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Technical Supplement

to the

FINAL REPORT

on the

DEVELOPMENT AND VALIDATION OF A METHOD TO DETERMINE THE COST/BENEFIT EFFECTIVENESS OF OCCUPATIONAL HEALTH PROGRAMS

Submitted to

Division of Occupational Health Programs
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16. Abstracts

A generic modelfor the analysis of costs and benefits of occupational health programs is developed, and data from Kaiser Steel Corporation's Fontana Works used to test the validity of the model. A cost accounting system is developed for the medical facility which permits categorizing all of the costs for the resources for the facility on an annual basis. The actual dollar and nondollar, or intangible, benefits and their effectiveness are difficult to determine because the model needs more precist data. An employee attitude survey, planned to help identify some of the intangible benefits is not implemented because labor negotiations are incomplete.

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INTRODUCTION

This Technical Supplement to the Final Report on the Development and Validation of a Method to Determine the Cost/Benefit Effectiveness of Occupational Health Programs presents additional technical data developed during Phase I of the project.

The text of the Technical Supplement further amplifies and expands upon the basic material presented in the Final Report.

The Table of Contents for the Technical Supplement uses the same numerical index system as employed in the Final Report; i.e., each subject item is related to the appropriate section of the Final Report. For example, the first subject item, "3.3 Cost/Benefit Effectiveness," follows item 3.2 listed in the Table of Contents of the Final Report document.

The Figures and Tables of the Technical Supplement are numbered in relation to those of the Final Report, and may be interdigitated by following the page numbers of the respective indices.

3.3 Cost/Benefit Effectiveness

Cost-benefit analysis has often been suggested as a rational method of appraisal of alternative investment projects(5). Klarman suggests that, as an economic method of evaluating programs, cost-benefit analysis should include all of the benefits and costs encountered(6). Costs and benefits of a program must be identified and assigned values.

The present study assumes that the program designer or planner seeks to achieve a program of minimum costs and maximum benefits. The planner must examine and compare the available alternative programs according to the goals of the enterprise he represents. The costs encompass the expenses associated with the operation and maintenance of the program, such as labor, capital and the time of the patient.

Benefits, especially the non-dollar benefits, must have a basis for judgment. A person reviewing the benefits establishes the goals of the program. These are judged according to whether or not they meet the goals expectations and criteria of the reviewer. In the study of the Fontana Occupational Health Program, plant management evaluated the benefits.

Traditional approaches in the evaluation of health programs have quantified all of the costs and benefits accrued each year. Some analysts have identified and placed cost-values on all benefits, including those benefits considered to be "intangible." Dollar

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(5) Seccombe, E.W.C.: Appraisal of health service projects using cost-benefit analysis. World Hospitals, 6:214-221, 1970

(6) Klarman, H.E.: Application of cost-benefit analysis to health systems technology. In Collen, M.F. (ed.), Technology and Health Care Systems in the 1980's, DHEW Pub. (HSM) 73-3016, Washington, D.C., U.S. Government Printing Office, 1973, pp 225-250

values have been placed on such intangibles as the value of human life and gross earnings used to assess the work output of human life(7).

This study used a more recent approach in assigning values, designating contemporary values to non-dollar or intangible benefits. Intangible benefits should not be converted into universal dollars, an operation often performed by economists. A non-dollar quantity which reflects the values and goals of those judging the program is assigned to the intangible benefits. This study substitutes the label "non-dollar benefits" for intangible benefits and agrees with Fuchs that "in the health industry...concentration on money costs alone may be frequently misleading."(8)

The cost/benefit effectiveness study at Fontana differs also in the inclusion of savings as benefits. Klarman considers savings in the use of health resources as a category of benefits. Since it is assumed that the most economically feasible program is always chosen, savings are not always a legitimately separate grouping.

Cost/benefit effectiveness is a measure of how well the selected program is operating. The effectiveness of a program is judged according to whether or not the criteria of the cost/benefit goals have been met.

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(7) Seccombe, E.W.C.: Appraisal of health service projects using cost benefit analysis. World Hospitals, 6:214-221, 1970

(8) Fuchs, V.R.: Essays in the Economics of Health and Medical Care, New York, National Bureau of Economic Research, 1972, p 12

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4.6 General Systems Model

The purpose of the general systems model is to understand and define the scope of the cost/benefit effectiveness of OHP's. The general systems model has been separated into a process model, an information model and a pressure model for clarity.

The process model, Figure 4.1, has four entities: industrial environment, OHP system, plant management, and employee. The employee is considered to be the principal entity in the system. He is affected by each of the other parts of the process model. All of the process entities are arranged to support the health and productivity of the employee. The OHP is in the middle of the model, transferring information, and communicating and enacting practices. The industrial environment includes all known or unknown health hazards and benefits. The dotted line from industrial environment to employee represents some physiological environmental effect to which the worker is exposed. Plant management is depicted as being able to control the industrial environment when necessary. The bilateral arrows represent the acting and reacting of the entities to each other. The small solid arrows indicate which entity influences another.

The information model, Figure 4.2, shows the interaction between the process system and the environment. The environment consists of labor, government, society, and enterprise, which is subdivided into financial and ethical. The various components in the process system communicate or transfer infor-

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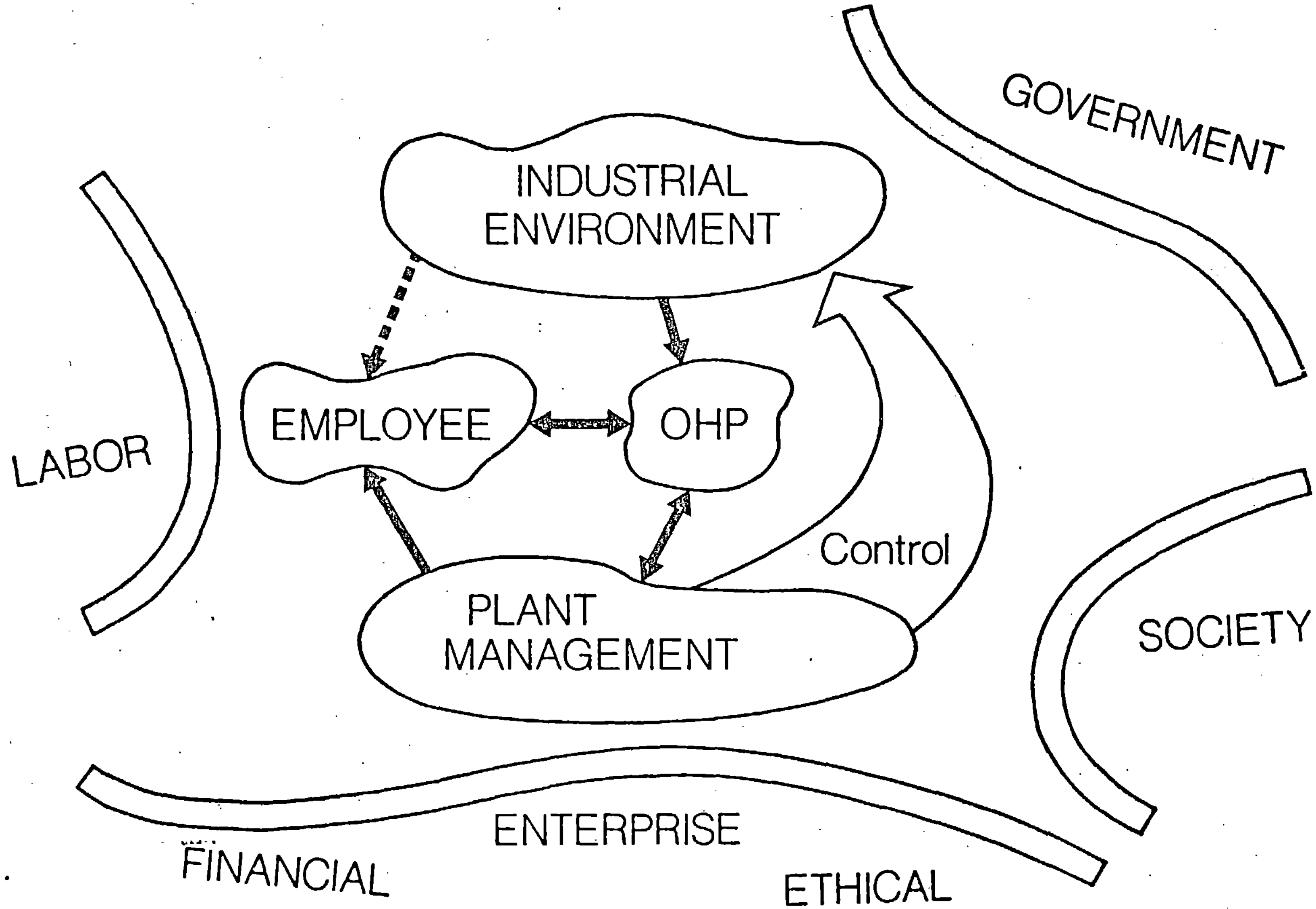

Figure 4.1

General Systems Model
PROCESS MODEL

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mation back and forth with the components of the surrounding environment. For instance, society, representing public information, and government, representing laws and political information, are shown to be communicating back and forth with each other. An important transference of information exists between plant management and government. The information sent by the plant management, often in the form of reports and surveys, influences the government's opinion and ideas about the plant's operations.

The pressure model, Figure 4.3, is concerned with the reasons or needs for the development of cost/benefit effectiveness measurements. All of the pressure exerted by the environment is directed to the plant management. In this model, the interaction is all unidirectional; there is no pressure coming direct from within the process system. The pressure from the government is in the form of laws and criteria documents regulating the industries. If the information provided by the entities in the process model to the environment is inadequate, the environment may exert greater and often inappropriate pressure. If the process model does not respond favorably to the pressure from the environment, the environment will assert greater and more rigid pressure until compliance has been reached. The more inflexible the pressure that is exerted, the more open the system becomes. An open system is one in which the system has no internal control. An open system is not advantageous to industry because its endeavors would be controlled by entities other than itself. The system must be capable of adjusting itself to the expectations of the environment or it will cease to exist.

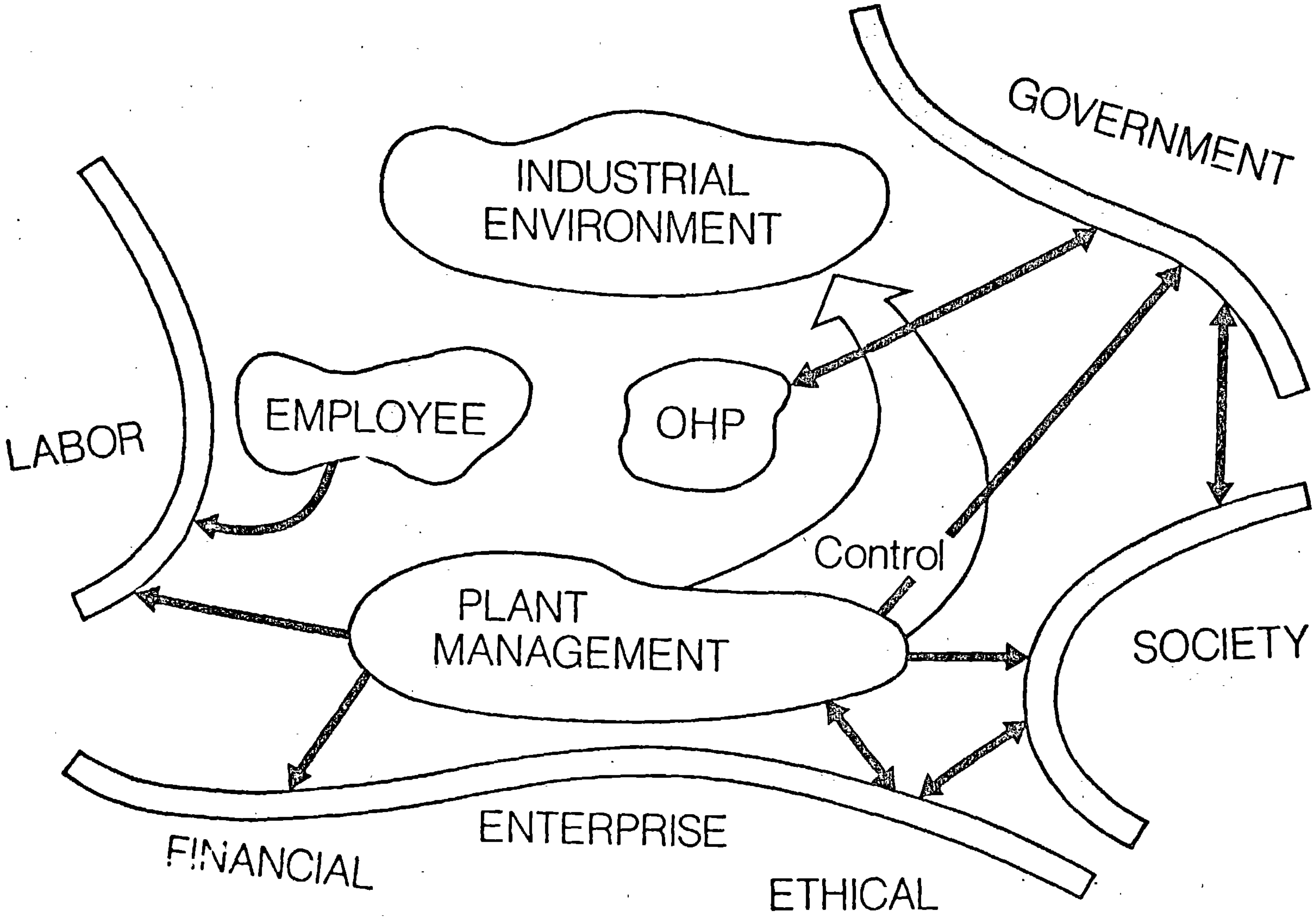

Figure 4.2

General Systems Model
INFORMATION MODEL

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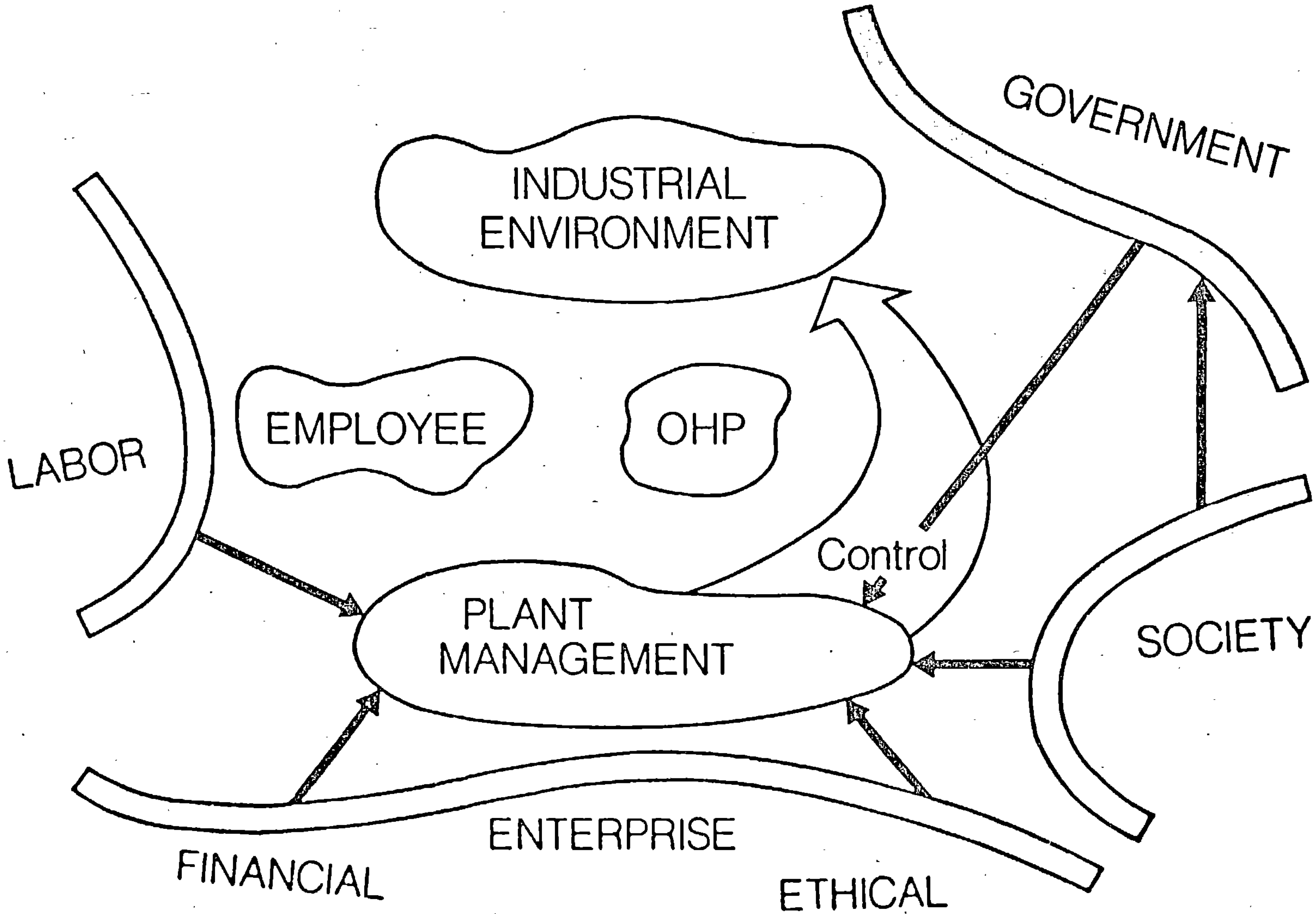

Figure 4.3

General Systems Model
PRESSURE MODEL

This study is providing information to the plant management to give to the environmental entities. The cost/benefit effectiveness study allows the plant management to receive information about the meaningfulness of its OHP. This information in turn can be delivered to the environment.

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6.3.6 Discussion of Utilization of Services Data. The observed visits for each service have been plotted by month. The optical visits have not been plotted because of inaccurate or invalid data. The miscellaneous visits have been rejected for use in the study because of lack of consistency in the types of visits included in this category.

Figure 6.1 is a plotting of KSC industrial first visits from 1956 through 1973. The peak number of visits occurs in June 1959 (998 visits); the lowest number of visits is in August 1959 (22 visits). In August 1959 a strike occurred at the Fontana plant, accounting for the low number of visits in that month. The high number of June visits may be representative of workers applying for medical excuses. During the months immediately preceding a strike, the workers often claim illness and injuries in order to claim California State Disability Insurance for the strike period ("hedging" against the strike). The number of visits has declined since 1956, either because an accident program had just begun or because the employees are more experienced. After adjusting for the seasonal fluctuations of the utilization of services since 1973, the number of visits has varied at approximately a constant mean.

The peak of KSC industrial subsequent visits (Figure 6.6) is in August 1969 (1207 visits). October 1959 had the lowest number of visits (96 visits). The 1959 strike caused the number of visits to drop rapidly at the end of the year; the January 1972 strike also caused the drop in visits in 1972.

The 1959 and 1972 strikes caused the decrease in KSC non-industrial first visits (Figure 6.5) in August 1959 (164 visits) and in early 1972. Since 1969 there has been a decline in the number of visits, possibly due to the medical department decision to change the policy and reduce the number of non-industrial injuries seen. The jump in December 1969 (1902 visits) may have been "hedging" in reaction to the 1969-1970 economic recession that caused many layoffs; the workers may have tried to get as many off-work orders as possible before lay-off.

The decision to change the medical department policy towards the treatment of non-industrial subsequent visits (Figure 6.2) caused the fluctuations in utilization after 1969. From the end of 1969 through the middle of 1973, the medical department decided not to treat as many non-industrial injuries. The increase of visits during the last three months of 1973 is due to another policy change. The medical department has decided that non-industrial subsequent visits may be seen as preventing an excess of lost workdays due to untreated non-industrial injuries or illnesses.

The number of executive physical examinations (Figure 6.3) varies with the size of the physician staff available. In December the medical department staff is often short of physicians and the number of executive physicals performed is reduced. The many executive physicals for March 1972 (35 visits) may be due to a reaction to the decision to remove executive physical examinations from the services offered

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by the medical department. In 1973, the medical department reinstated the executive physicals in their program.

The number of pre-employment physical examinations (Figure 6.4) is dependent on the seasonal hiring of extra workers. The peak of pre-employment visits occurs during the summer months when new workers are being hired to replace summer vacationing regular workers. Again, the 1959 strike accounts for the low number of visits in September 1959.

The number of periodic health examinations (Figure 6.7) depends on the type of examination conducted. The audiometric examination is the largest group of exams and is performed by location. The various locations are tested in different months, accounting for the fluctuations from month to month. The 1959 strike was the cause of the absence of any visits during September, October, or November 1959.

Figure 6.5
KSC Non-Industrial First Visit

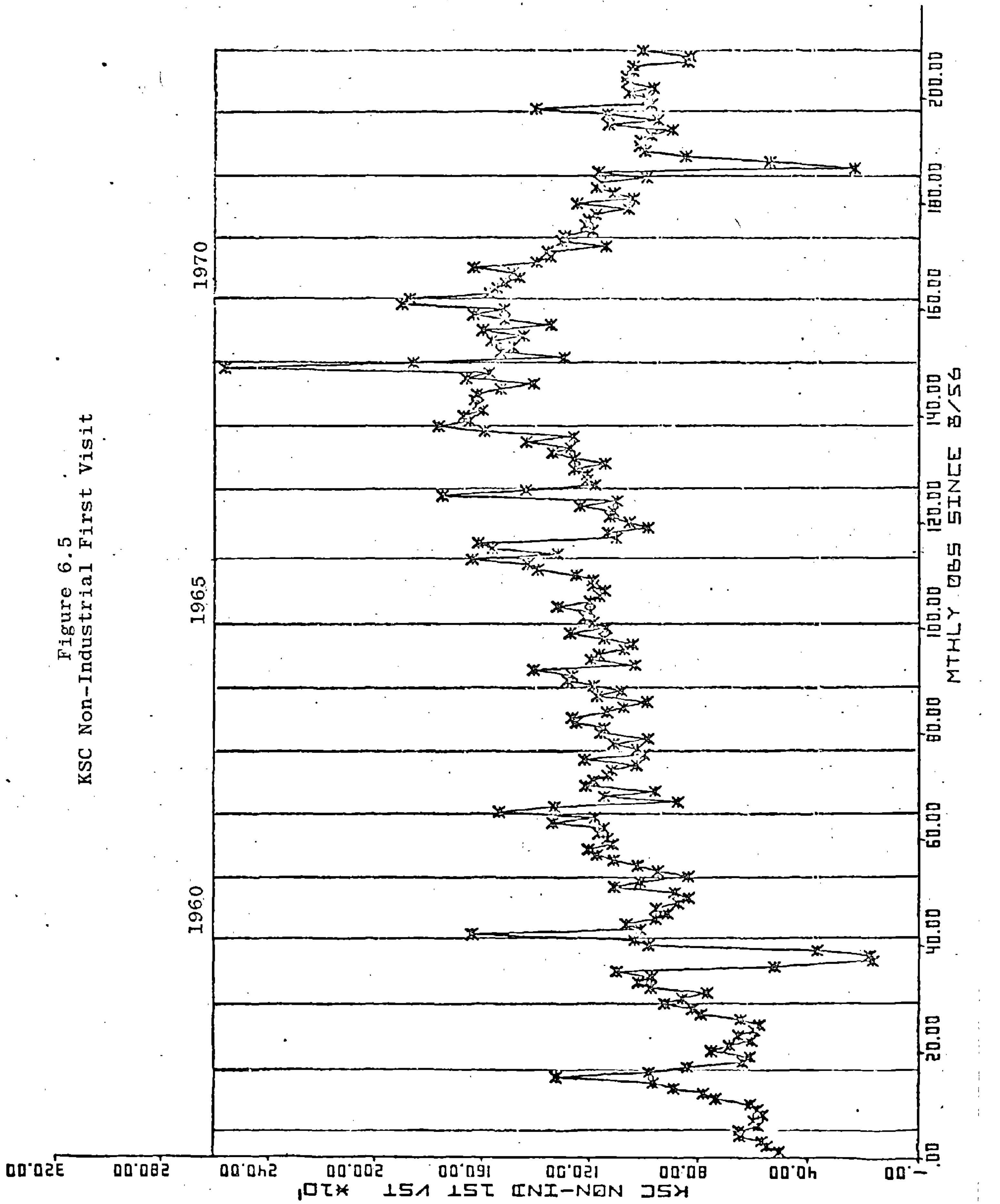

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Figure 6.6
KSC Industrial Subsequent Visits

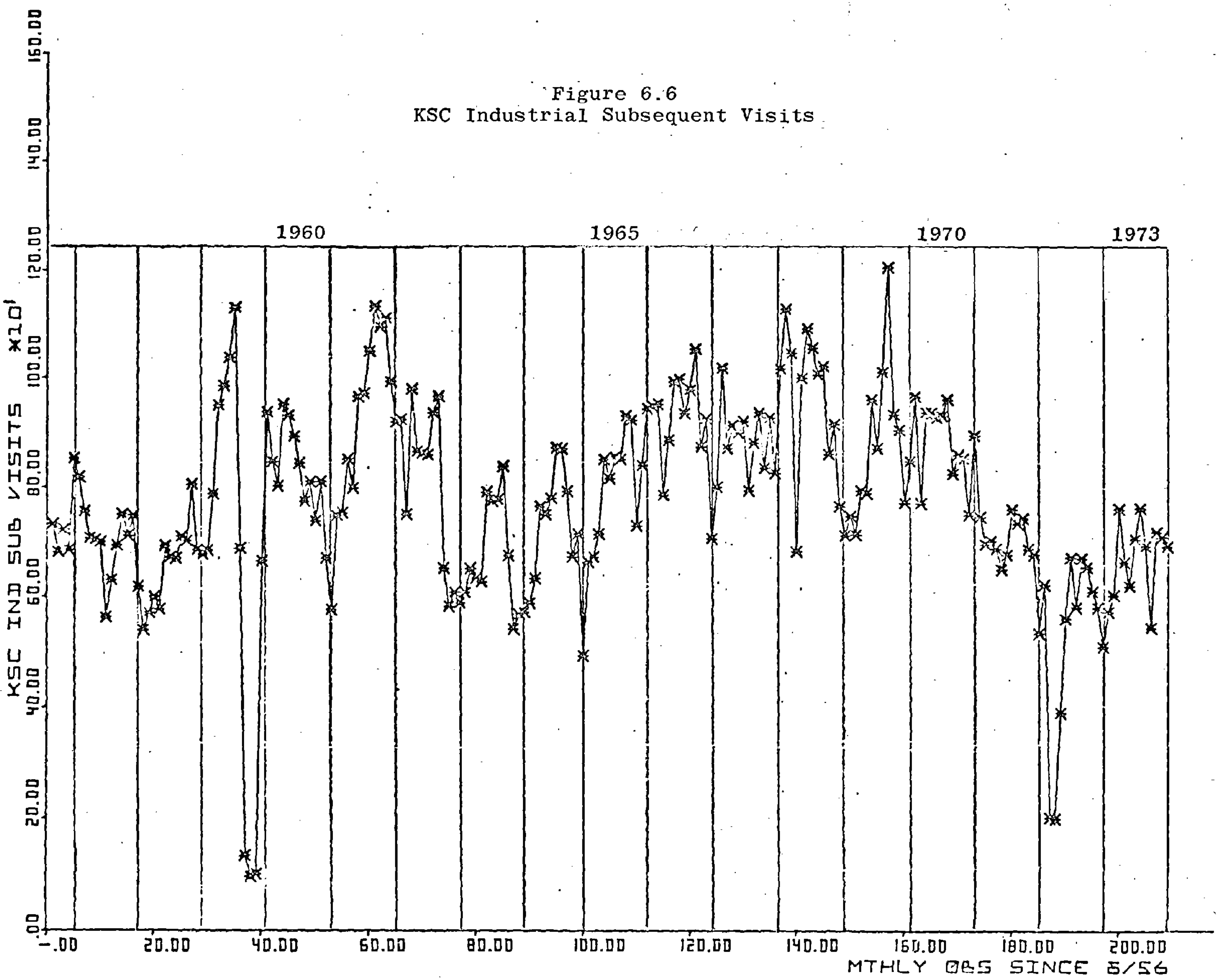

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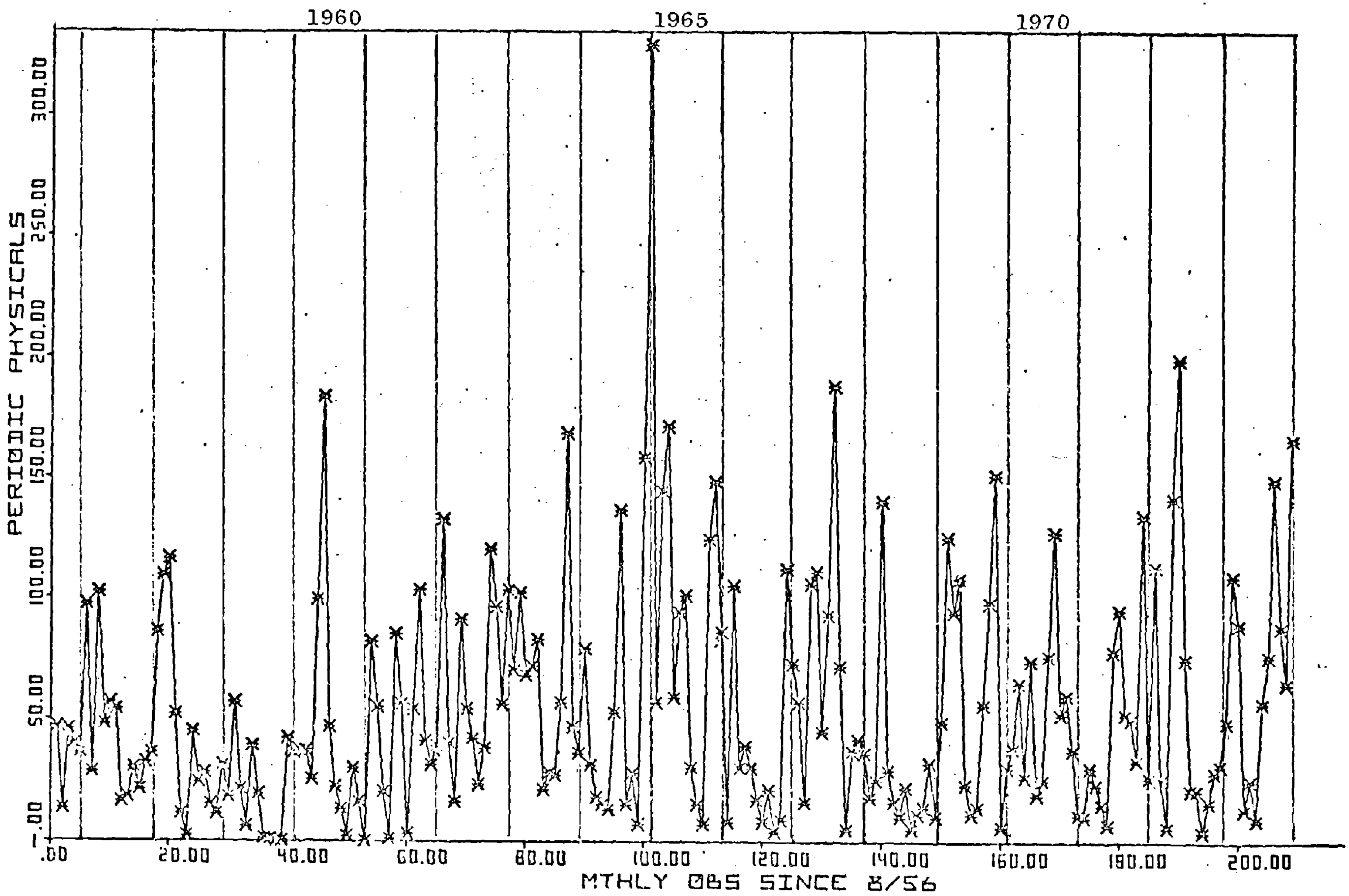
Figure 6.7
KSC Periodical Physicals



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6.4 Construction of Population-to-Service Matrix (continued)

The population-to-service table (Table 6.2) illustrates the utilization of services by population class and service type. At first, it had been postulated that the employee class could be divided into sex and age categories. After studying the available data, it was decided to separate the population class into hourly and salaried employees and the employee subclass by seniority.

Age and seniority are closely related groupings. The longer one works, the older net age one accumulates. The greatest turnover occurs among the younger employees and within three to five years of seniority class. After an employee has been with the same company for more than five years, there is a tendency to remain an employee of that company for many more years.

The hourly employees are the line operation workers. The salaried employees are the support staff, usually directly involved in supervision rather than in production.

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Table 6.2 shows the number of first visits to each of the medical department services by the hourly employees according to their seniority class. The name of the six seniority classes is the first column of the table. All of the employees in the 0 to 1 named class have a hire date of 1973 or 1974. For example, those in the named class 1 to 3 have hire dates of 1971 and 1972.

The second column is the total number of hourly employees in each of the seniority class groups. The next fourteen columns are the medical services, separated into the four major classifications of treatments, physical examinations, medical surveillance, and health maintenance. The number represents the frequency of first occurrences (visits) by each seniority class to the medical department.

For example, the hourly seniority class 0-1 (column 1) made 398 visits for industrial injury (column 3) during the course of the 179 day study. Using transformation nomenclature, this means that from seniority class 0-1 to industrial injury class of service there are 398 visits. The total number of visits to each medical service is given at the bottom of the table and the total visits by each seniority class are given at the right side of the table. For instance, the total visits for service by the 0-1 seniority class were 225 and the total industrial injuries were 1,372.

The next step in the construction of the population to service matrix, Table 6.4 is the scaling of all of the visits of the hourly employees (from Table 6.3) by the population. For example, in Table 6.3 the number of persons in seniority class 0-1 is 463 and the occurrences of industrial injury for that class is 812. Dividing 812 by 463, the value 1.7528 (column 2 of Table 6.4) is obtained. This means that for each person in the seniority class 0-1 there are 1.7528 utilizations of the industrial injury service. These values in Table 6.4, all computed in the same way as the 0-1 seniority class for industrial injury, represent the values scaled by the number of persons in each seniority class.

Table 6.5 is the final population-to-service matrix. The industrial injuries have been divided into the six types of injuries, using proportion derived from the 1973 accident summary report.

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In order to obtain the total service utilizations for the new population group, the value given in Table 6.4 is multiplied by the number of people in the population and the corresponding results are added to obtain the total service utilizations for the new population group. That is, if the population had changed for the 0-1 seniority class to 500, 1.75 is multiplied by 500 to obtain 875 visits, the total utilization for that class.

At this time, the answer to the important question, do the coefficients remain constant over time, remains unanswered. It is important to look at each of the proportions as they indicate the level of service which will need to be provided per individual employee. If there is a significant change statistically derived from the coefficients in the current year, the year of the study, and the next year, the program would have to be revised the year after the preliminary study to consider the change in the coefficients over time.

A closer look at the proportions for industrial injury in Table 6.4 shows that the from-to relationship for seniority class to industrial injury is roughly decreasing by the seniority class. The exception to this decreasing rule are the groups 3-6 and 6-15. If these two groups are combined, then the industrial injury service would be in a first visits decreasing order. The difference of 0.08 between 0.37 and 0.45 is large enough to indicate that there may be a true difference between these classes.

A second population-to-service matrix is necessary for salaried employees. Tables 6.6 through 6.9 show the same progression of computations that have been used for developing the hourly employee matrix. The first three seniority classes for the salaried employees have been combined because of the lack of observations of industrial injuries or illnesses in the salaried groups. Most of the injuries for the salaried workers tend to occur in the older age groups because these employees are the line foremen. Other salaried workers are the managers, typists and clerks.

Table 6.7 shows the service visits adjusted to an annual basis, enabling the model to be an annual model. An interesting comparison of Tables 6.4 and 6.8 can be made. The industrial injury and illness visits for the salaried employees are almost zero (0-0.06); the visits for the same service by the hourly employees are significantly higher (.1-1.8). Also, non-industrial illnesses are much lower for the salaried employees than for the hourly employees. Tables 6.4 and 6.8 are both essentially the population-to-service matrix, without the partitioning for the industrial injuries. A comparison of the service demand per person in each of the seniority classes can be made between the same industries or between different industries in the same way as the comparison between Tables 6.4 and 6.8 is made.

Table 6.6

Salaried Employees
Recorded First Occurrence Visits
by Service and Seniority Classes

Seniority Class		Treatments				Physical Examinations			Medical Surveillance					Health Maintenance		
Name	No. of Persons	Injury - Industrial	Illness Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse	Total
0-6	167	0	0	5	75	11	2	2	1	60	0	0	0	0	0	156
6-15	368	8	1	21	143	1	17	4	8	134	0	1	0	0	1	339
15-24	358	9	0	21	159	0	24	1	0	116	0	0	0	1	0	331
Over 24	157	5	0	4	81	0	8	0	2	48	0	0	0	0	0	148
Total	1,050	22	1	51	458	12	51	7	11	358	0	1	0	1	1	974

Table 6.7

Salaried Employees
Service Visits Adjusted to Annual Basis*

Seniority Class		Treatments				Physical Examinations			Medical Surveillance					Health Maintenance		
Name	No. of Persons	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse	Total
0-6	167	0	0	10	153	22	4	4	2	122	0	0	0	0	0	317
6-15	368	16	2	43	292	2	35	8	16	273	0	2	0	0	2	691
15-24	358	18	0	43	324	0	49	2	0	237	0	0	0	2	0	675
Over 24	157	10	0	8	165	0	16	0	4	98	0	0	0	0	0	301
Total	1,050	44	2	104	934	24	104	14	22	730	0	2	0	2	2	1,984

*365 days in the year divided by 179 days in the study, times all values in Table 2.1

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Table 6.8

Salaried Employees
Ratio of First Visits
to Number of Persons in Seniority Class

	Treatments				Physical Examinations			Medical Surveillance					Health Maintenance	
Name of Seniority Class	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse
0-6	0.0000	0.0000	0.0610	0.9158	0.1343	0.0244	0.0244	0.0122	0.7326	0.0000	0.0000	0.0000	0.0000	0.0000
6-15	0.0443	0.0055	0.1164	0.7924	0.0055	0.0942	0.0222	0.0443	0.7425	0.0000	0.0055	0.0000	0.0000	0.0055
15-24	0.0513	0.0000	0.1196	0.9056	0.0000	0.1367	0.0057	0.0000	0.6607	0.0000	0.0000	0.0000	0.0057	0.0000
Over 24	0.0649	0.0000	0.0520	1.0520	0.0000	0.1039	0.0000	0.0260	0.6234	0.0000	0.0000	0.0000	0.0000	0.0000

Table 6.9

Salaried Employees
Population-to-Service Matrix

Name of Seniority Class	Treatments									Physical Examinations			Medical Surveillance					Health Maintenance	
	Injury - Industrial																		
	Puncture	Contusion	Burn	Strain	Fracture	Other	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse
0-6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0610	0.9158	0.1343	0.0244	0.0244	0.0122	0.7326	0.0000	0.0000	0.0000	0.0000	0.0000
6-15	0.0143	0.0157	0.0085	0.0039	0.0016	0.0003	0.0055	0.1164	0.7924	0.0055	0.0942	0.0222	0.0443	0.7425	0.0000	0.0055	0.0000	0.0000	0.0055
15-24	0.0166	0.0181	0.0098	0.0045	0.0018	0.0004	0.0000	0.1196	0.9056	0.0000	0.1367	0.0057	0.0000	0.6607	0.0000	0.0000	0.0000	0.0057	0.0000
Over 24	0.0210	0.0229	0.0124	0.0057	0.0023	0.0005	0.0000	0.0520	1.0520	0.0000	0.1039	0.0000	0.0260	0.6234	0.0000	0.0000	0.0000	0.0000	0.0000

6.5 Application of Accident Data for Population-to-Service Matrix

The data for the 1973 industrial accidents have been collected and analyzed to provide methods of categorizing the population by the industrial injuries and illnesses at Fontana. The accident data are used to establish the preliminary categories for age and seniority based upon the industrial injury and illness experience. The accident data are also used as the basis for partitioning service class of industrial injuries (the largest class of data accumulated) into subclasses. A comparison of the Fontana accident statistics with the national figures for the steel industry has been included to show Fontana's position in the steel industry.

The accident statistics from Fontana are used to establish meaningful classes of employee population. The 1973 accident data presented in Tables 6.11 to 6.17 have been collected by the medical department. Forms for reporting the accidents, first report of injury or illness forms, are filled out for each occurrence by the medical department staff (Appendix D). The safety department checks the forms each day for compliance with OSHA regulations. Some of the forms report accidents with multiple injuries. The safety department decides which of the injuries are recorded in the accident statistics, using OSHA criteria; the non-primary multiple accidents are recorded only in the medical department files. The data obtained from these daily report forms are keypunched and an annual report is prepared. The total number of accidents actually reported in the medical department files is not always the same as the recordable number. Also, first aid cases are not included.

One of the purposes of this study is to adjust the model to the size and capabilities of OHP's at other plants. Table 6.10 shows that the number of accidents per 100 employees occurring within manufacturing plants does not necessarily increase with the size of the plant. The largest number of accidents seens to be occurring in the middle-sized plants, with the number decreasing after the 249-employees group. This may indicate that any scaling of the model will have to consider an adjustment of the services provided. Another explanation for the increase of recordable occupational accidents from plants with one employee to those with 249 employees, and the decrease in accidents with the 250-employee plants, could be differences in reporting accidents.

Table 6.10

Recordable Occupational Injury and Illness Incidence Rates by Size of Unit for Manufacturing Division - 1972

Number of Employees	Incidence Rate per 100 Employees
All sizes	15.6
1 to 19	11.8
20 to 49	16.5
50 to 99	19.5
100 to 249	20.2
250 to 499	17.3
500 to 999	14.3
1000 to 2499	11.9
2500 and over	12.4

Source: Bureau of Labor Statistics
U. S. Department of Labor

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Accident rates at Fontana compare favorably with the national steel industry rates. In 1973, there were 2145 accidents in the Fontana plant for the 6942 production and maintenance workers. According to the 1972 OSHA figures, there were 17.4 recordable accidents per 100 employees in the blast furnace and basic steel products category. The American Iron and Steel Institute, with 91.6% of all companies producing raw steel in 1972 reporting, listed 14.4 recordable accidents per 100 workers. For 1972, Fontana had 4.13 recordable accidents per 100 employees and in 1973 had only 3.07 recordable accidents.* The greatest portion of accidents at Fontana are the first aid cases, since Fontana had 27.6 accidents including first aid cases for 1973, and only 3.07 recordable accidents.

*Discussions with R. J. Wayne, Corporate Director of Safety, KSC, on 7/18/74.

Table 6.11

Accident Rates by Length of Service

Length of Service (number of years)	(1) Accidents: Proportion to Total Reported (2145)	(2) Population: Proportion of Total Seniority Group (6624)	Ratio: (1) to (2)
Less than 1	0.2732	0.1353	2.02
1 but less than 2	0.0624	0.0604	1.03
2 but less than 3	0.0471	0.0251	1.88
3 but less than 4	0.0531	0.0393	1.35
4 but less than 5	0.0350	0.0370	0.95
5 but less than 6	0.0438	0.0341	1.28
6 but less than 7	0.0392	0.0358	1.09
7 but less than 8	0.0462	0.0620	0.75
8 but less than 9	0.0312	0.0332	0.94
9 but less than 10	0.0261	0.0531	0.49
10 but less than 11	0.0075	0.0036	2.08
11 and over	0.3352	0.4811	0.70

The classes of length of service (Table 6.11) are defined by the safety reports. The length of service table shows the proportion of accidents in each class of seniority to the total number of accidents (2145). Column 1 provides the proportion of total accidents in each length of service category. The total reported for the seniority group is divided by the total number of reported accidents. The highest proportions of accidents are in the first and last seniority groups.

Column 2 represents the total number of people in each seniority group (as provided by the latest Industrial Relations report of union negotiations) divided by the total number of employees (6642) studied. Again, the highest proportions are in the first and last groups.

Column 3 is the proportion of Column 1 divided by Column 2. This scales the injury and illness rates by the population. The ratios are in descending order with two major exceptions, length of service class 3 and class 11. The high number in class 3 is explained by the high number of job changes occurring. After a few years of experience, the employees change to higher grade jobs and the high class 3 proportion represents an orientation to the new job and its safety requirements. The high proportion in class 11 may be accounted for by a random error which would show up clearly because the seniority group is small, with only 24 members.

The age groups in Table 6.12, accident rates by age, are dictated by the groups in the accident report forms. The age groups, except for the under 20 and over 60 classes, are in five and six year intervals. Column 1, the proportion of accidents in each age class, is computed by dividing the number of accidents in each class by the total number of accidents. Column 2 represents the number in each age group divided by the total population in the reporting year. Column 3 is the ratio of column 1 divided by Column 2. The ratios in Column 3 are in descending order, and from the age group 36-40 through the over-60 class the ratios occur randomly. The ratios indicate that a different grouping of age classes can be more meaningful. All of the ratios for the age groups above 30 years are very similar. The major age groups, for the occurrence of accidents, can be expected to be: under 20, 20-25, 26-30, and 30 and over.

Table 6.12

Accident Rates by Age

Age	(1) Proportion of Accidents	(2) Proportion in Total Population	Ratio (1) to (2)
Under 20	0.0951	0.0383	2.48
20-25	0.2522	0.1588	1.59
26-30	0.1198	0.1134	1.06
31-35	0.0909	0.1005	0.90
36-40	0.0914	0.1099	0.83
41-45	0.0816	0.1078	0.76
46-50	0.0797	0.1158	0.69
51-55	0.0876	0.1104	0.79
56-60	0.0615	0.0948	0.65
Over 60	0.0401	0.0503	0.80

Table 6.13 shows the proportion of accidents in each treatment category. In 1973, none of the accidents has resulted in restricted work or motion or transfer to another job. As pointed out previously, the majority - or 88% - of the 1973 accidents required first aid treatment only.

Table 6.13

Proportion of Injuries by Category

Injuries	
First Aid	0.8895
Medical Treatment	0.0671
Occupational Illness	0.0093
Lost Workday	0.0312
Loss of Consciousness	0.0019
Restricted Work or Motion	0
Transfer to Another Job	0
Not Related	0

Tables 6.14 to 6.17 represent an attempt to partition the accidents into more defined categories. Table 6.14 shows the occurrence of injuries by the part of the body affected. The proportions generated for each body part are well distributed, but since there is no indication of which resources are utilized in the treatment, it is not a good method of classification. It should be noted that 30% of the injuries affect the finger and 15% the shoulder, arm and wrist. The toes and abdomen are the body parts that are injured least often.

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Table 6.14

Injury - Part of Body

Skull	0.0168
Face/neck	0.0816
Eyes	0.0326
Shoulder, arm, wrist	0.1506
Hand	0.1068
Finger	0.3012
Thorax/below clavicle, above diaphragm	0.0145
Abdomen	0.0084
Back	0.0471
Hips, knees, legs	0.1413
Ankles	0.0350
Feet	0.1413
Toes	0.0089
Other	0.0028

Table 6.15 classifies the injuries by disposition. The table shows the severity of the injuries according to the ability of the injured worker to return immediately to the job. The numbers generated for each injury disposition class are not exclusive. In other words, the table is not appropriate as a classification method because an injury resulting in immediate return to work does not exclude the possibility of a revisit date.

Table 6.15

Injury by Disposition

Regular Work	0.3850
Home	0.0238
Hospital Admission	0.0075
Revisit Date	0.5814
Other	0.0014

Table 6.16 represents the occupational illness occurrence by type. It is rejected for use as a way to partition the industrial injuries and illnesses because the actual occurrence of occupational illness as a proportion of the total reported is so low (0.0103). It can be noted that 73% of the occupational illnesses are skin diseases.

Table 6.16

Occupational Illness by Type

Disease	Proportion of Total Occupational Illness
Skin Disease	0.73
Dust disease of lungs	0.0
Respiratory due to toxic agents	0.05
Poisoning	0.05
Disorders due to physical agents	0.09
Disorders due to repeated trauma	0.09
Other	0.0

Table 6.17, type of injury, is the table most relevant to the study. The injury type classes are the same as those on the accident report forms. More than 60% of the injuries fall into the laceration, puncture and abrasion, contusion categories. The amputation and other categories account for less than 1% of the total injuries.

Table 6.17

Type of Injury

Laceration, puncture	0.3230
Abrasion, contusion	0.3529
Burn	0.1911
Strain, sprain	0.0878
Fracture, dislocation	0.0359
Amputation	0.0014
Other	0.0065

7.4.2.1 Experience with Task and Job Descriptions. The time study involved the establishment of job definitions for the entire medical department staff. This was accomplished by the staff. Having the staff prepare the task definitions had two by-products. They were forced to study their jobs comprehensively in terms of particular tasks and services. Also, a clearer definition of the areas needing support by medical directives for nurses or physical therapists became obvious. In OHP's, which are often separate from the general medical community, it is easy for the medical director to assign certain tasks to a medical staff member who would ordinarily not be responsible for such a task.

note ✓ MMP

7.4.2.2 The Mathematics of Time Study Method. The mathematics model for computing the resource unit per service class or subclass is constructed by adding all of the task vectors associated with a particular service. A "task vector" will have as many components as each of the resources. Each component will quantitatively represent the total man years per service visit as estimated from the work sheet. The "expendables by areas" are allocated by the hours per service unit, and for outside services.

There are restrictions regarding personnel using both methods. The computation of multiplying services times the service-to-resource matrix results in resource utilizations such as, "Nine and one-quarter nurses are used." This statement indicates that 9-1/4 man years of nursing time are needed to provide the services. The nursing man years can be distributed according to the available personnel in the medical facility, not excluding part-time personnel. Resource persons may not always be available in the man year fractions required. In such cases facilities will have to decide between having a full-time resource person or no resource person at all to cover the fraction of man years.

A suggestion for the future is that the transition from services to resources could adjust to the scaling problem (economics of scale) better by using a mixed integer program which would always select the optimal set of resources within the specific constraints of the problem. In this program, one would always assume the minimum cost allocation of resources to perform the task. A pure minimization of the costs may also reduce the medical services provided (e.g., the salary of a general practitioner is lower than that of an accredited occupational physician, but an occupational physician would provide better medical services in an industrial medical facility.

The model transformation presented carries services into resources, regardless of the derivation methods used in the matrix estimations. The system as it has been so far discussed, can be mathematically represented as:

$$[R] = \left\{ \left([P_{salaried}] \times [PS_{salaried}] \right) + \left([P_{hourly}] \times [PS_{hourly}] \right) \right\} \times [SR]$$

Where $[R]$ is resource vector with 17 components

$[P]$ is a population vector with 6 components for the hourly and 4 components for salaried

$[PS]$ is the population to service matrix with 20 service components and 4 population components for salaried and 6 components for hourly.

A comparison of the various cells of the current resource-to-service matrix for an OHP between other years and industries, or intra-industrially, can be of great value.

7.4.4 Resource Substitution. It is important to note that in Table 7.2 certain facilities would substitute between classes. For instance, one facility might hire more nurses and fewer doctors to perform the medical duties. In other facilities, allied health personnel might be hired. The use of alternative personnel to staff an industrial medical department is an important consideration. (Appendix E)

7.5 Effect of Population Class on Resource Utilization

From the planning and operational point of view, it is important to consider the frequency per person per year of multiple visits. The previous tables dealt only with the first visits to the medical services. Table 7.3 represents all visits during the study period, and Table 7.4 represents the difference for all first visits subtracted from the total visits. Table 7.4 is therefore the table of true subsequent visits, or multiple visits, to the facility. Table 7.5 is the same as Table 7.4, adjusted to an annual basis.

Table 7.6 is the utilization per person. Note that industrial injuries decrease with increasing seniority. Seniority class 0-1 has 2.36 multiple visits per employee and the over 24 group is 0.3257. These data suggest that the younger seniority classes tend to have more severe injuries than the over 24 seniority class. The multiple visits for non-industrial injuries are also the greatest in the 0-1 seniority group. The multiple visits for carcinogens and for silica/asbestos reflect the type of medical monitoring that is used. In both programs, x-rays are taken and are often reviewed with the patient only when abnormalities are noticed.

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Table 7.3

Hourly Employees
All Visits During Test Period
by Service and Seniority Class

Seniority Class		Injury and Illness				Physical Examinations			Medical Surveillance					Health Maintenance		
Name	No. of Persons	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse	Total
0-1	463	934	1	79	768	52	15	27	37	766	0	19	71	10	40	2,819
1-3	587	512	2	34	514	0	4	34	10	300	0	23	33	14	1	1,481
3-6	919	619	6	38	521	2	8	34	21	292	0	32	26	26	2	1,627
6-15	1,515	1168	1	66	810	1	20	111	20	629	1	67	23	28	2	2,947
15-24	2,486	1111	0	46	614	0	17	119	26	609	1	67	42	27	0	2,679
Over 24	1,415	300	0	15	199	0	12	75	6	241	0	15	40	13	0	916
Total	7,385	4644	10	278	3426	55	76	400	120	2837	2	223	235	118	45	12,469

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Table 7.4

Hourly Employees
Multiple Visits During Test Period
by Service and Seniority Class

Seniority Class		Injury and Illness				Physical Examinations			Medical Surveillance					Health Maintenance		
Name	No. of Persons	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse	Total
0-1	463	536	1	8	25	9	1	2	0	0	0	1	1	0	0	584
1-3	587	342	1	2	12	0	0	2	0	0	0	0	1	0	0	360
3-6	919	451	5	4	8	1	0	4	0	0	0	1	2	2	0	478
6-15	1,515	832	1	7	15	0	2	5	0	0	0	5	0	0	0	867
15-24	2,486	885	0	4	27	0	3	3	0	0	0	3	3	0	0	928
Over 24	1,415	226	0	1	13	0	3	0	0	0	0	1	0	0	0	244
Total	7,385	3272	8	26	100	10	9	16	0	0	0	11	7	2	0	3,461

Table 7.5

Hourly Employees
Multiple Visits Adjusted to Annual Basis*

Seniority Class		Treatments				Physical Examinations			Medical Surveillance					Health Maintenance		
Name	No. of Persons	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse	Total
0-1	463	1093	2	16	51	18	2	4	0	0	0	2	2	0	0	1190
1-3	587	697	2	4	24	0	0	4	0	0	0	0	2	0	0	733
3-6	919	920	10	8	16	2	0	8	0	0	0	2	4	4	0	974
6-15	1,515	1697	2	14	31	0	4	10	0	0	0	10	0	0	0	1768
15-24	2,486	1805	0	8	55	0	6	6	0	0	0	6	6	0	0	1892
Over 24	1,415	461	0	2	27	0	6	0	0	0	0	2	0	0	0	498
Total	7,385	6673	16	52	204	20	18	32	0	0	0	22	14	4	0	7055

*365 days in the year divided by 179 days in the study, times all values in Table 3.2

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Table 7.6

Hourly Employees
Ratio of Multiple Visits
to Number of Persons in Seniority Class

	Treatments				Physical Examinations			Medical Surveillance					Health Maintenance	
Name of Seniority Class	Injury - Industrial	Illness - Industrial	Injury - Non-Industrial	Illness - Non-Industrial	Pre-employment Examination	Periodic Examination	Special Examination	Hearing Conservation	Optometric	Radiation	Carcinogens	Silica and Asbestos	Alcohol Abuse	Drug Abuse
0-1	2.3606	0.0044	0.0352	0.1101	0.0396	0.0044	0.0088	0.0000	0.0000	0.0000	0.0044	0.0044	0.0000	0.0000
1-3	1.1880	0.0035	0.0070	0.0417	0.0000	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0035	0.0000	0.0000
3-6	1.0007	0.0111	0.0089	0.0178	0.0022	0.0000	0.0089	0.0000	0.0000	0.0000	0.0022	0.0044	0.0044	0.0000
6-15	1.1198	0.0014	0.0094	0.0202	0.0000	0.0027	0.0067	0.0000	0.0000	0.0000	0.0067	0.0000	0.0000	0.0000
15-24	0.7259	0.0000	0.0033	0.0222	0.0000	0.0025	0.0025	0.0000	0.0000	0.0000	0.0025	0.0025	0.0000	0.0000
Over 24	0.3257	0.0000	0.0014	0.0187	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000	0.0014	0.0000	0.0000	0.0000

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A fuzzy set has grades of membership. There are two methods of defining the fuzziness of the goal in absolute values. One method uses a formula derived by L. A. Zadeh(1,2,3,4) and R. E. Bellman(5).

$$Fg(x) = (1 + a(x-15)^m)^{-1} \qquad \text{Eq. 9.1}$$

where a = fuzziness constant
m = fuzziness constant
x = performance score
Fg(x) = fuzzy goal given x

The other method uses assigned values.

For example, the statement "the performance score for audiometric surveillance should be in the vicinity of 15" is a fuzzy goal. Since we are interested in fuzzy values for some performance scores, we will calculate or assign values to numbers above and below the value 15. Using Eq. 9.1, we derive the following values for Fg(x) for 13, 14, 15 and 16:

Table 9.1

Fuzzy Variable Values: Calculated

x	13	14	15	16	17
Fg(x)	.2	.5	1.0	.5	.2

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(1) Zadeh, L.A.: A Fuzzy-Set-Theoretic Interpretation of Linguistic Hedges. Electronics Research Laboratory Memorandum No. ERL-M335, Berkeley, University of California, 1972

(2) Zadeh, L.A.: Fuzzy sets. Information and Control, 8:3, 1965

(3) Zadeh, L.A.: Quantitative fuzzy semantics. Information Sciences, 3:159-176, 1971

(4) Zadeh, L.A.: Probability measures of fuzzy events. Journal of Mathematical Analysis and Applications, 23:2, 1968

(5) Zadeh, L.A. and Bellman, R.E.: Decision-Making in a Fuzzy Environment. Electronics Research Laboratory Report No. ERL-69-8, Berkeley, University of California, 1969

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Using the other method of assigning values for Fg(x) for 13, 14, 15, and 16, we have the following function definition:

Table 9.2

Fuzzy Variable Values: Assigned

x	13	14	15	16	17
Fg(x)	.3	.8	1.0	.6	.5

ELSE Fg(x) = 0

The most difficult task in the construction of these tables is defining the fuzziness associated with the goals. The value of a goal or constraint plays a central role in the decision process. A decision is defined as the confluence of goals and constraints. The decision tabloid (Table 9.3) represents three alternative programs. Each column is a different alternative with fuzzy goals, Fg_1, and fuzzy constraints, Fc_1. The decision value, Fd, for each alternative is found by selecting the minimum value in each column. The three Fd or decision values are 0, 0.1, and 0.6. Alternative 3 has the greatest value and should be considered the best alternative.

Table 9.3

Fuzzy Decision Tabloid

	Alternatives 1	2	3
Fg_1	.0	.1	.7
Fg_2	.1	.6	.6
Fc	.3	.6	.7
Fc_2	.2	.4	1.0
Fd	.0	.1	.6

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9.1 Net Cash Value

This study considers costs as components of the dollar benefits. All system "costs" are subtracted from the revenue to yield net dollar benefits. These dollar benefits can be either positive or negative, depending upon the cash flow to and from the occupational health program. The costs considered in the Fontana study are the medical facility costs (classified by resource components), compensation insurance (indemnity and medical claims), and asset additions.

A corresponding price (unit cost) for each component of the resources must be established to evaluate the costs of the medical facility operations. The original invoices for the Fontana medical department were reviewed to allocate dollars into resource categories.

Some of the expenses, such as building maintenance, have been proportionally distributed according to medical area. Since salaries are confidential, "mid-range values" for all medical staff were substituted. The product of a resource vector and the price vector is the total cost for the year. Prices change each year so that price (unit cost) by resource will not be the same each year. The rate of change per year is termed the escalation rate. A general index of medical services may be used to determine an escalation rate when little historical information is available.

Every enterprise is legally required to provide on-the-job illness and injury compensation to its employees. This legal requirement is satisfied at Fontana with a cooperative effort by the safety department, the medical department, and the insurance department. The insurance department is in charge of the payment of all employee illness and injury claims.

Since Kaiser Steel Corporation is self-insured for compensation claims, these payments are considered as expenses. The compensation insurance costs include two different expenses to the manufacturing facility: medical claims and indemnity claims (Figures 9.1 and 9.2). The medical indemnity claims represent immediate negative cash flow. The state requires a reserve fund for future claims, usually placed in low yield bonds. These bonds provide a positive cash flow.

The safety department provides an industrial injury and illness prevention program which should reduce the demand for service. The implementation of the programs should reduce the frequency and severity of industrial injuries and illnesses and promote a healthful work environment. The reduced demand for services then results in a reduction of costs. The effectiveness of the safety programs may be measured according to the frequency of first industrial visits.

The Fontana medical department is responsible for preventing the occurrence of industrial illness through the implementation and administration of health surveillance programs. Insurance compensation claims are reduced by treating injuries and illnesses within the medical department, rather than sending the employees to outside health facilities. The medical department may also reduce compensation costs by alleviating the disabilities of injured employees through extended treatment, such as physical therapy. Outside health facilities may not be as concerned as the in-plant medical facility in preventing and alleviating disabilities.

Figure 9.1
DOLLARS PER MONTH OF INDEMNITY CLAIMS
(January 1970 through March 1974)

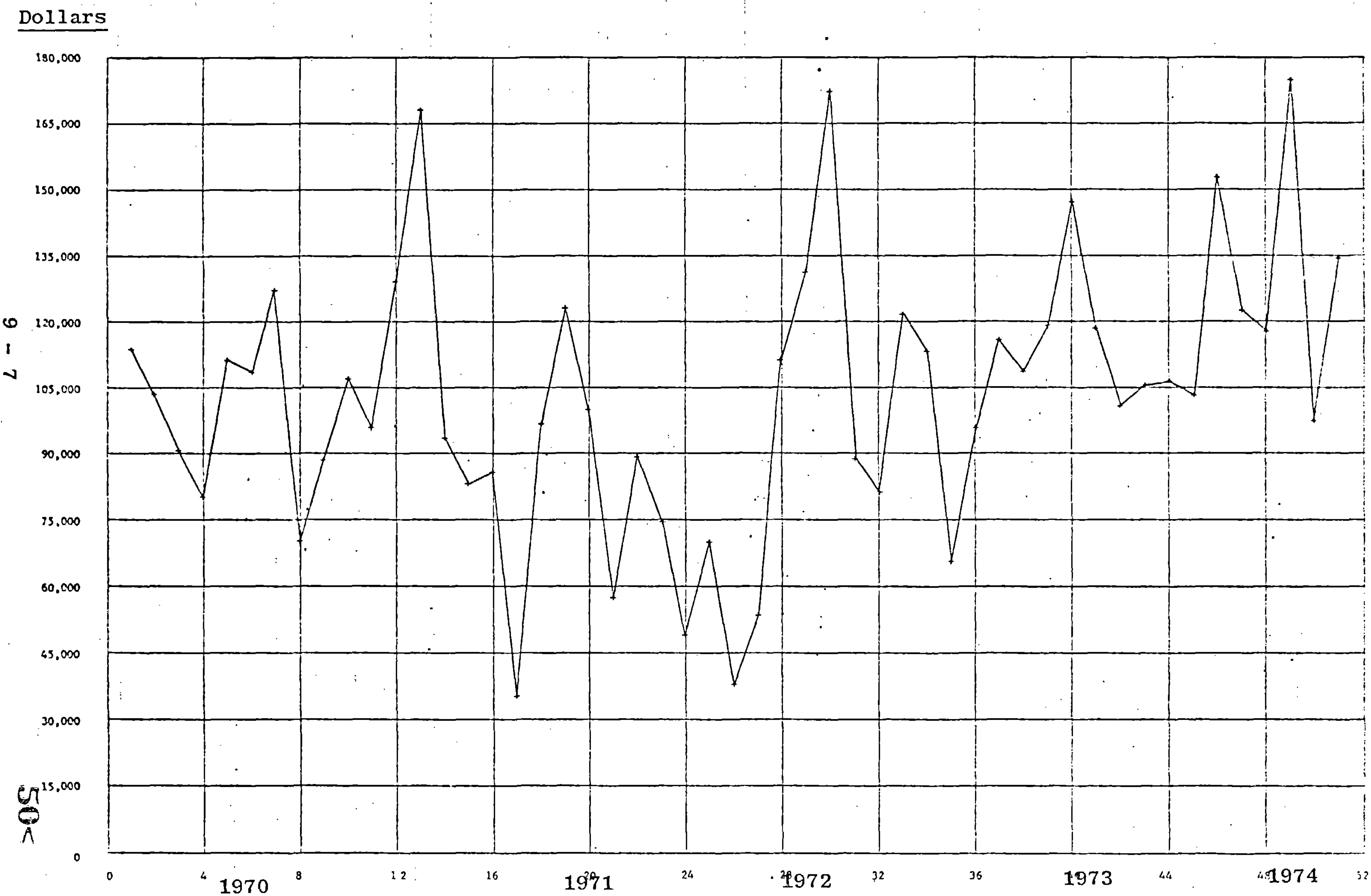

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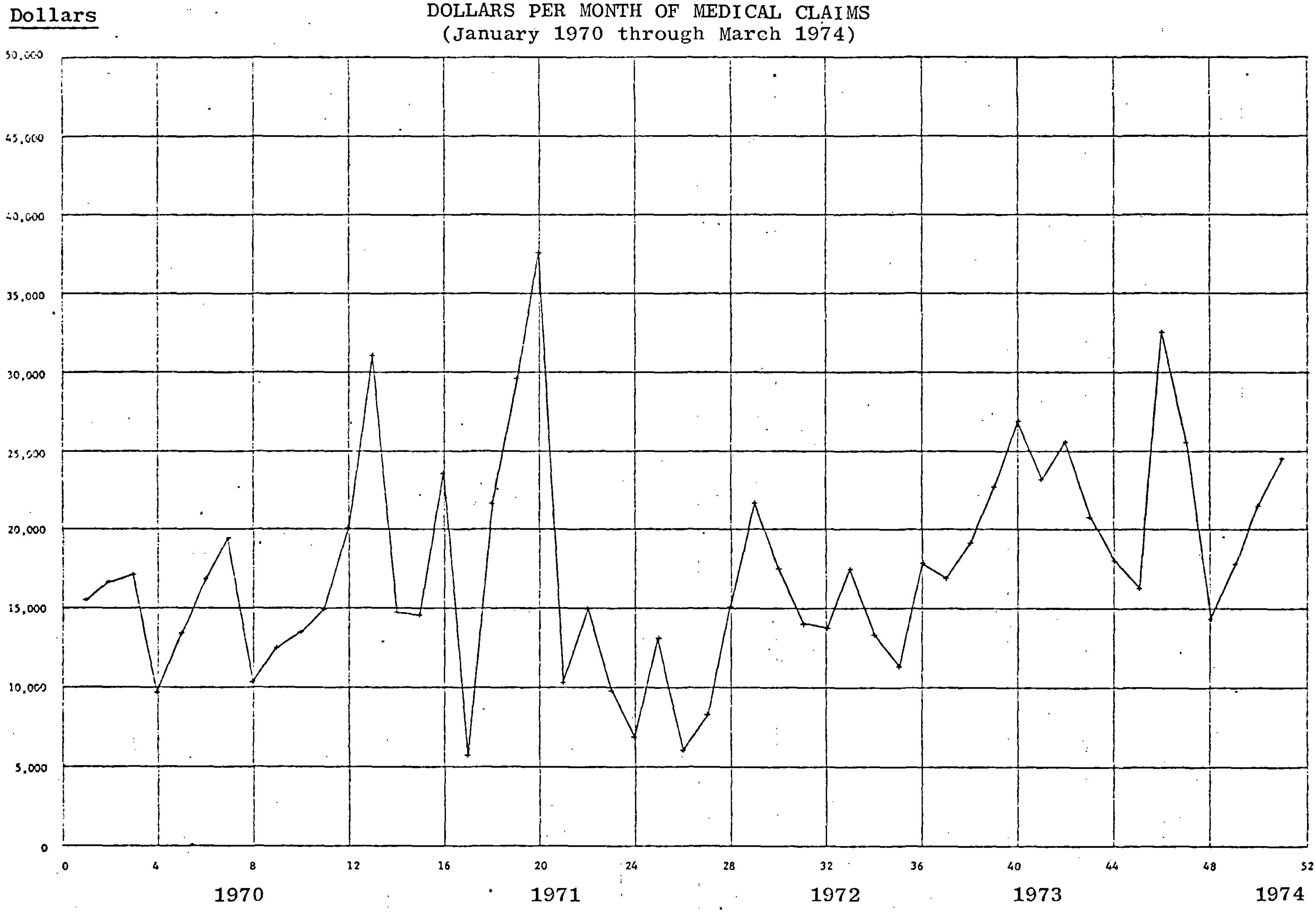
Figure 9.2
DOLLARS PER MONTH OF MEDICAL CLAIMS
(January 1970 through March 1974)



Another area of cost often referred to is the absenteeism due to non-occupational injuries and illnesses. The medical and personnel departments have joint responsibility for reducing absenteeism. The effectiveness of a program for reducing absenteeism is measured by a decreased ratio of non-industrial absences to the employees (Figures 9.4, 9.5 and 9.6). There has been no significant change in the Fontana absenteeism ratio since 1958.

Since there is a pool of workers at Fontana who may serve as substitutes for an absent employee, the absence of an individual does not generally affect production. The work force must be reduced by at least one worker before any cost savings should be claimed. In other industries, where each worker is directly responsible for unit output, individual absences may be felt more directly.

The final cost discussed is asset additions. An asset addition is the acquisition of a piece of equipment which has an expected life greater than one year.

All of the considered costs must then be subtracted from the revenue (income). Since the medical department is the responsibility of the SMG, revenue is seen as the transfer of funds to SMD from other divisions for the services for treatment of illnesses and injuries and income from the compensation trust fund. Figures 9.7, 9.8 and 9.9 indicate the historical utilization of the Fontana OHP by these divisions. Since the Eagle Mountain Mine employees receive only management physical examinations at Fontana, historical utilization has not been provided. Kaiser Engineers uses the medical facility during periods of major construction at Fontana.

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Figure 9.3
TOTAL NON-INDUSTRIAL MANDAYS OF ABSENCE
(January 1958 through December 1973)

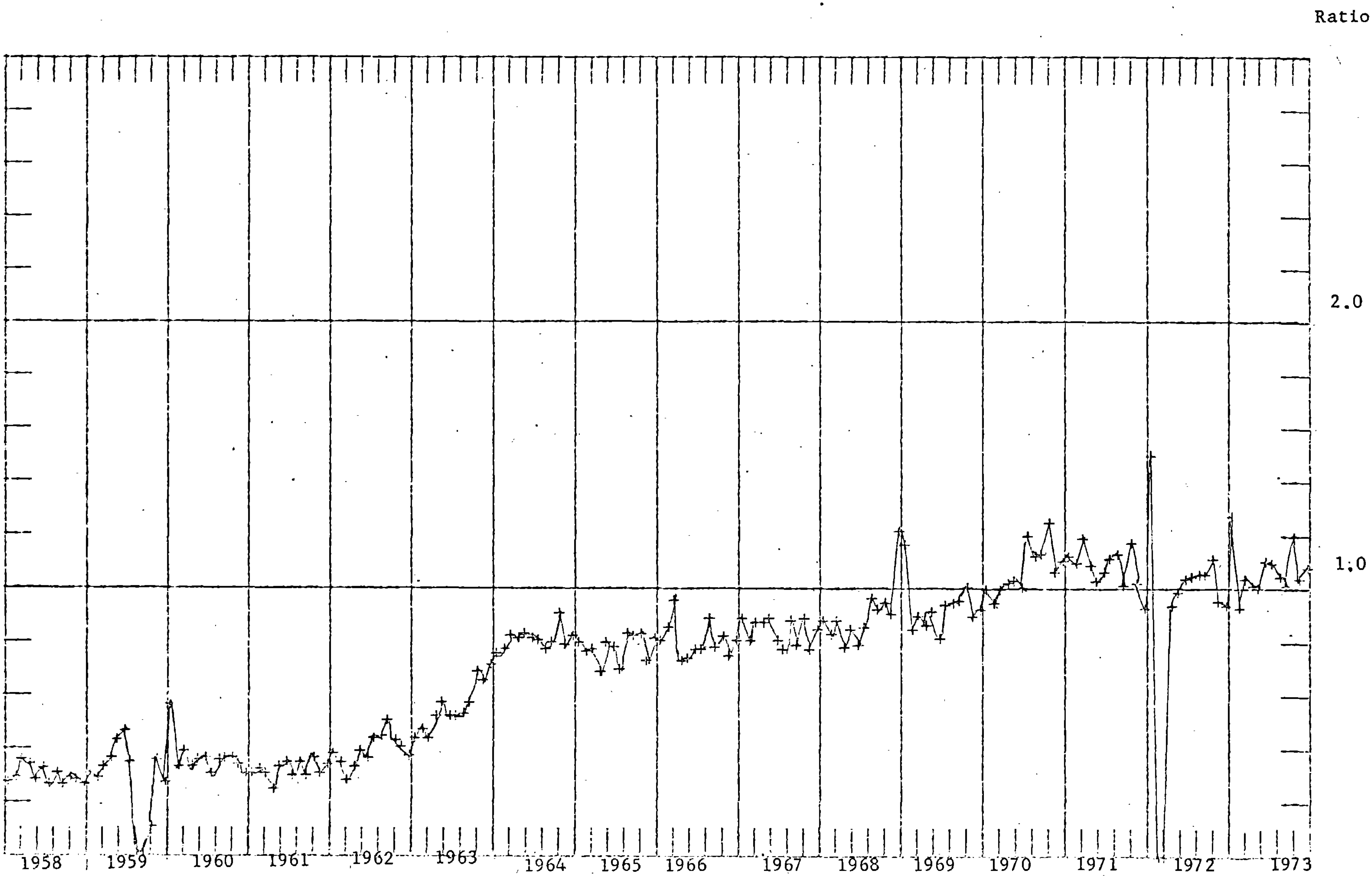

Figure 9.4

TOTAL ABSENCES DIVIDED BY TOTAL POPULATION
Production and Maintenance

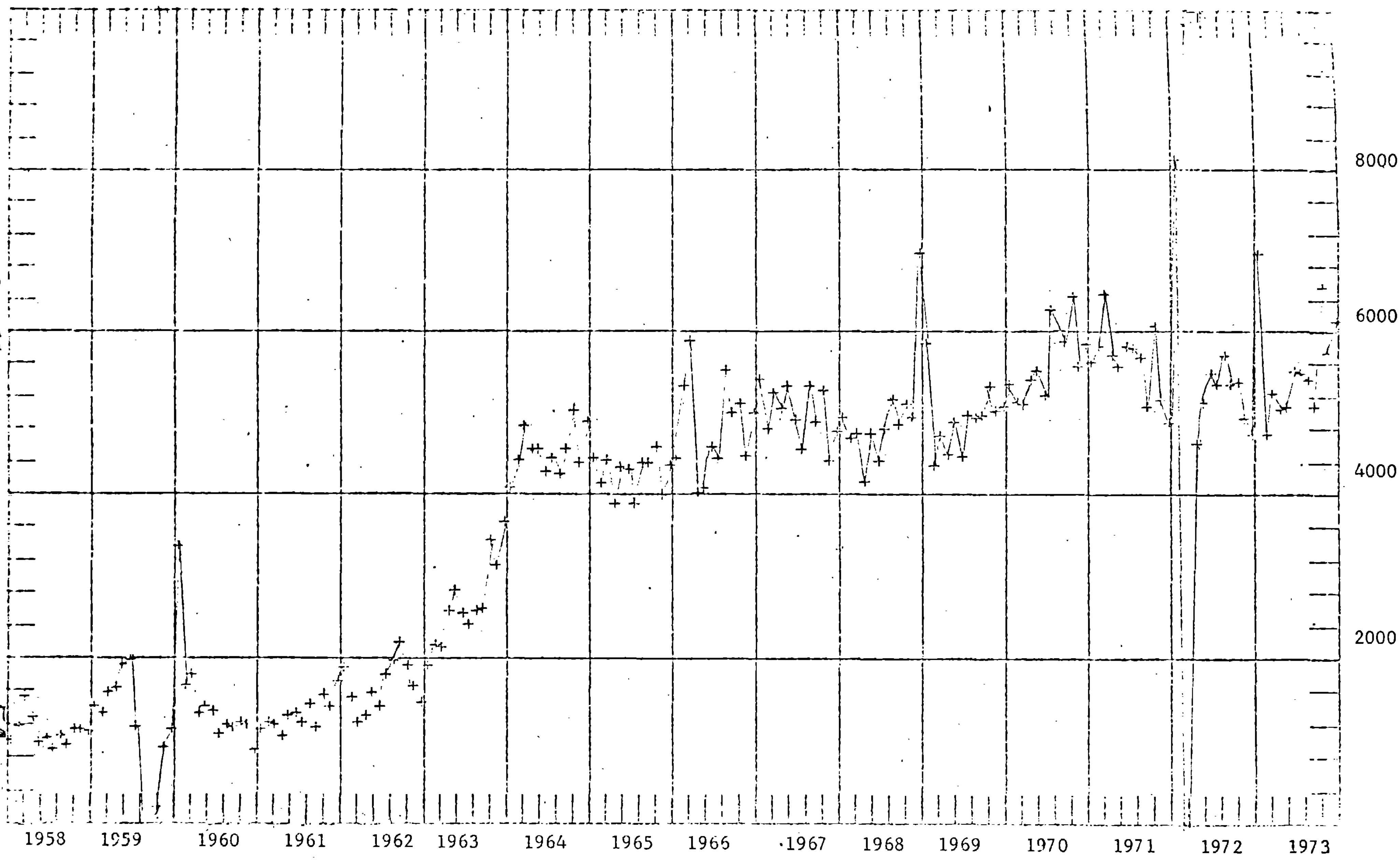

Figure 9.5

TOTAL ABSENCES DIVIDED BY MEMBERS IN POPULATION
Administrativr and Salaried

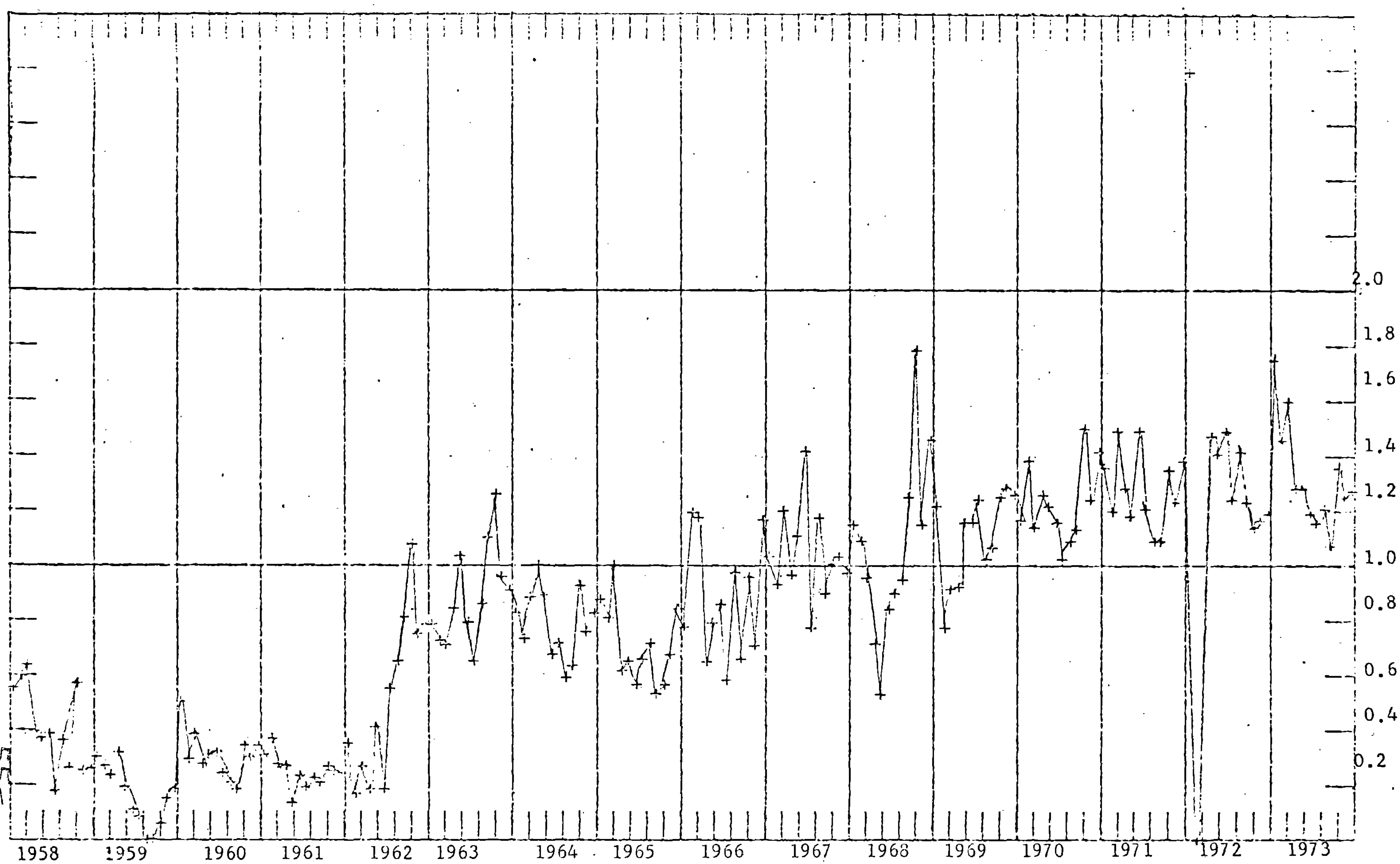

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Figure 9.6
FABRICATION DIVISION VISITS

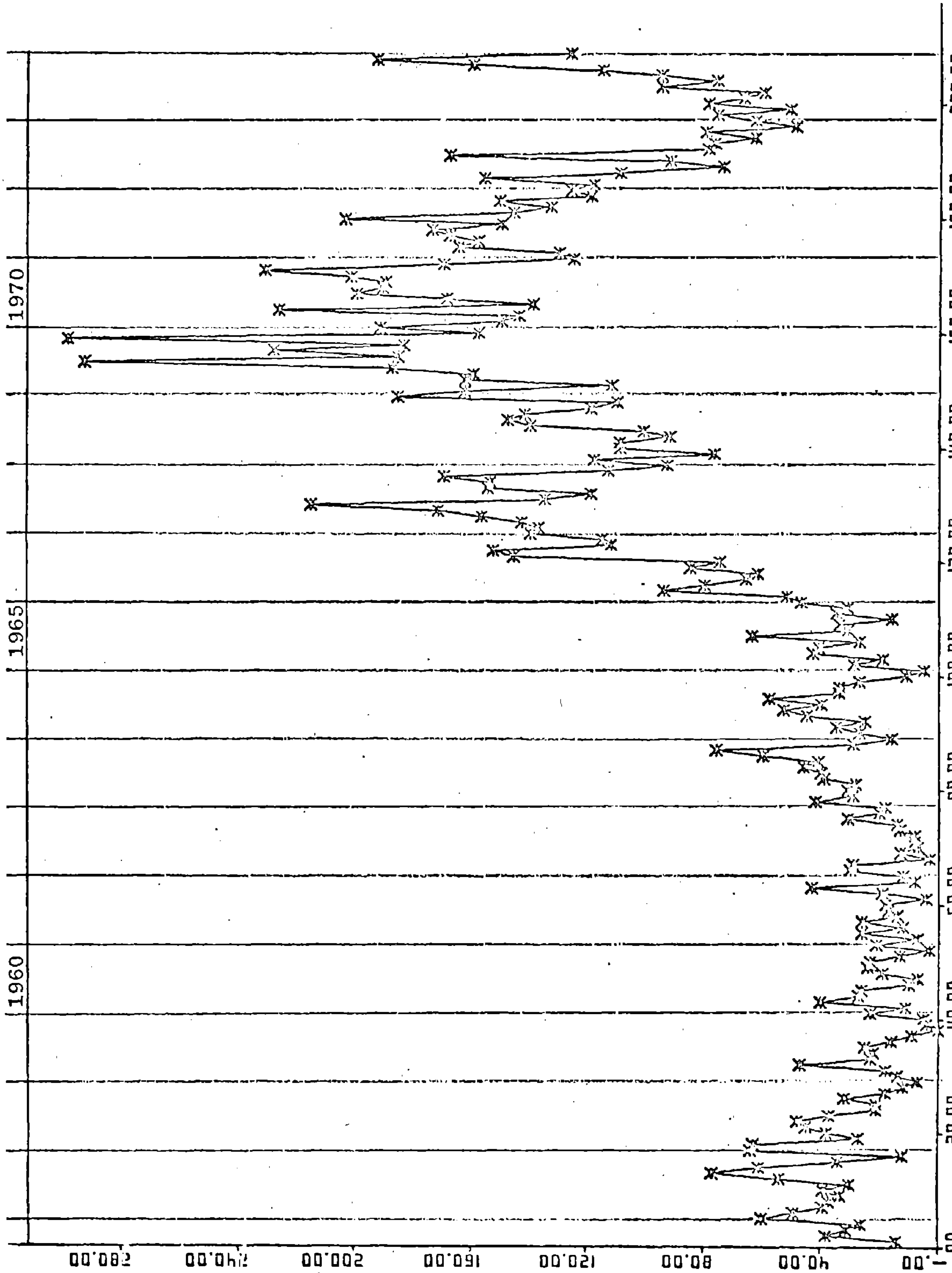

Figure 9.7
ERECTION DIVISION VISITS

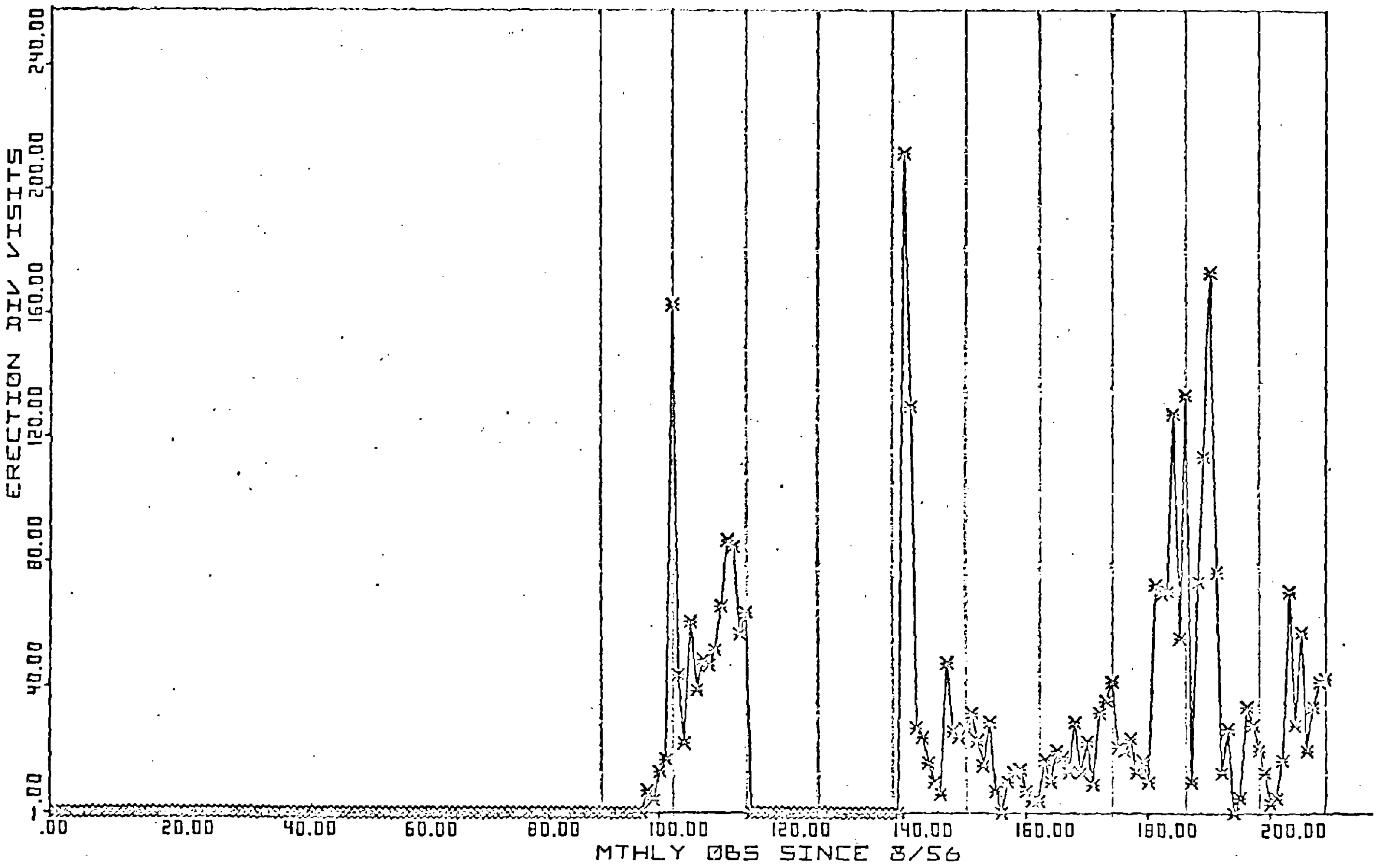

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Figure 9.8
KAISER ENGINEERS VISITS

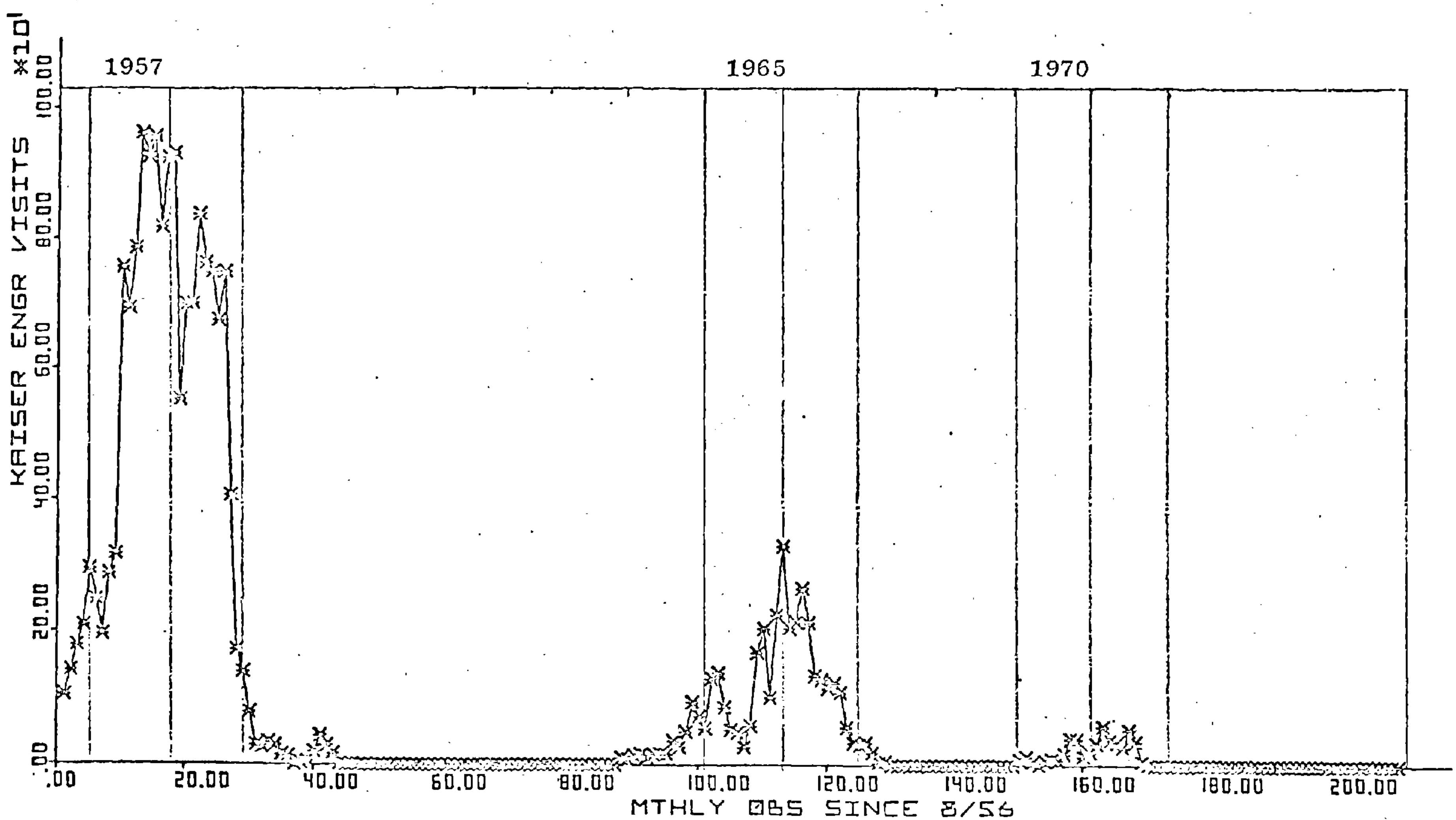

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Table 9.4 shows the frequency of visits for these divisions. Since there are fixed fees for each type of visit, the product of the fees per visit and the number of visits per year yields total annual revenue. The current fees per visit are:

Type of Visit	Revenue
Industrial first visit	$ 12.00
Industrial subsequent visit	6.00
Pre-employment examination	15.00
Eyewear program - fitting	5.00
Management health examination	100.00

The total revenue for the study year at Fontana is estimated to be $19,568.

The real dollars accrued (the revenue or benefits) represent the transfer of funds from one operating division to another. There is one value for total revenue and one value for total cost for each year of the planning period. The total cost subtracted from the total revenue in each year represents the net cash flow of the program in a specific year. Each year must be discounted to the present value. The sum of these discounted values represents the net present value (dollar benefits) of the OHP.

Table 9.4

Frequency of Visits

Type of Visits	Minimum	Maximum	Mean	Standard Deviation	Expected Annual
Fabrication Division					
Industrial, 1st	24	33	29.17	3.76	350
Industrial, subsequent	51	80	62.67	11.59	752
Pre-employment	5	54	23.67	17.31	284
Eye	4	4	4.00	--	48
Management Physical Examinations	--	--	--	--	9
Erection Division					
Industrial, 1st	2	22	15.00	7.95	180
Industrial, subsequent	2	36	17.17	13.98	206
Eagle Mountain Division					
Management Physical Examinations	--	--	--	--	23

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9.2 Non-Dollar Benefits

Non-dollar benefits are referred to as intangible benefits. An example of a non-dollar benefit is improved assurance to the employee of health and safety in his workplace. Each non-dollar benefit is considered to be a goal that must be met within the program. These goals can be set externally or internally to the OHP.

The statements of the goals of this type are imprecise. Imprecision does not indicate randomness. The imprecision is, in part, a result of the term "job satisfaction" which does not have sharply defined boundaries (i.e., one which allows a yes or no reply). More importantly, the implied assessment terms, good, satisfactory, bad, unacceptable, are not correctly addressed by an exact numerical value. How does one proceed when faced with complex classes which do not exhibit well-defined boundaries?

There are two important reasons for considering non-dollar benefits:

1. An information feedback is necessary to prevent cost minimization which reduces or eliminates programs which do not contribute to dollars of saving for the enterprise;

2. Labor and government should be provided with meaningful measurements of the value of the OHP system so that rational strategies can be developed.

At this point, the proposed treatment of cost and benefit has been described. In addition, two effectiveness measures have been developed: (1) the current values of goals and constraints (decision value); and (2) the net present worth of the investment in OHP.

Let us for the sake of convenience refer to the first effectiveness measure as "value" (in the ethical connotation of the word value), and the second as "dollars" (in language planning, NPV should be used). If the dollar benefits, revenue, and the total cost at each expected level of "value" are plotted, then the break-even analysis shown in Figure 9.9 is expected. Those services which are expected to yield the greatest dollar return would be selected first. As a "value" of one is approached, the net return on investment is expected to decrease as shown. At this stage of the research, there is insufficient data to support the break-even displayed. Certainly, an OHP system would find such a device instructive display of the trade-off between dollars and non-dollars.

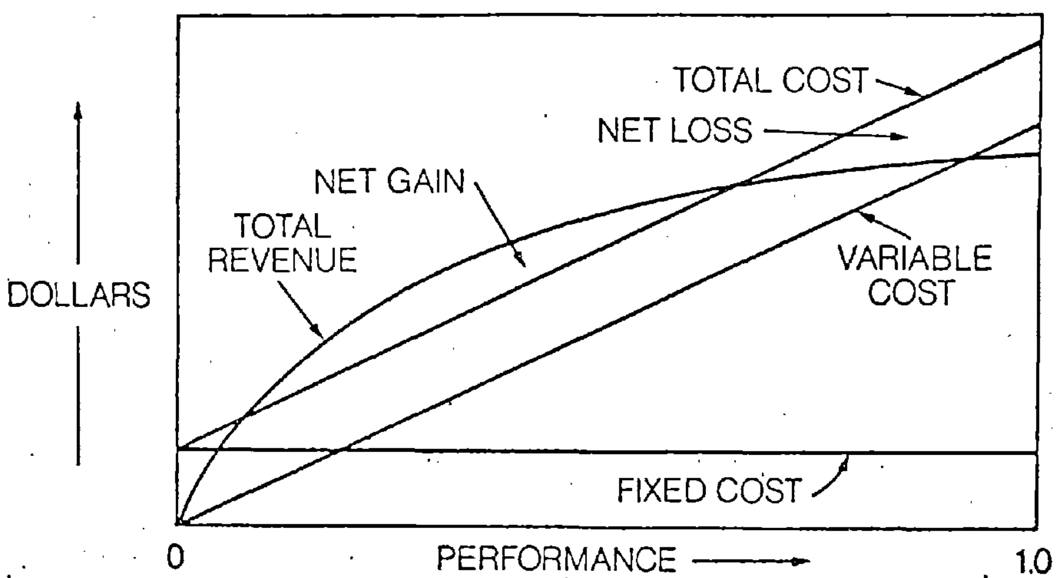

Figure 9.9
BREAK-EVEN ANALYSIS

The goals will change with time as the expectations of the environmental entities drift. The fuzzy variable technique will allow for changes in ethical value systems. The OHP system must adapt to the "environmental entity drift." The sensitivity and adaptability of the OHP system under various assumptions would be important to those wishing to evaluate traumatic conditions which might jeopardize the currently identified OHP. The "tools" suggested in the proposed methodology are well within the province of dynamic optimization, should the OHP system have need for determining the best direction, under changing conditions.

The principal reason for developing the planning model was to provide a reference structure to use mathematical analyses to define essential categories, cost structure, and study methods of measuring non-dollar benefits. The concepts presented will change as the project experience continues.

A non-dollar benefit is the performance measurement associated with health surveillance. This measurement describes how well the health surveillance program performs all of the conditions and actions of its stated policy. The service class, health surveillance, consists of all comprehensive programs designed to prevent the occurrence of illness caused by known hazards in the work environment.

Figure 9.10 is a model of a health surveillance system. The employee is affected by changes in the environment and reports to the medical department for special tests to determine that he has not been adversely affected. The new information and the patient's medical history are used to decide upon the necessary action to be taken. A comparison between the actual biologic policy as implemented and the stated policy yields a performance score. The performance score is used by medical management to decide whether or not a policy change is needed.

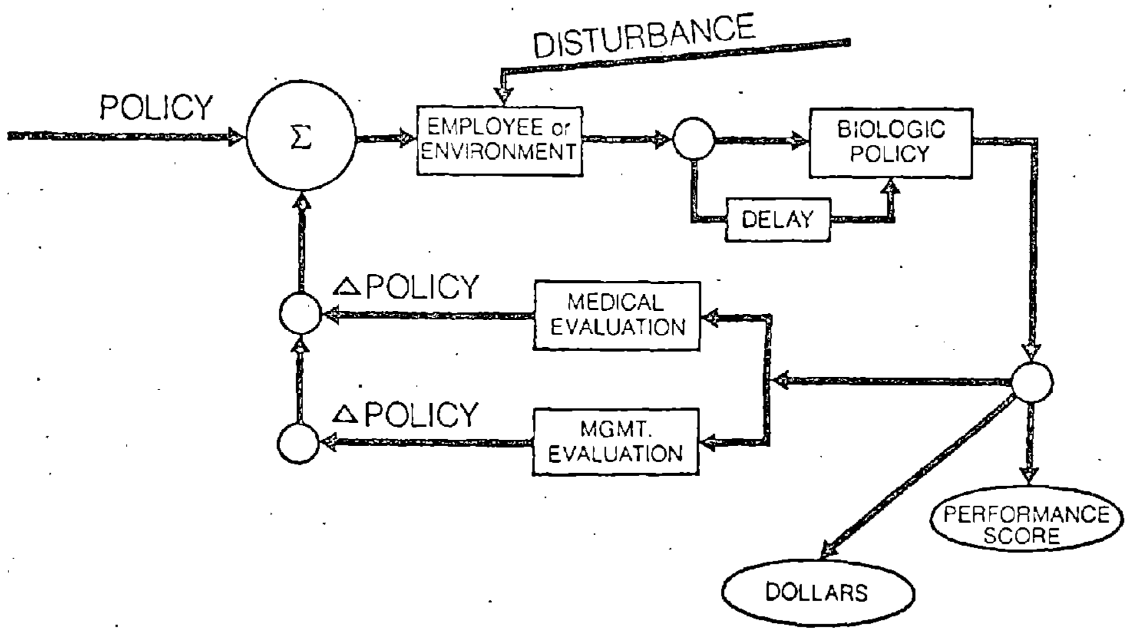

Figure 9.10
HEALTH SURVEILLANCE SYSTEM

A decision table method (Table 9.5) of defining health surveillance programs has been recommended to assist the physician. The table clarifies the definitions of the conditions and actions needed for health surveillance programs. Decision tables describe in tabular form the decision rules and actions that must be taken in all of the anticipated cases. The two sections of the table are: "if" (conditions) and "then" (actions).

The conditions are a listing of the surveillance criteria. Both yes and no are associated with a condition. Blank spaces indicate that the condition does not apply to the alternative. The actions associated with the defined conditions are represented by "X". The decision table has been used to describe the Fontana health surveillance program information. The decision table is suitable for automation.

Table 9.5
Decision Table for Audiometric Testing

IF - (CONDITION)	1	2	3	4	5	6		7	8	9
Audiometer not calibrated.	N									
Meets criteria for audio testing		y	y	y	y	y		y	y	
Baseline audio test ~~not~~ taken		n	y	y	y	y		y	y	
Within limits of - - Normal (A)				y						
- Mild loss (B)					y					
- Significant loss (C)						y				
Periodic audio test not taken		n	n	y	y	y	y	y	y	
*Results - - <25 dBA baseline or 20 dBA shift								y		
- >25 dBA baseline or 10-15 dBA shift									y	
Shift persists										y
*See proposed OSHA Noise Standard 1910.95, Section (c)(7)(ii).										
THEN -										
Schedule calibration	x									
Schedule audiometric test		x	x							
Audio test to worker - - with interpretation A				x						
- with interpretation B					x					
- with interpretation C						x				
Schedule retest in one month								x	x	
Provide ear protection if needed										x
Counsel employee										x
Copy of audio test to employee										x
Printout of complete record (including historical)										x
Medical referral										x

The best measurement of health surveillance program performance at Fontana is the ratio (expressed as a percentage) of those tested to the total number of employees in a designated test area. Five mills - E.W. pipe, C.W. pipe, plate, structural, and 5 stand tin - provided a variety of performance scores: E.W. pipe 51.1%; C.W. pipe 100.0%; plate mill 42.1%; structural mill 45.8%; 5 stand tin 164.0%. The standard crew at the five stand tin mill was 25; however, extra shifts were needed on occasion to increase production. The department manager was assiduous.

The following shows a current goal conversion of the performance scores into "fuzzy" values. It defines the words "The performance should be significantly greater than 75%" in terms of numerical values.

Performance Score	Fuzzy Value
100%	1.0
95%	.9
90%	.5
88%	.3
80%	.1
All Else	Zero

Only the 5 stand tin mill and C.W. pipe mill are assigned values of 1.0. All others would be assigned a zero value. The combined value for the audiometric health surveillance program is zero under current decision rules.

There must be directed efforts to both decide upon what "values" need quantification and then develop the quantification method (e.g., a survey or a comparison test). Clearly, these needs will not be met immediately, but it is hoped that they will become a part of the ongoing development process.

A method to generate a single value representing the net worth of the OHP in dollars has been developed and substantiated. In addition, a method to convert all intangible (non-dollar) benefits into a single quantity has been given. The two values represent the current effectiveness of the OHP. The trade-off between dollar benefits and non-dollar benefits can be obvious by a comparison of alternative programs.

One of the important findings of this study is that the dollar and non-dollar benefits resulting from a new policy implementation always show immediate changes. The changes are in these cases proportional to the total possible benefit level which has yet to be achieved. Such non-linear models can be estimated if well designed experiences are recorded. The developed model from these new sub-program implementation can be used by other Occupational Health Programs to assess value of including the new sub-programs within the existing program.

The medical program at Fontana has planned more automated and comprehensive programs of health surveillance to improve control and system performance measures.

66<

[redacted]ST REPORT OF JURY or ILLNESS

KAISER STEEL CORPORATION
300 Lakeside Drive
Oakland, Ca. 94604

1218 R-7

(1-2) CHECK ESTABLISHMENT CONCERNED

			MYERS DRUM			
(1) RATON	(5) SMO	(11) ST	(15) OAK.	(18) LA	(21) TUC.	(25) OTHER
(2) SUN.	(7) KST	(12) LM	(16) EM.	(19) ELOY	(22) PHX	
(3) EMM	(8) NAPA	(13) NCE	(17) RICH.	(20) PORT.	(23) MONT.	
	(10) PF	(14) SCE				

(3-7) EMPLOYEE BADGE NO	EMPLOYEE NAME LAST FIRST INITIAL	(8) SEX M F 1 2	(9-17) SOCIAL SECURITY NO.	(18-19) AGE	REPORT DATE

)-24) POSITION CODE	EMPLOYEE ADDRESS	DEPARTMENT	TIME LEFT JOB

(25-30) INJURY/ILLNESS DATE	INJURY/ILLNESS TIME	SUPERVISOR NAME	PHONE	(31-35) SUPV. BADGE NO.	FORM PREPARED BY

(36) SHIFT (CIRCLE) G D S 1 2 3	OCCUPATION	EXACT ACCIDENT LOCATION

IPLOYEE STATEMENT CONCERNING INJURY/ILLNESS

Remove top two pages before writing below this line. Bottom three pages to Medical Department immediately after injury.

HAT TASK WAS BEING DONE?

WHAT STEP OF THE TASK WAS IN PROGRESS?

OW OFTEN IS THIS TASK NORMALLY PERFORMED BY INJURED?

WHEN WAS LAST PREVIOUS TIME THIS TASK WAS PERFORMED BY INJURED?

VHAT HAPPENED? (DESCRIBE IN SEQUENCE (A) THE EMPLOYEE'S RELATIONSHIP TO THE PHYSICAL SURROUNDINGS, (B) HOW HE WAS DOING WHAT HE WAS DOING, (C) WHAT HAPPENED THAT RESULTED IN THE ACCIDENT, INCLUDE, IN ADDITION, ANY OTHER FACTS NECESSARY TO CLARIFY WHAT HAPPENED.)

VHAT DID THE EMPLOYEE DO OR FAIL TO DO THAT CONTRIBUTED TO THE ACCIDENT?

WHAT DID SOME PERSON OTHER THAN THE INJURED DO OR FAIL TO DO THAT CONTRIBUTED TO THE ACCIDENT?

WHAT CONDITIONS OF THE EMPLOYEE'S ENVIRONMENT (TOOLS, EQUIPMENT, MACHINES, STRUCTURES, MATERIALS, ETC.) CONTRIBUTED TO THE ACCIDENT?

	YRS.	MOS.
(37-40) EMPLOYEE TIME ON JOB		
(41-44) LENGTH OF SERVICE		
(45-46) INJURIES PAST 12 MONTHS		
(47) TOTAL NUMBER DISABLING CASES		

WITNESS

BADGE

WITNESS

BADGE

PROTECTIVE EQUIPMENT WORN AT INJURY/ILLNESS TIME

(48) EYE PROTECTION		
NONE	1	
SPECTACLE	2	
SPECTACLE WITH SIDE SHIELDS	3	
OTHER	4	
(49) SAFETY SHOES		
REGULAR	1	
METATARSAL GUARD	2	
(50) HARD HAT	1	
(51) GLOVES	1	
(52) LEGGINGS	1	
(53) COAT	1	
(54) RESPIRATORY DEVICE	1	
(55) OTHER	1	

WHAT ACTION HAVE YOU TAKEN AND/OR DO YOU PLAN TO TAKE TO PREVENT RECURRENCE?

WHAT FURTHER RECOMMENDATIONS DO YOU MAKE?

SUPERINTENDENT SIGNATURE

REQUIRES FURTHER INVESTIGATION

(56-57) AGENCY OF ACCIDENT	(58-59) HAZARDOUS CONDITIONS	(60-61) ACCIDENT TYPE	(62-63) PERSONAL FACTOR	(64-65) UNSAFE ACT	SAFETY SUPERVISOR

SAFETY DEPARTMENT COPY (To be completed by Operating Dept. before the end of the turn and forwarded within 24 hours.)

ALLIED HEALTH PERSONNEL

The shortage of physicians in this country, the concern over high physician fees and salaries, and the belief that many of the traditional responsibilities of the physician could and should be performed by other health personnel, have led to an increased use of allied health workers. In the 1971 AMA guidelines for allied medical educational programs, medical assistants are defined as "...persons who assist a doctor of medicine in a number of settings...supervised by physicians...".[1]

Some of the allied health personnel see themselves as assistants to the physicians, others believe that they function as substitutes for the physicians. The nurse practitioner is most often taught to be complementary to the physician. The "specialty nurse practitioner is appropriately trained to assume therapeutic roles otherwise divided among a variety of ancillary health personnel..."[2]. The physician's assistant is considered "to effect a better utilization of the physician's time" while the paramedic is seen as a "health care provider who performs primary tasks formerly reserved for the physician".[3]

The education and clinical training of the various allied health workers differs with the type of work they are required to perform. Nurse practitioners are generally directed toward health maintenance and close contact with the family within the health care system. The nurse practitioner, whose independence to practice has increased with increased education and training, often uses the clinic or private office as a home base.[4]

The physician's assistants trained at Duke University Medical School, in a two year course of basic science and practical experience, are expected to make physical examination, take histories, supervise lab tests, and present cases to the physician. They are authorized to make diagnoses, write prescriptions, or initiate treatment. In rural New Mexico, physician's assistants in an urban medical center offer continuous, on-the-spot health care under the supervision of physicians.[5]

Paramedic programs are short term, as they usually accept only those students who are already highly trained and experienced. The paramedics are then given new orientation, academic training, and new clinical skills.

The AMA has recently reported results of the first certifying examinations for physician's assistants in primary care. The candidates were all graduates of formalized programs of the type approved by the AMA Council on Medical Education, the Medex program, or a nurse practitioner program. Seven hundred seventy of the 880 candidates passed this certifying exam.[6]

The extent to which the allied health workers can perform those roles traditionally held by the physician often depends on the existing laws of the particular state. In 1971, fourteen states adopted some form of delegation amendment to their medical practices act. By April 1972, nine more states had amendments pending. All of the states insist that the medical assistants must act under the supervision, control, and responsibility" of the licensed physician.[7]

The Arkansas amendment states that all of the acts must be performed under "direct supervision and control" of physician, while in New York and Iowa the direct supervision and control does not necessarily mean that the physician need be present in person as the supervisor. Supervision in Iowa and New York can be: over the shoulder, on the premises someplace, or remote with a regular review.[8]

California, on the other hand, has strictly regulated provisions for the education and conduct of any medical assistant. Many proponents of the extended use of physician's assistants feel that California's regulations greatly curtail the effectiveness of the physician's assistant. The 1971 California law stipulates that the physician's assistant's training be for at least one year, with residence required in a full-time clinical training program with direct contact with the patients. The educational program required in California must approximate that of the program taken at the junior college level with enough credits to equal an associate degree. All physician's assistants must be properly identified within their working environment, wearing an ID badge. The California requirement for the supervision of the physician's assistant is strict. The physician's assistant must consult with the supervisory physician before and after performing routine lab, screening and therapeutic procedures. The supervisory physician must be approved for the supervision by the Board of Medical Examiners and must supervise only one or two at any one time.[8]

Allied health personnel can be useful members of an occupational health program. Nurses, paramedics, and physician's associates are trained to perform some of the tasks that are now occupying the physician's time in the plant medical facility.

At Fontana, the industrial injuries constitute the main portion of the physician's treatment time and practice. A paramedic or physician's associate could be hired to replace or supplement the physician's time given to first aid and emergency treatment. Physician's associates are trained to provide respiratory therapy and rescusitation in emergency situations. Paramedics have a great deal of experience and training in treating accidents that require stitching and bandaging.

In plant medical facility that uses the physician's time to perform the routine and special physical exams, a physician's associate could be hired. Physician's associates are taught to conduct a general physical exam and to take a prescribed medical history. At the Fontana medical facility, nurses are conducting all of the physical exams that do not require diagnosis, and the results of the exams are reviewed by one of the physicians. Since the nurses are already relieving the physicians of some of their routine work, paramedics and physician's associates are not needed at the Fontana facility. Other occupational health programs, however, may not have the nursing staff available to relieve the physicians; in these OHP's, it would be advisable to hire allied health personnel.

Nurses, paramedics and physician's associates are qualified to assist in physical therapy treatment. Performance of some of the physical therapist's tasks, such as patient instruction for back exercises, can easily be provided by trained allied health personnel. Assistance by allied health personnel in physical therapy releases the physical therapist to engage in more specialized treatment and research.

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