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A COST-BENEFIT ANALYSIS OF THE
M.I.T. FACULTY HEALTH SURVEY PROGRAM

Daniel S. Diamond
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June, 1969

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I. The Development of Periodic Health Examinations

Periodic health examinations have gained wide-spread acceptance in the United States in recent years. Beginning as early as 1915 (5), articles in support of such checkups began appearing in medical journals. In 1922, the American Medical Association officially recognized and approved the value of periodic physical checkups. However, a review of over 150 articles and papers on the subject of periodic health examinations written in the last 48 years (14) reveals that much of the support for such examinations is ideological and philosophic---not empirical.

A vast majority of the articles are concerned with one or more of the following themes. First, what are---or better still, what should be---the goals and objectives of such programs? Second, what should a "typical" or "complete" physical examination consist of? And third, what have been the findings in these exams; i.e., what hitherto undiscovered conditions have been uncovered and how serious are these conditions? Few of the papers discussed the cost of administering such exams and only three out of all the articles examined attempted to quantify the benefits which accrued to the effort.

In examining these three points, the second is purely a medical question (e.g., should proctosigmoidoscopy be performed?) and is not appropriate for discussion here. The first and third points, however, are essential to the issue of determining the benefits of such health programs. They will be discussed in the following pages.

In looking at costs, charges ranged from \$10 for streamlined industrial health screenings (with a physician spending no more than ten to fifteen minutes with each individual) to up to \$300 for extensive three-day "executive-type" physicals at the various prestigious medical clinics around the country. It is interesting to note that many of the authors point to the unwillingness of individuals to seek out and pay for such examinations on their own. The growth of regular health checkup programs has been almost entirely in institutional settings.

To many individuals who have no apparent medical problem, it seems to be a waste of both their time and the doctors' to be told something that they already know; namely, that they are all right (or, more typically, "You are overweight---reduce."). Understandably, this has led to a general lack of support among physicians in private practice for administering regular exams because they sense that patients are unwilling to pay for such examinations. Doctors must spend at least as much time with these supposedly healthy patients as with sick ones (and frequently more because the doctor does not know what ailment, if any, he is looking for) while the patients are more reluctant to pay for this time than if the doctor had "done something" for them. Also, doctors generally prefer seeing sick people to healthy ones because it is more interesting and challenging medicine. Indeed, in some of the articles examined (1, 11, 15) the point was made that physicians should restrict their practice to that for which they were trained, that is, the treatment of the ill. One article (13) even went so far as to suggest that doctors who

go into this type of work tend to be less "learned and skilled" than their colleagues who devote their time entirely to sick patients.

In examining the question of the benefits of periodic health examinations, two questions must be answered: first, what benefits are anticipated, and second, to what extent are these benefits realized. Summarizing the articles studied, five objectives or anticipated benefits were encountered. These were

- (1) The early discovery of disease or infection.
- (2) Health education and counseling for better health habits.
- (3) The reassurance of the patient.
- (4) The establishment of a continuing doctor-patient relationship.
- (5) The development of a data base for medical research.

Items (3) and (4) can only be appraised in a very subjective fashion. The literature indicates that doctors by and large do feel these objectives are being met although some expressed concern about the possible adverse effects of creating a false sense of security in some patients.

Item (5), data for medical research, is a separate item from the other four. The benefits which flow from medical research are seldom of any value to the individuals who are directly involved (except possibly for some professional recognition for the doctor). They are of a more diffuse and long-term nature. Some research leads to policy decisions (e.g., the contamination of the air in mines must be below a certain level); other research leads to identifying health hazards (e.g., cigarette smoking contributes to lung

cancer); and still other research helps to indicate types of treatment which are more effective than previous methods. It is possible that any or all of these benefits could result from information derived from data gathered in connection with periodic health exams. However, in all of the articles reviewed, no explicit discussion was given as to the anticipated benefits that are to be expected from medical research; the value of such efforts is accepted as a given, and further justification is not offered.

If direct benefits are to be claimed for periodic physical checkups, however, it must be that items (1) and (2) result in some tangible, measurable effects. As stated earlier, there were only three studies which attempted to quantify these benefits in monetary terms. Several others pointed to the humanitarian benefits to the few individuals who had potentially-fatal conditions which were brought to light early enough to be treated. But the question in these cases is whether or not these conditions might not have been uncovered even without regular checkups. As a number of the authors suggested, nature is very good in the number of symptoms which it provides in order to bring potential health hazards to the attention of the individual (the few exceptions being diseases like cancer, glaucoma, syphilis, and tuberculosis).

Therefore, in the studies that follow, there is no basis for inferring causality. In other words, even though mortality or disability was reduced in the groups undergoing the regular checkups, there is no proof that these reductions were due solely to the initiation of such programs. It is very possible that such factors as

self-selection (all programs are voluntary) were also at work.

The first study to attempt to match benefits to costs was done in the period 1914-1921 by the Life Extension Institute under a contract from the Metropolitan Insurance Co. (3, 4, 10, 12). The study consisted of 16,662 Metropolitan policyholders who were given physical examinations at no cost to themselves. From among the approximately 6,000 men who participated for the entire duration of the project, 217 deaths occurred. The expected mortality for such a group was 303. The cost of administering the exams was approximately \$46,000 while the saving to the company of not having the expected mortality realized (and thereby not having to pay the death claims) was somewhat in excess of \$126,000.

The second study was done by the Westinghouse Electric Corporation and reported on in 1960 (2). Here 1,455 employees were covered by the study and the average cost per examination was \$51. Because of the Corporation's commitment to provide disability payments for non-work-connected disability (e.g., cancer), it was possible to calculate the potential savings to the company if serious conditions could be detected early and treated before death or disability resulted. In the case of the early discovery of cancerous rectal growths (the only example given in the article), the estimated savings were over \$120,000; this figure alone was more than the total cost of the program.

The third study which discussed both the costs and benefits of regular checkups was done by the Consolidated

Edison Company of New York in the period 1949-1959 (6, 7, 8, 9). 717 persons were involved in the study, with an average cost per exam of \$30 to \$35. Unlike the first two studies, the savings to the company in reduced disability or death payments were not expressed in dollars and cents, but several percentages were given which indicated significant decreases in both mortality rates as well as in illnesses which are considered totally disabling. A statement was made that these reductions more than paid for the cost of the program.

In fairness to many of the other articles examined, it should be pointed out that almost all of them were written by and for doctors. It is quite possible that many of the examples of the early detection of disease which were described could be translated into monetary benefits in a very straight forward fashion. What is interesting is that so few of the authors felt it important enough to bother to make such a calculation.

II. Overview of the Cost-Benefit Analysis

The purpose of this paper is to analyze the present M.I.T. Faculty Health Survey program with respect to its costs and benefits in order to establish whether or not the program is worthwhile; and, if not, what action should be taken.

A number of questions follow from this objective:

1. From whose standpoint should the costs and benefits be investigated?
2. What is a measure of "worthwhileness"? In other words, how does one define and measure the performance of the program?
3. What is the time horizon of the costs and benefits (immediate vs. long range)?

In answer to the first question, the parties most directly involved in the program were identified. These are

1. The faculty members who are entitled to the service.
2. The Medical Department which performs the service.
3. The M.I.T. administration which pays for the service.
4. The M.I.T. community as a whole, which is affected by what happens to the faculty members.

Parties who are more remotely connected with the program were not considered. Examples of these would be the families of the faculty members and society at large. The distinction was made on the basis of who is within the M.I.T. boundaries and who is outside of them.

The second question raises the problem of some combined "index of worthwhileness" which would be used to guide decisions concerning the retention, modification or cancellation of the program.

Since only the administration decides on the fate of the program, it is necessary to combine all costs and benefits to all parties into a single equation, as seen by the administration.

The administration's criteria function, C , may be described as

$$C = a(I)X(I) + a(C)X(C) + a(A)X(A)$$

where

$a(I)$ = the relative weight, in the eyes of the administration, of the individual faculty member's cost-benefit relationship.

For $X(I) \geq 0$, we have $a(I)'$, otherwise $a(I)''$

$a(C)$ = the relative weight, in the eyes of the administration, of the Medical Department's (clinic's) cost-benefit relationship.

For $X(C) \geq 0$, we have $a(C)'$, otherwise $a(C)''$

$a(A)$ = the relative weight, in the eyes of the administration, of its own cost-benefit relationship.

For $X(A) \geq 0$, we have $a(A)'$, otherwise $a(A)''$

$$X(I) = B(I) - K(I)$$

$$X(C) = B(C) - K(C)$$

$$X(A) = B(A) - K(A)$$

where B are benefits and K are costs.

The composition of costs and benefits to each party will be discussed in the following sections.

For each party, (i) , $B = \sum b(i)Y(i)$ and $K = \sum w(i)Z(i)$, where $Y(i)$ are the benefits, $Z(i)$ the costs, and $b(i)$ and $w(i)$ their respective relative weights.

This short analysis indicates that the problem ahead is that of identifying and quantifying all the $Y(i)$, $Z(i)$, $a(i)$, $b(i)$ and $w(i)$.

The objective is to maximize C , and only positive solutions are acceptable.

The third question is whether the program has to be justified on a budget-year by budget-year basis or whether this is an investment for the future. Since the program is preventative, and involves the reduction of sickness and death over the work-life of an individual, the benefits will accrue over this whole time span. This, therefore, is the more appropriate time horizon.

In the next section, the program itself will be examined, including its purpose and scope. Following this will come the analysis of costs and benefits to each party followed by a discussion of the findings.

III. The Present System

Faculty Health Survey examinations are being scheduled for 1968-1969. We hope that you will take advantage of this opportunity for the evaluation of your health, as our experience with this program has shown it to be of great value. For the information of new members of the Faculty and Administration, this program includes a medical interview, a complete physical examination, routine blood tests and urinalysis, all without charge. There is a fee of \$10 for the chest x-ray. If an electrocardiogram is indicated there will be an additional \$10 charge. Special laboratory studies are done by an outside laboratory, and will be charged to you at the cost to the Medical Department.

All those over 40 should return for examination on a yearly basis. Those under 40 should plan to have an examination every two years, unless there is some special health problem which makes more frequent examination advisable.

The above statement is contained in a letter sent to members of the faculty and administration of M.I.T. each year. It is an appropriate introduction to a discussion of the M.I.T. Faculty Health Survey because, first, it is a concise description of the program, and second, it is the only description of the program. This latter fact is a reflection of the manner in which the Survey came into being. The original rationale for the program was that "it would be a good thing for the Institute" and therefore further justification or documentation was not felt to be necessary. As a result, all records have been kept on an individual patient basis and no general statistics concerning the overall program have been maintained.

The preceding remarks should not be construed as a criticism of either the concept of the program or of its current execution. They are merely mentioned to provide

support for the common complaint (perhaps alibi) of nearly all analysts that without detailed data, the resultant analysis is necessarily tentative.

The Faculty Health Survey of the M.I.T. Medical Department was inaugurated approximately ten years ago. Originally it was designed to offer periodic physical examinations to senior faculty members and important members of the Institute administration on a purely voluntary basis. It has since been expanded to include all faculty members of the rank of assistant professor or above as well as certain selected employees of the Division of Sponsored Research (DSR).

The personnel from the DSR who are to be included in the Survey are selected by the DSR itself. The basis for selection is a combination of position, seniority, and age (not unlike the procedure used to select people from the administration). The cost for these examinations was, until recently, cross-charged from the Medical Department to the DSR at a rate of \$20 per exam. This has now been discontinued and no cross-charge is made. There is no cost to the individual except for the special laboratory work noted in the letter. There is also an Employee Health Survey for other employees of the Institute, but it is of a slightly different nature and will not be discussed here.

Each year, notification is sent to all eligible individuals (an excerpt of the letter was given above); and in the most recent period, fiscal year 1967-1968, 883 persons availed themselves of the offer. This number is about 75% of all those eligible. The names of those who are considered eligible are derived from the current edition of

the M.I.T. General Catalogue and from lists of names furnished by the administration and the DSR. Only one notification is sent out; and if the faculty member chooses not to respond, there is no follow-up.

Since no physical examinations are required of faculty members as a condition of employment, it is possible for an individual to come to M.I.T., spend his entire career on the faculty, and never once enter the Medical Department. Such freedom of action is, of course, entirely in keeping with the climate of a university, but it makes the appraisal of the benefits of the Health Survey program rather difficult. Without some sort of reference or control group, it is difficult to judge whether those who do use the program are any better off than those who do not.

IV. Cost Analysis

Because of the special nature of the administrative departments within M.I.T. (including the Medical Department), the concepts of cost accounting and cost control are little used. The reasons why this should be so are not difficult to understand. Costs are not used in any systematic way in the appraisal of administrative performance and no staff is provided to the department heads to assist them in making such calculations. With so little emphasis given to costs, it is not surprising that the task of assigning costs to the Faculty Health Survey must be in the nature of an educated guess.

From the earlier discussion it will be recalled that for some period of time, a charge of \$20 was levied against the DSR for examinations performed upon their personnel. On the surface, it would appear that this figure represented at least an approximation of the cost of conducting the examination. Upon investigation, however, it was disclosed that this was not the case; it was intended merely to cover the cost of laboratory tests (an "out-of-pocket" cost to the Medical Department) which were provided without cost to the DSR personnel.

Recently, however, the Medical Department has found it necessary to furnish certain figures to Medicare in order to be accredited as a full-fledged medical facility. These figures were prepared under the direction of the M.I.T. Audit Division and serve as a useful source of cost information.

With the assistance of Mr. L. D. Caplice, Administrative Officer of the Medical Department, the following costs were derived for a typical Faculty Health Survey physical examination:

Primary physician 1-1/2 hours at \$20/hr.	\$30.00
Consulting specialist 1 hour at \$20/hr.	20.00
Non-reimbursed laboratory expenses	15.00
Nurses, technicians, secretaries and administrative personnel (pro-rated)	7.50
	<u>\$72.50</u>

With 883 examinations having been administered during the past year, the total cost of the program is estimated to have been approximately \$64,000.

In addition to this cost which is underwritten by the M.I.T. administration, there is the cost that is faced by the individual faculty member. For some of them this is the additional charge for the special tests mentioned in the letter from the Medical Department to the faculty member. For all of them there is the time lost and the possible discomfort and inconvenience faced in undergoing the exam. The cost that each faculty member assigns to these is, of course, different for each individual. However, in the absence of evidence to the contrary, it must be assumed that these subjective costs are exceeded by the subjective benefits, at least for those faculty members who choose to avail themselves of the service. The question that must be answered is whether or not the same is true for the administration. In other words, do the benefits, however

defined, exceed the annual cost of \$64,000 a year, and thus justify a continuation of the program?

V. Benefit Analysis

In attempting to estimate the benefits of the M.I.T. Faculty Health Survey program, it is important to recognize the following points. First, the M.I.T. Medical Department does not at present distinguish among its several programs in assessing its total effectiveness. Second, at the present time the performance of the Department is judged, and future budgets set, almost entirely on the basis of the degree to which the facilities of the department are used.

For example, if an x-ray unit operates 75% of the total time it could possibly run, this is considered to be better than if it were used only 50% of the time. Further, if it begins to be used 90% or more of the time, a decision to purchase additional equipment will be considered. It is important to note that near-capacity use of a piece of equipment is highly unlikely to bring about a detailed analysis of this use. Thus, a decision to x-ray less liberally (i.e., only when a certain level of severity is judged), which would reduce the load on the equipment and delay the purchase of additional equipment, is almost certainly not going to be made by the Medical Department without a major change in policy.

Finally, while several sources of possible benefits are identified below, most of these are not taken into consideration at present. Although one of the purposes of the Faculty Health Survey program is to protect the Institute's investment in its faculty, economic considerations are almost totally ignored. It is clear,

then, that what is presented below is, for the most part, a proposal for the analysis of benefits, and not a description of how it is done or how it might be done with available data.

For purposes of benefit analysis three groups are identified, the first two of which are subsets of the third. For each group both the benefits and the data necessary to measure these benefits are specified. Decisions on whether the benefits of the program outweigh its cost and on how to best allocate existing and additional resources require more than a simple identification of benefits and costs. In particular, an objective function must be specified. An objective function is critical here because the conversions of many of the relevant benefits to dollars will appear both difficult and repugnant to the administrators involved. In fact, however, the specification of an objective function, in which weights are associated with the relative importance of the several benefits, is tantamount to the same thing.

The first, and most obvious, group who ought to benefit from the Faculty Health Survey are the faculty themselves. While the debate rages on as to whether any such program really does significantly contribute to the discovery of health problems before they become serious, this possibility cannot be overlooked. Furthermore, in cases that would be identifiable if the data were available, for certain individuals the periodic examination would have been the difference between life and death. However, one immediately runs into the problem of unavailable data. As each examination is carried out, the physician makes notes for the faculty member's medical record. Except for a personal

letter sent to the faculty member by the physician soon after the examination, no additional record of the results is made. The M.I.T. medical record is not, as it is presently maintained, a readily usable source of data. First, it is considered, as perhaps it should be, to be very confidential. Second, entries in the medical record are non-uniform, and, third, often illegible. Therefore, measuring the performance of the Faculty Health Survey program on the basis of discovery of health problems before they become serious will require either the encoding of parts of the medical record or the separate recording of the relevant data. The second approach would not provide historical data, but it should be relatively easy to implement. The results of the exam could be recorded by the doctor or his secretary in a uniform, specified manner on standard forms provided for that purpose.

The second benefit of the program to the faculty member is considerably less tangible than the first: the reduction of anxiety. No one is free from occasional concern about a seemingly too-rapid heartbeat, a shortness of breath, a pain in the side, or the history of a particular illness in the family. The Faculty Health Survey program can contribute to eliminating such concern for a faculty member when it is groundless. At least one case where this was an important factor has come to the attention of the Medical Department administration. A professor had lost a brother due to heart disease shortly before the faculty member's scheduled examination. There had also been an established history of heart disease in both his mother's and father's families. Not only did the professor rely on the Health Survey to

allay his fears, but was quite insistent that he be given tests that were much more thorough than the examining physician judged to be necessary.

This benefit, the reduction of anxiety on the part of the faculty, brings up a new data problem. Any benefit received in this way must be highly subjective and will probably not be derivable from any source other than the professor himself. Fears of this type will often remain uncommunicated to the examining physician; and the physician has no way of recording what he has not observed. A questionnaire, depth interview, or similar mechanism will have to be used to elicit such information. There is, however, no way of avoiding the bias that will necessarily be applied to any response the faculty member might make. It is clear, then, that as important as this benefit might be to the faculty member, it is doubtful that it could be measured objectively.

While we view the reduction of anxiety as a benefit, one must consider the possibility of creating anxiety. If, as the result of his exam, a faculty member learns that he has a medical problem, anxiety is likely to occur. One's first reaction to this is usually that any such anxiety created should be more than offset by the improved health that can be expected to result from the treatment of the problem that has been discovered. However, as pointed out by Dr. Melvin H. Rodman, one of the administrator of the program, it sometimes turns out that the medical problem discovered will be one that little can be done about until it progresses further. As it progresses, the faculty member would become aware of its symptoms and present himself to a physician for

examination. Thus, anxiety has needlessly been created earlier than was necessary. Without better data there is no way of knowing the magnitude of this difficulty. Although there is medical controversy about it such a potentially fatal disease as diabetes is felt to be in this class.

The third, and final, faculty benefit identified is that of the positive nature of the relationship he establishes with the physician. While it is certainly a good idea that everyone should have a doctor upon whom he feels free to call for medical advice in the event of problems, many of us do not. The Health Survey program presents an opportunity for the faculty member to establish such a relationship. But here again is the problem of objective measurement. It is known that roughly three-fourths of the faculty invited to come in for exams actually do appear. However, this says nothing about the professor-physician relationship, which requires measuring an attitude. It is possible that this measurement can be made with less bias than can the measurement of anxiety reduction since it involves less emotion.

The second group that can be seen as benefitting from the Faculty Health Survey program is the M.I.T. Medical Department. As was pointed out earlier in this section, the various programs of the department are not evaluated independently. However, in order to recognize benefits from the Faculty Health Survey program, this would obviously have to be changed. Also, it was suggested that the utilization of the departments' resources is the major determinant of future resource availabilities (budgets). If one is willing to accept that the Medical Department views the growth of

its budget as a measure of success, then the Faculty Health Survey program can contribute to this success. First, the greater the extent to which the faculty take advantage of the services offered through the program, the greater the usage rate of the resources of the department will tend to be. Second, if the benefits of the program to the faculty can be efficiently marketed to them, the demand for the program can be expected to increase.

A second benefit that might be derived by the Medical Department from the Faculty Health Survey program is scientific in nature. While there is a fair amount of research going on in the field of periodic medical exams, a vast amount is yet to be learned. The Medical Department, through data collection and analysis, could contribute to this body of knowledge. Their motivation might be both from the point of view of improving the general health of the M.I.T. faculty and as well as more outwardly-directed medical research. In suggesting this potential benefit, however, it must be recognized that, at M.I.T., the Medical Department has no primary research commitment as do the other academic departments. Therefore, such a research project may be overextending the Medical Department, at least as it is presently constituted.

The doctor-patient relationship, identified as a benefit to the faculty member, is also recognized to be a benefit by the physician. In other words, it is important to the Medical Department physician that the faculty member feel free to call upon him whenever he feels the need to do so. It is also possible that the physician benefits from his side of the relationship, knowing that he, the

professional healer, will be called upon in time of need. Needless to say, not only measurement but quantification will be difficult.

In attempting to measure the benefits of the Faculty Health Survey Program, as perceived by the Medical Department physicians, a questionnaire was sent to each of the Department doctors who currently administer these examinations. The doctors were asked to rank, in order of importance, five reasons for having periodic checkups. The results are shown in Table 1.

**Physicians' Rankings of Reasons for Conducting
the Faculty Health Survey Program**

Reason	Doctor								Total Points
	A	E	C	D	E	F	G	H	
Early detection of disease	1*	4	1	2	4	1	1	4	51
Health education and counseling	1*	2	2	1	2	4	3	2	45
Reassurance of the patient	2	1	3*	4	1	5	4	3	36
Establish a doctor- patient relation- ship	3	3	3*	3	3	2	2	1	35
Medical research	-	5	3*	5	5	3	5	-	10

*Doctor gave the same ranking to more than one reason.

Points were awarded as follows: 10 for a 1st choice, 5 for a 2nd choice, 3 for a 3rd choice, 2 for a 4th choice and 1 for a 5th choice.

Table 1

The final benefit to the Medical Department is somewhat related to the second part of the previous benefit. A successful Faculty Health Survey program will enhance the reputation and status of the Medical Department. As pointed out earlier, it can appear that the physician engaged in health screening, as opposed to healing the sick, is viewed by some as being less competent and, therefore, of lower professional status. The extent to which this applies to the M.I.T. Community's view of the Medical Department is uncertain. It may well have little effect, since the Medical Department serves other functions in addition to conducting Health Survey programs. Nevertheless, the status and professionalism of the Department are important, particularly where the Visiting Committee that periodically evaluates the Medical department is concerned.

We now turn our attention to the M.I.T. Community as a whole to consider the benefits it receives from the Faculty Health Survey program. By the Community we mean the totality of its various constituent parts: students, faculty, staff, and most particularly, the administration, which is responsible for the budget. First, and quite obviously, the community benefits if, through the program, a communicable disease is discovered and its spread prevented. The problems of measurement here are identical to those discussed under the benefit to the faculty members of the discovery of disease. One advantage in this case is that the law requires the discovery of certain communicable diseases to be officially reported.

A second potential benefit of the program to the M.I.T.

Community, particularly to the administration, is to receive a greater number of working days each year, and a greater number of working years from its faculty. The faculty of an institution like M.I.T. is a highly skilled group. The competition among universities for professors of this quality is quite high. The loss, therefore, of a faculty member due to illness, or, worse, death, is indeed serious.

In addition, the work of a faculty member on various departmental and Institute committees as well as his work with students, makes such a loss even harder to take. For example, it may turn out that upon the death of Professor X, Professor Y of another university is available. Professor Y's list of publications and honors as well as his reputation may be on a par with those of Professor X. However, the four graduate theses being supervised by Professor X as well as his work on the Committee to End All Committees are not going to be easily handled by a new man.

To measure this effect, the cooperation of each department would be essential. In most cases, only the department administration would be in a position to supply data regarding the medical absence or cause of death of its faculty members.

Finally, the program may be viewed as a tool for creating good will toward M.I.T. on the part of its current and potential faculty members. The program may be viewed by the faculty as a real "fringe benefit" like vacations or pension plan. The only way to measure the extent to which good will has been, or might be, created through the program would be by means of attitude surveys of both current and newly hired faculty as well as those who declined the offer

of a position from M.I.T.

VI. Discussion and Recommendations

One of the greatest benefits of the cost-benefit analysis itself is a greater awareness and increased understanding on the part of the decision makers of the dimensions and magnitude of the decisions involved.

The following discussion exemplifies the needs which still exist. These can be summed up as

- (1) Additional data
- (2) Complete knowledge of available alternatives
- (3) Rules which lead from data to alternatives.

Additional Data

The need for data can be broken into a number of data sets.

Probabilities

Two major types of probabilities are required. One is needed in order to help determine the benefits of the program, and the other is helpful in deciding which diseases to check for.

In calculating the benefits of the program, it is important to remember that the crucial variable is not the percent of people who had an illness arrested or cured due to early detection through this program. Rather it is the difference between this fraction (taken as a probability) and the probability of the illness being arrested or cured due to a check_up (periodic or otherwise) outside of the program.

In order to determine which diseases to check for, we need to know probabilities of occurrences of various diseases

in the population with which we are concerned and probabilities of successful treatment once a disease is detected.

Value Functions

The exact value of the program to the individual (directly as a demand function, or indirectly by using the fraction of faculty members who take advantage of the service as an "index of satisfaction") must be established.

The value must be found of this individual satisfaction to the administration. For example, is this criteria function linear (e.g., is it twice as worthwhile if 600 rather than 300 faculty members participate) or is it a more complicated function? An example of such a function is given in the illustration of the decision algorithm given below.

Market Behavior

It is important to determine the trends of faculty participation in the program over the ten years that it has been in existence. Data on new faculty joining as well as on participants dropping out as related to the program and to characteristics of the faculty would be of great interest.

Unfortunately, most of the information suggested above is currently unavailable. Guessing will not suffice, since the analysis is very sensitive to these probabilities.

The Need for Knowledge of Alternatives

Between expansion and cancellation of the program, there exists a wide range of possible modifications. Benefits to the administration may be increased by the following strategies:

- (1) Increase the number of faculty members

participating in the program. This can be achieved by offering inducements and/or applying pressure, in the form of a "pull" or "push."

(a) Increase the pull.

(i) Improve the image of the program.

(ii) Change the faculty members' perception of it (perhaps through an educational program).

(iii) Give incentives.

(b) Increase the push.

(i) Make it compulsory.

(ii) Sanction members who do not use it.

(2) Change the composition of the group eligible for this service. The variables to be manipulated under this strategy may be age, time at the Institute, position in the Institute, past medical record, etc. This may be achieved by

(a) Expanding the coverage.

(b) Making it available only to that group for whom the benefits are the greatest.

(3) Change the frequency of the examinations.

(a) Examine more---or less---often.

(b) Examine only upon entrance to the Institute.

(c) Make the decision to examine a function of age and past medical record.

(d) Examine on a random basis.

(4) Change the type and composition of the examination.

(a) Standardize the composition of the examination.

- (b) Leave it to the discretion of the doctor.
- (c) Change the specific tests that are administered.
- (d) Expand---or reduce---the list of illnesses tested for.
- (e) Vary the list of illnesses tested for from examination to examination.

Costs to the administration can be reduced by strategies (2), (3) and (4) or by encouraging the faculty to get this service outside of M.I.T., by self-administered tests, etc.

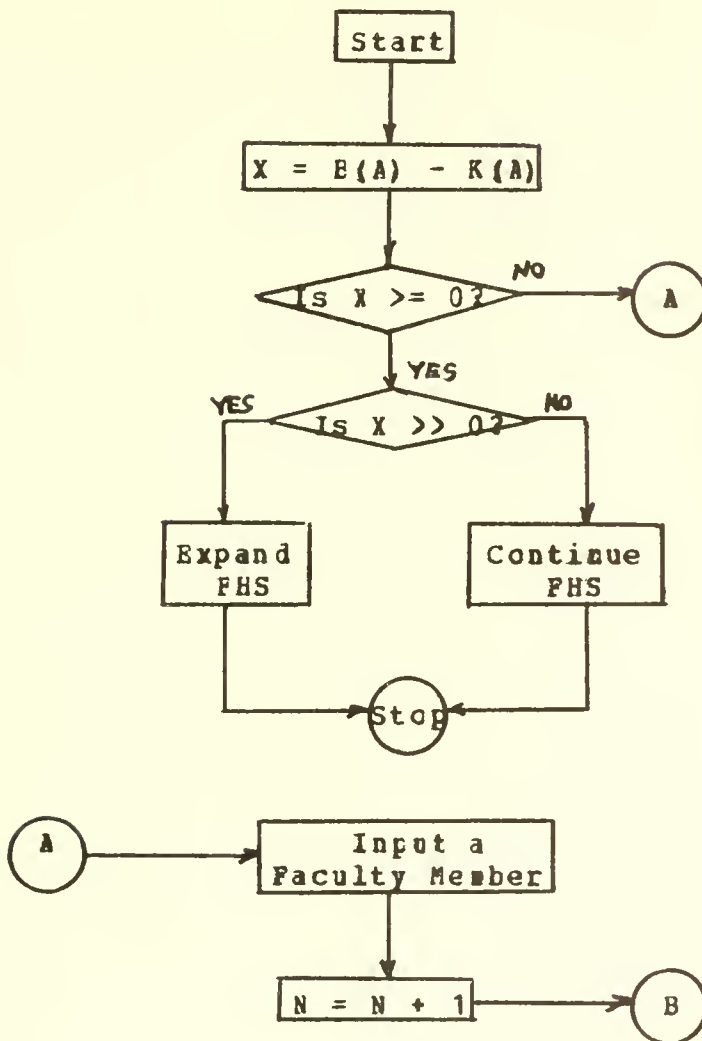
Benefits to the Medical Department can be increased by collecting data which may serve as a basis for research and by increasing the number of participants in the program. Any of these alternatives would also change the costs and benefits to the individual.

The Need to Know the Transformation Process

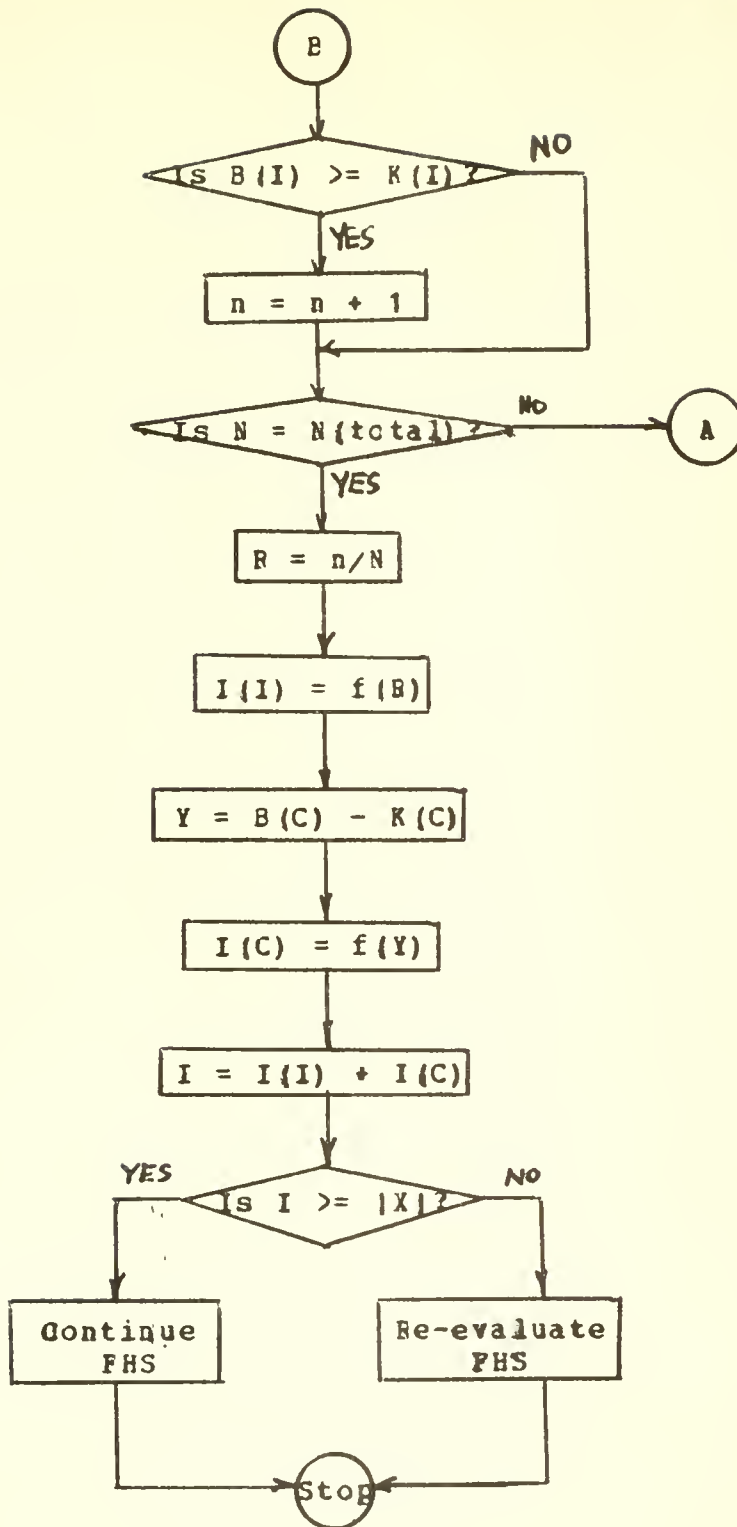
It must be determined how all costs and benefits are interrelated and how they are related to various policy alternatives as discussed above. The following logical flow diagram of the decision-making process is an attempt to conceptualize this problem. The diagram shows how the costs and benefits to the individual, clinic and administration might be brought together in order to determine the policy to be followed by M.I.T. The diagram is followed by a numerical example that illustrates how it may be used.

M.I.T. Faculty Health Survey Program

Decision-Making Process



$B(A)$ = benefits realized directly by the administration
 $K(A)$ = costs incurred directly by the administration
 $B(I)$ = benefits realized directly by the individual
 $K(I)$ = costs incurred directly by the individual
 $B(C)$ = benefits realized directly by the clinic
 $K(C)$ = costs incurred directly by the clinic
 $I(I)$ = index of individual's satisfaction with the program
 $I(C)$ = index of clinic's satisfaction with the program
 I = total satisfaction index
 n = faculty who use service
 N = faculty eligible for service



In order to illustrate the decision-making diagram, the following numerical example may be of assistance. As was previously mentioned, the annual cost of the Faculty Health Survey, $K(A)$, is estimated to be \$64,000. Let us assume that the benefits that are directly realized by the

administration, $B(A)$, have one of three possible values. These benefits are those which were discussed in the earlier section and consist of death and disability payments that are avoided, as well as the expense that is avoided by not having to replace a highly-regarded member of the faculty with an outsider.

First, let us assume that this figure is \$100,000.

$$\begin{aligned} X &= B(A) - K(A) \\ &= 100,000 - 64,000 \\ &= 36,000 \end{aligned}$$

With $X = 36,000$, this is both greater than zero ($X > 0$) and very much greater than zero ($X \gg 0$). Therefore, the indicated course of action is to expand the Faculty Health Survey. This expansion can take many forms: Make the examinations compulsory (difficult to do in a university setting), increase the "marketing" effort on behalf of the program, increase the frequency of the examinations, and so forth.

As a second case, let us assume the benefits to be \$65,000.

$$\begin{aligned} X &= 65,000 - 64,000 \\ &= 1,000 \end{aligned}$$

Here, X is greater than zero, but not very much greater. Thus the Health Survey is continued, but not expanded.

As a final case, let us assume that the direct benefits to the administration are only \$40,000. Since this results in X being less than zero, the benefits which accrue to the individual faculty member and to the clinic must be examined.

The first step is a canvass of the faculty as to

whether they wish to avail themselves of the Health Survey. Each faculty member, 1 of N , is invited to have a physical examination. The faculty member compares the cost, $K(I)$ (consisting of the out-of-pocket cost for laboratory tests, etc, plus the intangible cost of time lost), to the benefit of, $B(I)$, the decision is made to have the examination, and n is incremented by 1. The canvass is continued until all eligible faculty members have been "asked," i.e., $N = N$ (total).

The ratio, R , represents the fraction of the faculty, n/N , who have expressed a positive disposition toward the Survey, i.e., they have had an examination. This figure is currently about 75%. Given this R , an index, $I(I)$, is derived from the function shown below. The exact shape of the curve and the scale along the abscissa (expressed in dollars) are determined by administration policy makers. For this example, let us assume that for $R = .75$, $I(I) = 20,000$.

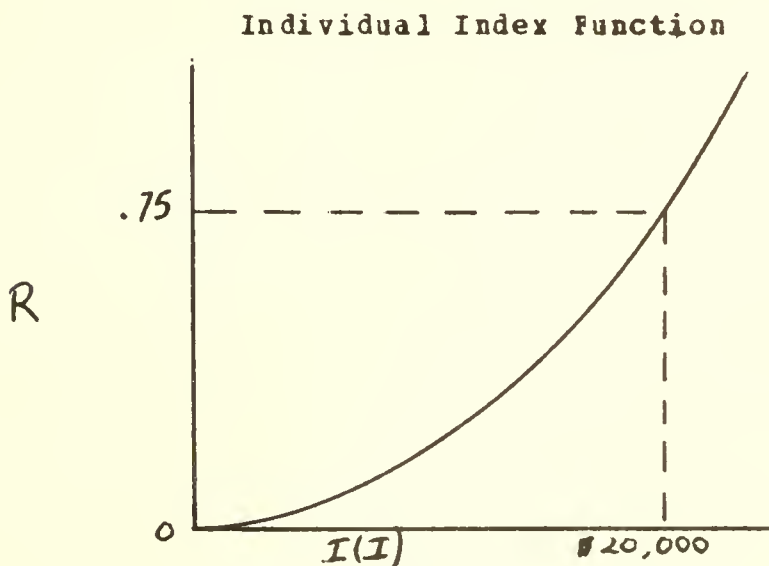
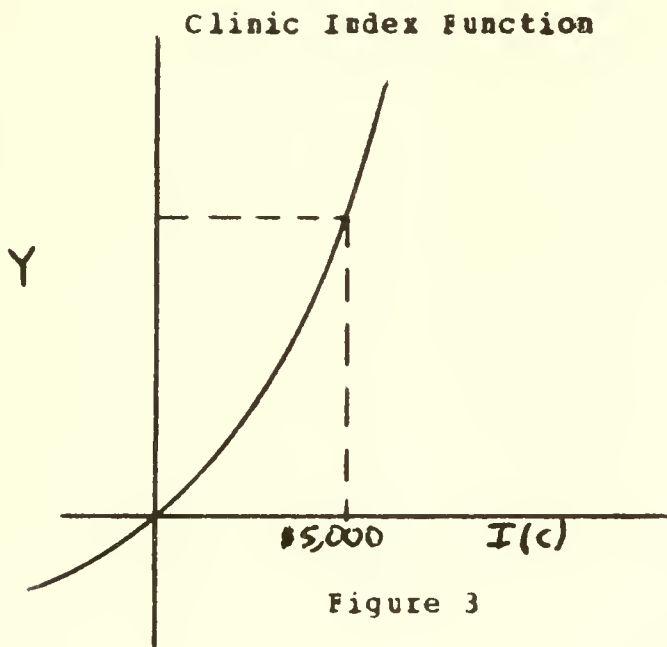


Figure 2

The next step is to examine the relationship, Y ,

between costs, $K(C)$, and benefits, $B(C)$, for the Medical Department (the clinic). This number is arrived at by the clinic staff and may be positive or negative. Here again, an index, $I(C)$, is derived from this value, Y , from a function whose general shape is shown below. (As before, the shape of the curve and the scale of the abscissa are determined by the administration.) In this case, let us assume that $I(C) = 5,000$.



The overall index, I , is but the sum of the individual and clinic indices. In this example,

$$\begin{aligned}
 I &= I(I) + I(C) \\
 &= 20,000 + 5,000 \\
 &= 25,000
 \end{aligned}$$

From the earlier assumption that $B(A) = 40,000$, X then equals $40,000 - 64,000$ or $-24,000$. In other words, the direct benefit to the administration is insufficient to cover the cost of the program by \$24,000. The index, I , comprising the benefits that are realized by the individual

faculty members and by the clinic---as appraised by the administration---is now compared to this difference. In particular, is $I \geq |X|$? Substituting $(25,000 \geq |-24,000|)$, the answer is clearly yes, Thus, the decision is made to continue the program.

If the index had been less than X , i.e., if the additional benefits had not been sufficient to underwrite the deficit, the Faculty Health Survey program would have to be re-evaluated and possibly downgraded.

VII. Summary and Conclusions

No clear-cut answer to the problem of estimating the costs and benefits of the M.I.T. Faculty Health Survey program has been found. From the standpoint of the administration, costs can be quantified, but not the benefits. The Medical Department has not ^{clearly} identified the costs of running this program, as distinguished from others, and no policy has been established for the estimation of benefits. The individual has both costs and benefits originating, for the most part, from his psychological make-up. Because of the lack of data, the individual was treated as a black box represented by the fraction of faculty members who participate in the program. The most important deficiency is that of information on how the administration (the decision-maker) views the costs and benefits to the individual and to the Medical Department.

In light of this situation, the best course of action was felt to be that of outlining how a cost-benefit analysis might be conducted, what information should be collected and how this information should be incorporated into the analysis. A numerical example was also provided. As a result of this study, the problem was formalized and structured, attention was called to its most sensitive aspects and new lines of action, for increased benefits, have emerged.

This study may serve the M.I.T. administration, as well as those of other institutions with similar programs, as a guide for collecting information and subsequently evaluating

their programs. Its publication may also serve to inform the prime beneficiaries of the program (the faculty) and perhaps result in some change in their attitudes toward it.

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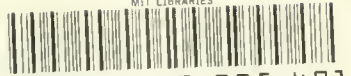
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