program (LVL-PR SCHL) | | |
| | a. primary incomplete | PRI INC | b |
| | b. primary complete | PRI CPLT* | b |

TABLE 33.--continued

| Variable Block | Variable Description | Variable Name Code | Variable Code (c) continuous (b) binary |
|---|---|---|---|
| | c. academic or commercial middle school incomplete | M AC INC | b |
| | d. academic or commercial middle school complete and higher | M AC CPLT+ | b |
| | e. industrial middle school incomplete | M IND INC | b |
| | f. industrial middle school complete or higher | M IND CPLT+ | b |
| | effort to complete highest grade (EFRT SCHL) | | |
| | a. normal time | NORMAL | b |
| | b. 1 year extra | +1 | b |
| | c. 2 years extra | +2 | b |
| | d. 3 years extra | +3 | b |
| | e. 4 or 5 years extra | +4 or 5 | b |
| | f. 6 or more years extra | +6+ | b |
| | special formal education (SPECIAL SCHL) | | |
| | a. none | NONE | b |
| | b. middle school program incomplete | M INC | b |
| | c. middle school program complete or high school incomplete | M CPLT+ | b |
| WEX | Work Experience | | |
| | experience before entering the area of lathe operation (BFOR AR LO) | | |
| | a. started in area | ST LO | b |
| | b. started in related area | ST RLO | b |
| | c. started in other industrial area, but had related experience | OI RLO | b |
| | d. started in other area, but had related experience | OTH RLO | b |
| | e. started in other industrial area, and no related experience | OI | b |
| | f. started in other area, but had industrial experience | OTH OI | b |
| | g. start in other occupation, and had no industrial experience | OTH* | b |

TABLE 33.--continued

| Variable Block | Variable Description | Variable Name Code | Variable Code (c) continuous (b) binary |
|---|---|---|---|
| | time span between first job and first job in area of lathe operation | YRS WK-AR LO | c |
| | time span between first job in area of lathe operation and first job as skilled lathe setter-operator | YRS AR LO-SLO** | c |
| | years working as skilled lathe setter-operator | YRS SLO | c |
| TR | Training | | |
| | total course hours completed | CRS HRS CPLT | c |
| | types of courses taken (CRS TYPE) | | |
| | a. lathe operation | LO | b |
| | b. lathe operation, design | LO+D | b |
| | c. lathe operation, design, related or other | LO+D+ | b |
| | d. lathe operation, related or other | LO+ | b |
| | e. design | D | b |
| | f. design, related or other | D+ | b |
| | g. related and other | RLO+O | b |
| | h. no course or other | NCR-O* | b |
| | number of courses taken (NUMBER CRS) | | |
| | a. 1 course | 1 | b |
| | b. 2 courses | 2 | b |
| | c. 3 courses | 3 | b |
| | d. no courses | NCR* | b |
| | sponsors of courses taken (CRS SPONSOR) | | |
| | a. SENAI | SN | b |
| | b. SENAI, private | SN+PR | b |
| | c. SENAI, private, public or other | SN+PR+ | b |
| | d. private | PR | b |
| | e. private, public or other | PR+ | b |
| | f. public | PUB | b |
| | g. no courses or other | NCR-O* | b |

TABLE 33.--continued

| Variable Block | Variable Description | Variable Name Code | Variable Code (c) continuous (b) binary |
|---|---|---|---|
| | SENAI apprenticeship (SENAI APR) | | |
| | a. lathe operation complete | LO CPLT | b |
| | b. lathe operation incomplete | LO INC | b |
| | c. related to lathe operation complete | RLO CPLT | b |
| | d. related to lathe operation incomplete | RLO INC | b |
| | e. no SENAI apprenticeship | NONE* | b |

*Omitted binary variable.

**Dependent variable for one of the regression models.

WA H (PWS, PWSC, IC, FED, WEX, TR)

where: WA H refers to the dependent variable (variable to be explained), and PWS, PWSC, IC, FED, WEX, and TR refer to the blocks of independent variables (explanatory variables) used in the construction of the linear regression model. All blocks, with the exception of PWS, contained the variables specified in Table 33. The PWS block contained only two variables: number of operations performed (OP DO), and the index of the difficulty of the operations performed (TOP OP).

Wage per hour - factors not significant--The variable blocks IC (initial conditions), FED (formal education), and TR (training) did not contain any variables which had a significant influence on the hourly wage rate (WAH). When, where, and to whom an individual is born (initial conditions) may have an influence on the occupational area that is entered and the types of learning experiences to which the individual is exposed; but after the skilled occupational level is reached, the effects of such differences are lost.

It could not be established that having more than a complete primary education resulted in higher earnings. Regardless of the type of secondary education (academic or industrial), there was no significant difference in earnings. Given the scope of the study, the claim that more formal education leads to higher earnings could not be supported.

Regardless of the type, sponsor, or duration of the industrial training received, there was no significant difference in earnings. There was no significant difference between the earnings of those who had SENAI apprenticeship training and those who did not. Further, private school courses were not shown to be inferior to SENAI sponsored training courses. The hourly earnings of those who had private school courses were not significantly different from the hourly earnings of those who had SENAI courses.

Wage per hour - significant factors--The variable blocks PWS (present work situation), PWSC (present work situation control), and WEX (work experience) all contained variables which had a significant influence on the hourly wage rate (WA H). What is done on the job (PWS) does have a significant influence on the wage received. There was a significant and positive relationship between the number of operations performed and hourly wage rates. Other things equal, the more operations performed on the job, the higher the hourly wage rate.

Prior work experience did influence hourly wage rates. The influence, however, was felt only in the early years of the professional work life. During the first five or six years that the individual worked at the skilled occupational level, there was a significant positive relationship between the number of years working at the skilled level and the hourly wage rate. There was some indication that work experience prior to entering the area of lathe operation was important. The level at which the individual entered the factory was also significant. Those who entered in the area of lathe operation, but at less than the skilled level, were paid less than those who entered at the skilled level. Those using old type lathes were paid less than those using modern lathes. As stated, the influence of these factors faded with time. After 6 or 7 years of work at the skilled level, the length of time the worker was employed in the firm became significant. Other things equal, the more years the individual worked in the firm, the higher the hourly wage rate.

Regardless of the stage of the professional work life, the size and type of firm in which the individual was employed had a strong influence on wage rates. Larger firms, in general, paid more than smaller firms. Though there was some evidence that the type of product produced by the firm and the type of market served had an influence on wage rates, the patterns were not clear. Both factors, however, must still be judged as significant.

EXPLANATION OF THE VARIATION IN WHAT WAS DONE ON THE JOB

There are two variables which define what was done on the job: number of operations performed (OP DO), and an index of the difficulty of the operations performed (TOP OP). The number of operations performed on the job ranged from 1 to 41. The mean was 30.5 and the associated standard deviation was 9.6. The variation in the difficulty of the operations performed was not so great as the variation in the number of operations performed. The mean rank on the difficulty scale was 39.4 and the associated standard deviation was 4.3. Though both variables were treated separately in the original regression analysis, the regression models used and the results obtained were essentially the same. Thus, in the discussion which follows the two variables, (OP DO) and (TOP OP) are treated as one. The variable which combines both the original dependent variables is referred to as (DOJ), done on the job.

The general form of the regression model used to explain the variation in what was done on the job (DOJ) was:

DOJ (PWSC, IC, FED, WEX, TR)

where: DOJ refers to the dependent variable (variable to be explained), and PWSC, IC, FED, WEX, and TR refer to the blocks of independent variables (explanatory variables) used in the construction of the linear regression model. All blocks contained the variables specified in Table 33.

Done on the job - factors not significant--The variable blocks IC (initial conditions), FED (formal education), WEX (work experience), and TR (training) did not contain any variables which had a significant influence on what was done on the job (DOJ). After the skilled occupational level is reached, differences in origin (initial conditions) and in the types of learning experiences to which an individual was exposed (formal education, work experience, and training) do not have any significant influence on either the number of operations performed or the difficulty of the operations performed. Any claim that having either more or less formal education, one type of prior work experience or another, or that industrial training of one type or another from one source or another results in more and more difficult work being performed on the job, cannot be supported. Once the skilled level is reached, the origin and learning path taken are no longer important.

Done on the job - significant factors--The only variable block which contained variables which had a significant influence on what was done on the job was PWSC (present work situation control). Specifically, those who worked in the maintenance sector did both more and more difficult operation than those who worked in the production sector. The opposite was true for those who used either old or specialized lathes. Those who used old and specialized

lathes did both fewer and less difficult operations than those using modern lathes. There was some evidence that those who worked in larger firms did both fewer and less difficult operations than those working in smaller firms. The exact relationship, however, depended on the type of product produced by the firm. The final factor which had a significant influence on what was done on the job was the number of years that the individual had been employed in the firm. The longer the individual worked with the firm, the more operations he performed. In general, what was done on the job was determined only by the situation in which work took place.

EXPLANATION OF TIME TAKEN TO REACH THE SKILLED OCCUPATIONAL LEVEL

The time taken to reach the skilled occupational level was defined as the time span between the first job in the area of lathe operation and the first job as a skilled lathe setter-operator. It was shown that the range in years was from 0 (36 individuals started as skilled lathe setter-operators) to 21. The mean number of years was 3.9 and the associated standard deviation was 2.9.

The general form of the regression model used to explain the variation in the time taken to reach the skilled occupational level (YRS AR LO-SLO) was:

YRS AR LO-SLO (IC, FED, WEX, TR)

where: YRS AR LO-SLO refers to the dependent variable (variable to be explained), and IC, FED, WEX, and TR refer to the blocks of independent variables (explanatory variables) used in the construction of the linear regression model. The IC, FED, and TR blocks contained the same variables specified in Table 33. The data, however, were adjusted to include only those events which came before the

skilled occupational level was reached. The WEX block contained only the two variables which dealt with work experience before the area of lathe operation was entered: the type of work experience (BFOR AR LO), and the duration of the experience (YRS WK-AR LO).

Time to reach the skilled level - factors not significant--The variable blocks IC (initial conditions) and TR (training) contained no variables which were significant in explaining the variation in the time taken to reach the skilled occupational level.[30] Again, when, where, and to whom an individual was born (initial conditions) may influence the occupation area entered and the types of learning experiences to which the individual was exposed, but after the area of lathe operation is entered, the effects are lost.

Regardless of the type, sponsor, or duration of the industrial training received, there was no significant difference in the time taken to reach the skilled occupational level. It was not possible to establish that SENAI apprenticeship graduates reached the skilled level any more quickly than those who developed their skills through short courses. Further, there was no significant difference between private school courses and SENAI courses. Neither the form of the training (apprenticeship or course) nor the sponsor of the training (private or SENAI) was significant in explaining the variation in the time taken to reach the skilled occupational level.

Time to reach the skilled level - significant factors--Both the FED (formal education) and WEX (work experience) block contained variables which were significant in explaining the variation in the time taken to reach the skilled occupational

level. In general, those who had more than a complete primary school education reached the skilled level more quickly than those with just a primary school education. Further, those who completed the special middle school equivalency program (madureza) also reached the skilled level more quickly. The results for the industrial school graduates were expected, as the industrial school graduate begins his work life already trained. This is not the case with formal academic education. Generally, industrial training (work experience and training) does not begin until after the formal education is completed and the work life begins. The data indicate that more formal academic education facilitates the more rapid development of specific industrial skills. As noted, a skilled industrial worker must be able to do much more than perform certain physical operations. He must be able to read designs and make some rather difficult mathematical calculations. The classroom part of most industrial training courses is devoted to such topics. The better base developed in mathematics in the formal school system, the less that must be learned in courses or on the job. Further, it is possible, that the formal school system teaches an individual how to learn. That is, the techniques of learning and the discipline obtained in the formal school system may be transferable to other types of learning situations. Though definitive answers are not possible, the study does show that more formal academic education is associated with reaching the skilled occupational level more quickly.

Work experience was also found to be important. Both the type and duration of work experience prior to entering

the area of lathe operation had an influence on the time taken to reach the qualified level. Generally the closer the work experience approached the area of lathe operation and the longer the duration of the experience, the more beneficial it was in terms of reducing the time required to reach the skilled level.

## CONCLUSION

(1) Although this study has shown that many factors are important in the development of skilled industrial workers, industrial training of some sort is generally required to reach the skilled occupational level. The two major sources of such training are the private industrial schools and SENAI. Numerically, the private schools have given more courses and reached more individuals than SENAI. In terms of earnings, what is done on the job, and the time taken to reach the skilled occupational level, private school training was not shown to be inferior in any way to SENAI training. This implies that, for those who do attain skilled industrial positions, the benefits of private school training are the same as the benefits of SENAI training. Other things equal, society's decision to invest in one form of training or another should be based on the comparison of relative costs and benefits.

The major question in comparative cost/benefit analysis is not whether the entire private school system is an alternative to the entire SENAI system but rather, whether some types of private school training are alternatives to some types of SENAI training. Alternative programs are those designed for the same "types" of individuals and which have as an objective the development of the same specific type of skilled industrial worker. For example, the SENAI apprenticeship programs are designed for individuals 14 years of age who have recently completed their primary educations and have

little work experience. If the objective is to train this type of individual, there is no alternative private school program. The only area in which real alternatives do exist is in the training of adult workers. Again the problem is that both the private schools and SENAI offer a wide range of courses for many different types of individuals. Even within a given occupational area there are entry level courses, rapid development courses, normal courses, up-grading courses, etc. Each is designed for a different type of individual. Further, courses for the same type of individual vary greatly in duration. Some private school courses in the area of lathe operation are planned for less than 200 hours, others for over 1,000 hours. In sum, the identification of real alternatives is not a simple task. Both the private school system and the SENAI system must be disaggregated to the point where real alternatives can be identified and comparative cost/benefit analysis becomes meaningful.

Even when real alternatives are identified the costing-out of the programs is not straightforward. First, it must be established who is paying the cost--government, society, or the individual. Second, costs must be identified. They may be explicit, implicit, or joint costs. The relevance of a specific type of cost depends on whose costs are being considered. Joint costs are probably the most difficult to handle. Both SENAI and the private schools have many different types of programs. Somehow, the general costs of administration, depreciation, and equipment used for different programs must be allocated to specific programs.

In sum, the identification and costing-out of alternatives is extremely difficult. Yet, if resources are to be allocated

rationally and the most efficient programs identified, such research is called for. This study has provided some basic information on alternatives. The next logical step is to cost-out these alternatives.

(2) More than a complete four-year primary education was not shown to result in higher earnings. Such formal education must be judged on other grounds if it is to be justified. SENAI's apprenticeship courses are currently being "upgraded" to include academic subjects which will make the SENAI program equivalent to the middle school level of the formal school system. Graduation from the SENAI program will give the individual the right to enter the formal high school. If the objective of the SENAI apprenticeship program is to develop skilled industrial workers, then two problems may develop. First, the type of individual who is drawn to the SENAI program may change. As has been noted, the Brazilian formal school system is extremely selective at all levels. Very few who began a particular level complete that level. Of those who do, very few go on to the next. As graduation from the SENAI program will give the individual the legal right to reenter the formal educational stream, the SENAI apprenticeship program will become an alternative path to the university. Those who enter the SENAI program may have no intention of ever working in a blue-collar industrial occupation. Second, even if the intentions of the students are to become skilled blue-collar workers, the added cost of providing academic subjects probably cannot be justified in terms of increased earnings. Although there may well be social and even private

non-monetary returns to such additions. A clear statement of SENAI objectives would help to clarify the issue. Research on the characteristics of entering students before and after the new program is implemented would give an indication of the problems that might develop.

(3) The present skilled industrial workers in São Paulo were not drawn from the lower socio-economic levels of Brazilian society nor were they drawn from the agricultural sector. Other areas in Brazil or other countries which are now beginning to industrialize do not have such an urban-lower middle class pool from which to recruit potential skilled industrial workers. The problems to be faced in these areas may be the problems faced in Sao Paulo during the first decades of the 1900's. The transfer of the industrial educational technology presently used in São Paulo may not be appropriate. Research, of a nature similar to this study, conducted in an area less industrialized than São Paulo would be useful to identify possible transfer problems.

(4) This study deals with only one important industrial occupation. The results probably are applicable to other similar skilled industrial occupations. There are, however, many industrial occupations which are dissimilar and to which extension of these results may be doubtful.

## FOOTNOTES

1. Brasil, Governo do Estado de São Paulo, Secretaria de Economia e Planejamento, Departamento de Estatística, Seção de Estatísticas da Produção Industrial do Estado de São Paulo. These figures were calculated from Industrial Census data and released by the above mentioned department.

2. Ibid., this figure was calculated from unpublished data and released by the above mentioned department.

3. Brasil, Ministério do Planejamento e Coordenação Geral, Fundação IBGE, Instituto Brasileiro de Estatística, Departamento de Censos, Censo demográfico Brasil, VIII Recenseamento geral, 1970, v. I (Rio de Janeiro: Fundação IBGE, 1970), p. 2, Table 1.

4. Ibid., p. 81, Table 21.

5. Brasil, Ministério do Trabalho e Previdência Social, Departmento Nacional de Mão Departamento Nacional de Mao Obra, Composição e distribuição de mão de obra, São Paulo (Rio de Janeiro, Departamento Nacional de Mão de Obra, 1970), p. 13.

6. Italo Bologna, A mao de obra industrial (São Paulo: Centro de Estudos Roberto Mange, 1967), p. 2 (Mimeographed)

7. This discrepancy is caused by the change in definition of "qualified" noted in Table 4. The lower estimate is calculated directly from the published data. The upper figure is obtained by applying the 1955 adjustment ratio to the published 1946 data. Both figures should be recognized as rough estimates.

8. Adapted from: Robert J. Havighurst, and Aparecida J. Gouveia, Brazilian Secondary Education and Socio-Economic Development (New York: Praeger Publishers, 1969), p. 20. There is some variation in the structure at the formal school system in different areas of Brazil. In some rural areas only three years of primary school are offered, while in some urban areas, pre-primary as well as one or two years of supplemental primary school is offered.

9. USAID/Brazil, Human Resources Office, Brazil, Education Sector Analysis (Rio de Janeiro: Human Resources Office, November, 1972), p. 25. (Mimeographed)

10. Ibid., p. 42.

11. Brasil, Ministério do Planejamento e Coordenação Geral; Fundação IBGE, Instituto Brasileiro de Estatística, Anuário Estatístico do Brasil 1972 (Rio de Janeiro: Fundação IBGE, 1972).

12. The following discussion relies heavily on: Celso Suckow da Fonseca, História do ensino industrial no Brasil, vols. I & II (Rio de Janeiro: Escola Tecnica Nacional, 1961).

13. Ibid., p. 313.

14. Ibid., p. 326.

15. Ibid., p. 356.

16. Italo Bologna, SENAI: origens, evolução, organização (São Paulo: Centro de Estudos Roberto Mange, 1972) p. 10. (Mimeographed)

17. João Baptista Salles da Silva, and Paulo Ernesto Tolle, SENAI: An Instrument of Brazilian Industries for Manpower Training Through Formal and Non-Formal Education (São Paulo: SENAI/SP, 1974), pp. 11-14.

18. Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Nacional, Relatorio 1972, Ed. provisória (Rio de Janeiro: SENAI/DN, 1972), p. 24.

19. Hla Myint, The Economics of Developing Countries (New York: Praeger Publishers, 1964), p. 173.

20. Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Nacional, Manuel do docente de tornearia (Rio de Janeiro: SENAI/DN, 1972).

21. International Standard Classification of Occupations (Geneva: International Labour Office, 1969) p. 199.

22. Brasil, Ministério do Planajamento e Coordenação Geral, Fundação IBGE, Instituto Brasileiro de Estatística, Departamento de Censos, Censo demografico Brasil.

23. Serviço National de Aprendizagem Industrial (SENAI), Departamento Regional de São Paulo. Data taken from unpublished internal documents.

24. Brasil, Governo do Estado de São Paulo, Secretaria de Economia e Planejamento, Departamento de Estatística, Seção de Estatísticas da Produção Industrial do Estado de São Paulo.

25. Serviço Nacional de Aprendizagem Industrial (SENAI), Departamento Regional de São Paulo, "Levantamento Industrial 1972." (unpublished internal document.)

26. Brasil, Ministério do Trabalho e Previdência Social.

27. Ibid.

28. Ibid.

29. See: Jan Kmenta, Elements of Econometrics (New York: Macmillan Co., 1971).