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ABSTRACT

This paper describes and evaluates the effectiveness of a program designed to improve technology transfer and utilization that was implemented in 1971 by the Naval Facilities Engineering Command. The authors first describe the organization of the technology transfer program and then attempt to evaluate its effectiveness over the three-year period 1972-74. In order to improve the accuracy of cost/benefit comparisons, a "benefit evaluation decision model" was developed. The authors discuss the design and use of this model and then apply it to the analysis of data for fiscal year 1974. This analysis of the technology transfer and utilization program shows that it produced $2.72 in benefits for each dollar spent. (Author/JG)

TECHNOLOGY TRANSFER AND UTILIZATION: A LONGITUDINAL STUDY USING BENEFIT ANALYSIS TO MEASURE THE RESULTS FROM AN R&D LABORATORY

by

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ABSTRACT

A description is given of a program designed to improve technology transfer and utilization in a classical organization consisting of a research and development activity and several engineering oriented user activities. The effectiveness of the technology transfer and utilization program is longitudinally studied. Three year comparisons of several parameters are reported. A benefit evaluation decision model is introduced in order to improve the accuracy of the cost/benefit evaluation of the technology transfer and utilization program. Using this model further longitudinal comparisons are made. Finally the general usefulness of the benefit evaluation decision model is argued by showing that for each dollar of investment this particular program gave a present value return of $2.72 in benefit. Several additional comparisons that could be made are suggested.

Technology Transfer, Introduction

The concept of "technology transfer" is difficult to define since its meaning seems to vary with the audience discussing it. In general, however, the transfer of technology differs from the usual dissemination of scientific knowledge in that it is more concerned with the usage of technological information obtained through research/development effort. "Any mechanism developed for transferring technology from its origin to its usage should be directed more toward suggesting methods and areas of application than toward merely publishing scientific results in technical documents to be filed in technical sections of depositories" (Doctors, 1969, p. 56).

In the United States the federal laboratory system represents a vast resource of science and technology, with over 469 major research and development (R&D) installations (RCSG, 1973, p. iii). These agencies have been producing technological reports at about 50,000 per year (Olken, 1972, p. 9). Over the past decade the executive branch of the government has emphasized the need for the federal government to actively disseminate this technology to the public and private sectors in an effort to increase the economic benefit of the information.

At present the federal government is supporting a number of technology transfer programs in several agencies and departments; however, it is very difficult to measure their results. "... there is a need for comprehensive experiments ... which would investigate the acquisition, evaluation, and dissemination of technical information and the measurement of its use after dissemination" (Doctors, 1969, pp. 7-8).

Objective of the Study

The objective of this study was to use longitudinal data to evaluate the effectiveness of a technology transfer and utilization program that had been funded in 1971 by the Naval Facilities Engineering Command.[1] Specifically the program under study was the Facilities Engineering Support Office (FESO) of the Navy's Civil Engineering Laboratory (CEL).[2]

In the process of upgrading the evaluation techniques a benefit evaluation decision model was introduced.

A second objective of the study was to show that the benefit evaluation decision model is a useful tool in terms of providing a meaningful method of quantifying the benefits of a technology transfer and utilization program.

General Background

The Naval Facilities Engineering Command (NAVFAC) executes a program of research, development, test and evaluation (RDT&E) for shore facilities, advance base and amphibious operations, sea floor structures, environmental control and those aspects of

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[1]This research was supported in part by the Naval Facilities Engineering Command, Washington, D. C. The principle researchers on the project were J. A. Jolly, J. W. Creighton, J. E. Hendrickson and W. G. Fisher, Jr.

[2]The assistance rendered by Mr. Eugene H. Early, Head of the Facilities Engineering Support Office of the Civil Engineering Laboratory, was greatly appreciated by the researchers and is hereby gratefully acknowledged.

weapon systems related to its mission. A significant portion of the emphasis of NAVFAC's program is to provide RDT&E which will benefit the Navy's shore facilities in efficiently and effectively meeting their independent missions. NAVFAC's link to the shore facilities is primarily through the Engineering Field Divisions (EFD's), Public Works Centers (PWC's), Public Works Departments (PWD's), and its construction program with Officers in Charge of Construction (OICC's) and Resident Officers in Charge of Construction (ROICC's). Figure 1 shows these relationships. A major portion of NAVFAC's RDT&E effort is assigned to CEL in the form of specific research projects.

The Civil Engineering Laboratory (CEL) is the principle research, development, test and evaluation center for shore and sea floor facilities and for support of Navy and Marine Corps construction forces (NCEL Inst. 1970, 1972). The staff of CEL consists of approximately 320 personnel, 150 of whom are professional engineers.

Funding for CEL's FY'74 program exceeded $13 million. For FY'74 the bulk of CEL's efforts, about 76%, were in exploratory development (applied research). Roughly 1% of the effort was in research, and the balance, about 23%, was in advanced engineering and operational systems development (RAP BRIEF 1974, p. ii).

NAVFAC's Technology Transfer Program

The Navy's RDT&E funds are administered by a division of NAVFAC which has the responsibility of insuring that the input and output of R&D information is transferred between all levels of the

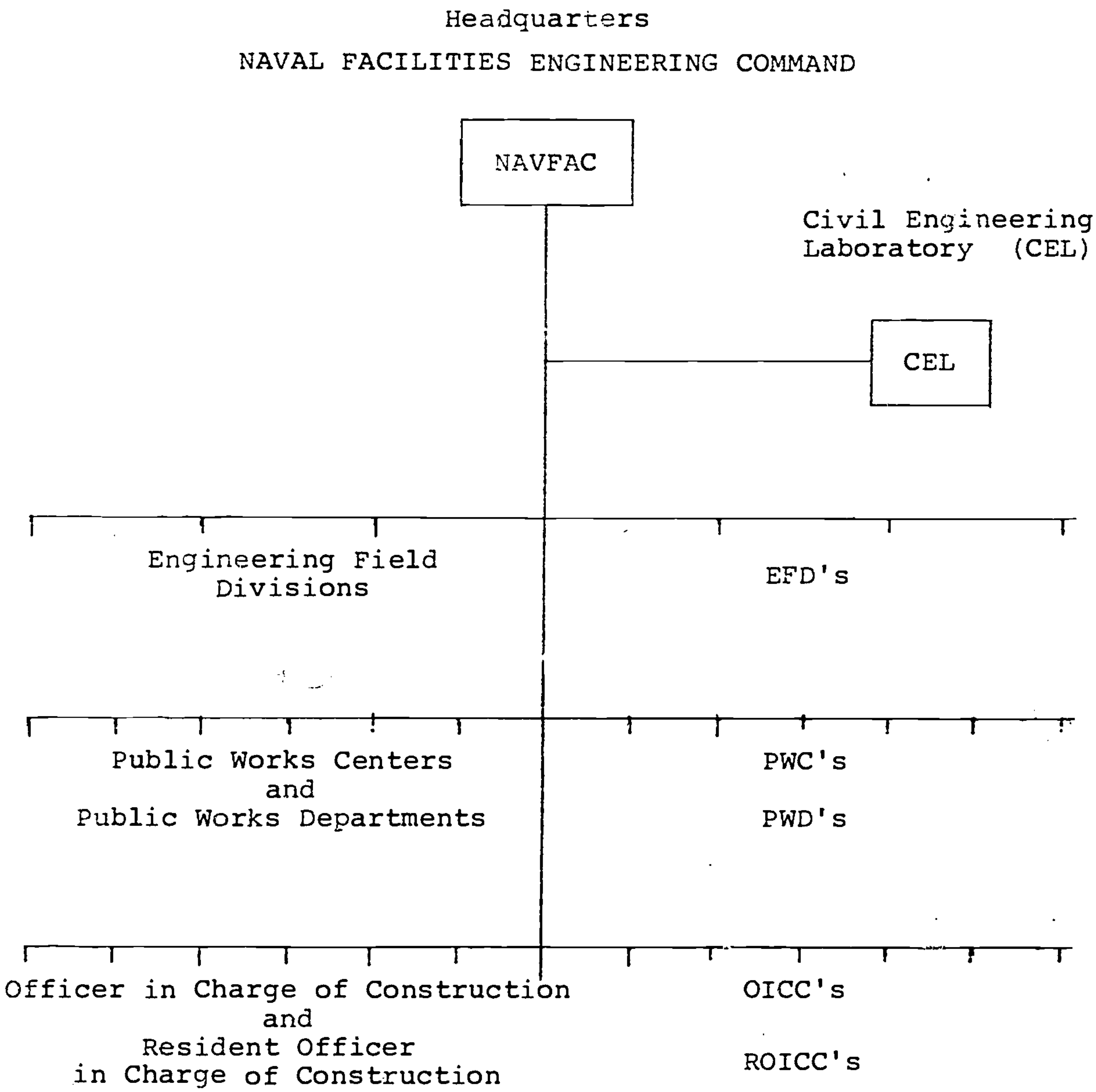

Figure 1. Navy's Civil Engineering Activity

An organizational diagram showing the flow of technical information between the Naval Facilities Command Headquarters, the Civil Engineering Laboratory and the various engineering field activities.

Navy to insure that the maximum benefit from R&D expenditures is obtained. Two specific organizational innovations are funded by NAVFAC in an effort to better coordinate the flow of R&D information from and to the field operating units (see Figure 2):

1. The Facilities Engineering Support Office (FESO).
2. The Engineering Field Division Liaison Billets.

The Facilities Engineering Support Office

The FESO organization was established by CEL and funded by NAVFAC to perform the function of coordinating services and communications related to RDT&E assistance to Naval shore activities. The specific objective of this program was to provide RDT&E assistance to Naval shore activities by having CEL perform short-term services to determine the relative value and suitability of new materials, equipments, processes and construction or maintenance procedures (NCEL Inst. 1971).

Conceptually, the FESO is in a liaison position and as such consists at the present time of one civilian. He administers the functions of the office by coordinating and recording the flow of information between the field units and the specific laboratory individuals having expertise in the area of the inquiry. In addition, this office is tasked with assuring that field units are knowledgeable of the lab's current programs and the availability of the FESO service. This advertisement function is pursued through various media including leaflets, bulletins and site visits. A 24 hour phone service is also maintained by FESO to handle and record incoming calls world-wide. In general, CEL's internal

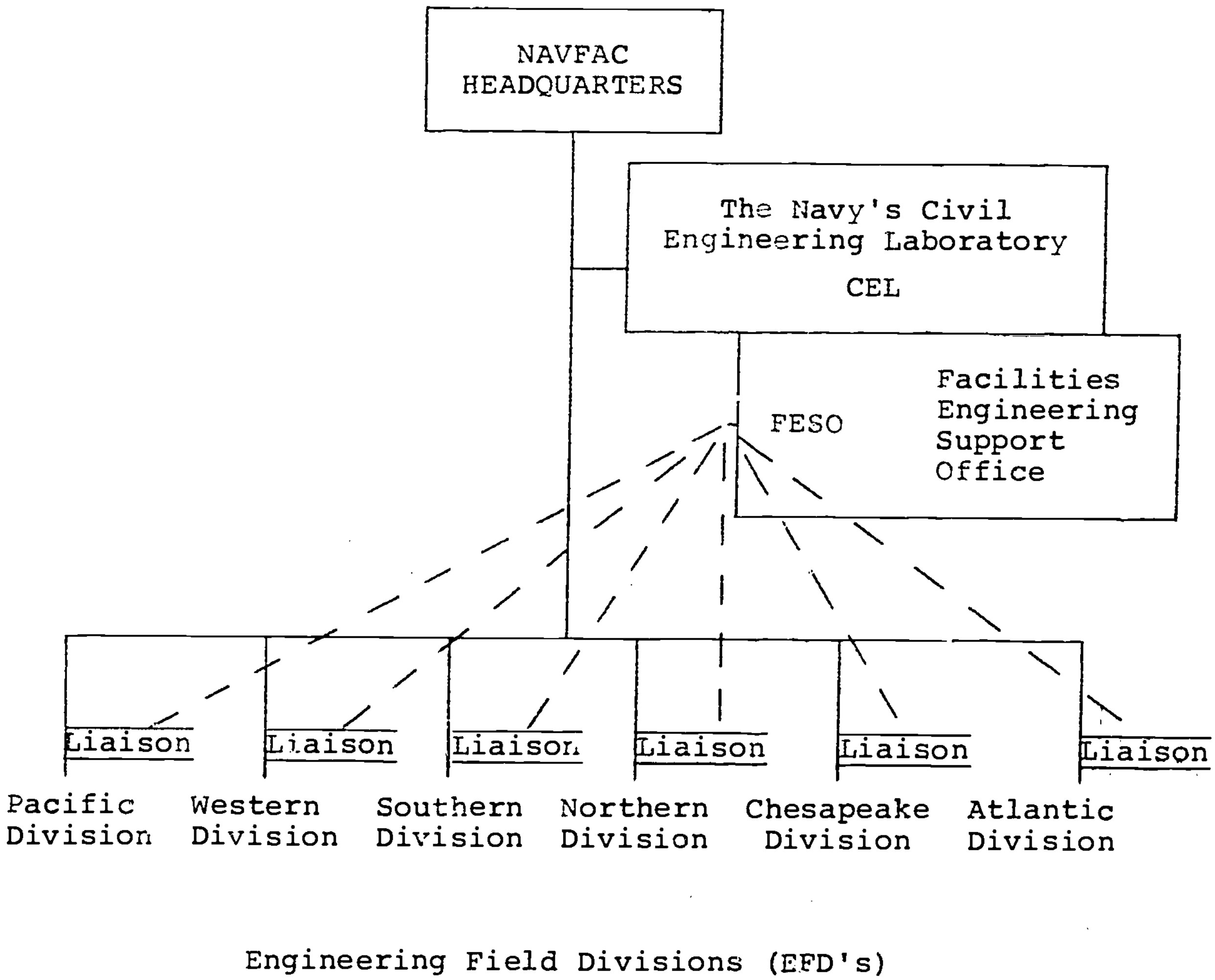

Figure 2. NAVFAC Technology Transfer Program

The organizational action taken by CEL was to establish a Facilities Engineering Support Office at the Civil Engineering Laboratory. NAVFAC established a Liaison Representative at each of the Engineering Field Divisions.

guidelines for expenditures of the funds allotted to the FESO provides that assistance requests involving twenty man-hours or less are approved at Division/Department level. Requests for services involving more than twenty man-hours (or $500) or frequently recurring requests of a similar nature are categorized as job order requests. These requests must be approved by the technical director.

The Engineering Field Division (EFD) Liaison Billets

The RDT&E liaison billet was intended to facilitate communication between field activities and NAVFAC in the area of RDT&E and to serve to improve and expedite the evaluation of new ideas, concepts, procedures, new materials, equipment, and to insure feedback to NAVFAC for further dissemination Navy-wide. They study technical problems unique to the field forces and transmit to NAVFAC proposals for research effort to initiate corrective measures (NAVFAC 3900.6 of 13 July 1966). They also serve as the CEL FESO primary point of contact at each of the EFD's.

Evaluation of FESO Benefits[1]

1. Quantity of Requests

The number of requests recorded by the FESO office were as follows: FY1972 = 281, FY1973 = 349 and FY1974 = 396. Under the assumption that an increasing number of requests indicated increasing benefit to the field activities, the program has been expanding well.

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[1]Survey techniques and details of each year's evaluation may be found in the technical reports listed in the reference [Jolly and Creighton, 1973, Jolly et al. Sept. 1974, Jolley et al. Dec. 1974].

2. Categories of Project Requests

Identifying specific categories of requests by project type is beneficial for determining major problem areas encountered by the EFDs. This information could be utilized in emphasizing future R&D efforts as well as affecting manpower requirements within the laboratory. By far the most common request in each year studied was in the area of paint and coatings. These accounted for between 18% and 25% of the total. Other problem areas achieving some significance, and ranging from 3% to 12%, included water pollution, classified disposal, structural, corrosion, concrete, electronic, pavement, mechanical, electrical, and miscellaneous pollution.

3. Means of Communication

The communication link to and from CEL was considered of vital importance to the program. The communication system must be accessible to those seeking information and also have the ability to transmit comprehensive and timely data. Survey data showed that the telephone was the predominant means of communicating requests from the Field to CEL. The use of the telephone increased from 60.2% of the total request in FY'72 to 75.5% in FY'74. Contributing factors to this sizable increase were the establishment of a 24 hour answering service in the FESO office and emphasis in CEL advertisement of their accessibility by telephone. The survey information also indicated that the telephone was a major means of communicating responses from CEL to the field, 41.5% in FY'72 and 54.8% in FY'74. It should be noted, however, that the data used to calculate the above percentages was based on initial request and initial response. In many cases, letter and message follow up documentation of both request and responses were used.

4. Response Time

One of the objectives of the program was to provide a rapid response to field requests. Results of measuring this parameter are shown as Figure 3. It is interesting to note that approximately one-half of all requests were answered within seven days of the initial request.

5. Utilization of Assistance

An important measurement of the program effectiveness is the determination of the degree to which the information obtained from CEL was used by the requesting activities. Figure 4 is a comparison of the productive versus the unproductive contacts. The results are expressed in percentage. It is difficult to attach any statistical significance to the relative small change that was observed over the three year span.

6. Dollar Benefit of Assistance

The measurement of the dollar benefit of the NAVFAC technology transfer program involving the CEL and the EFD's was considered desirable. The measures discussed up to this point in this paper tend to indicate that the program was working well, but they are not expressed in dollar benefits. In fact, each years evaluation questionnaire attempted to determine dollar benefits by asking the requestor to quantify within specific

Time Period	1 day	2 days	7 days	14 days	30 days
FY'72	26	34	45	57	76
FY'73	31	35	52	65	76
FY'74	27	37	57	63	75

Figure 3. Percent of Total Requests Answered Within Time Period

Shown is the cumulative percent of requests that were answered within a specific time period. As can be seen approximately one-half of all requests were answered within seven days.

	FY1972	FY1973	FY1974
Productive Output	72.8	82.8	79.0
Unproductive Output	27.2	17.2	21.0

Figure 4. Percentage Utilization of the Output Resulting from Requests

It is quite apparent that the year to year change in productive versus unproductive output from the requests is such that it is difficult to attach any statistical significance to the small change. It would appear that a 70 to 80 percent utilization over time can be expected. The results shown are from survey data.

ranges the estimated five year operating cost of individual projects, with and without the assistance from CEL. The difference between the with and without assistance cost was used as the benefit. Using this method the results reported are given in Figure 5.

In compiling the data reported in Figure 5 it was observed that only a small fraction of the requestors that completed the questionnaire were willing to assign a dollar value to their use of the CEL information. For example in FY1972 of the sample of 83, only 12 or 14.5% gave dollar values such that dollar benefit could be calculated. It was somewhat better in FY1973, the sample was 93 and 28 or 30% gave dollar values such that dollar benefit could be calculated. Even so, it was felt that the true value of the benefit was not being evaluated using this system. The next few paragraphs will describe in detail an alternate method of obtaining a dollar value for the benefits derived from the transfer of technology by the CEL to the EFD's.

Benefit Evaluation, The Problem

Objectively quantifying the benefits of the CEL technology transfer effort, as indicated in the previous paragraphs, was at best highly subjective and lead to varying results. There existed a considerable range of latitude when an attempt was made to quantify the dollar value of the benefit derived from a piece of information.

A specific recommendation to solve a particular problem may easily be quantified if it will reduce out of pocket expenditures to achieve identical results. Factors such as quality of output could, however, tend to cloud even this type of calculation. Quantifying benefits derived from one piece of information which is only a part of the total information required to arrive at a decision leaves room for even greater subjectivity. At the other end of the scale, quantifying an intangible benefit such as increased moral, safety, and general information probably is the most subjective measurement of all (Quinn, 1959, p. 11).

In essence, any attempt to quantify the benefit of information is necessarily highly subjective, and recognition of this fact is an underlying consideration in the development of a new approach which is presented here.

Benefit Evaluation, The Model

It was determined that the major issue in evaluating the benefit from a technical recommendation was the categorization process. A system was needed to test whether or not a benefit resulted and if a benefit resulted then to what extent the recommendation was responsible for the final benefit. This categorization may be accomplished by the benefit evaluation decision model shown as Figure 6 (Hendrickson and Fisher, 1974, p. 33-47).

Using Figure 6 and starting with an answer to a request for technical information the question at A is, "Did the answer to the request for technical information result in a benefit either tangible or intangible?" If the answer to the question is no, then the analysis terminates and that information request or recommendation is counted as having zero benefit. If the answer is yes,

Year	Total Requests Number	Sample Size	Estimate from Sample	Extrapolated to Total Requests
FY'72	281	29.5%	$28,000	$ 94,915
FY'73	349	26.6%	$46,000	$172,932
FY'74	396	26.5%	$77,000	$290,566

Figure 5. Benefit from CEL Assistance Program

Estimate of benefits using survey questionnaire data. This does not include extraordinary benefits reported, i.e. FY'73 = $15,000 and FY'74 = [illegible]87,000.

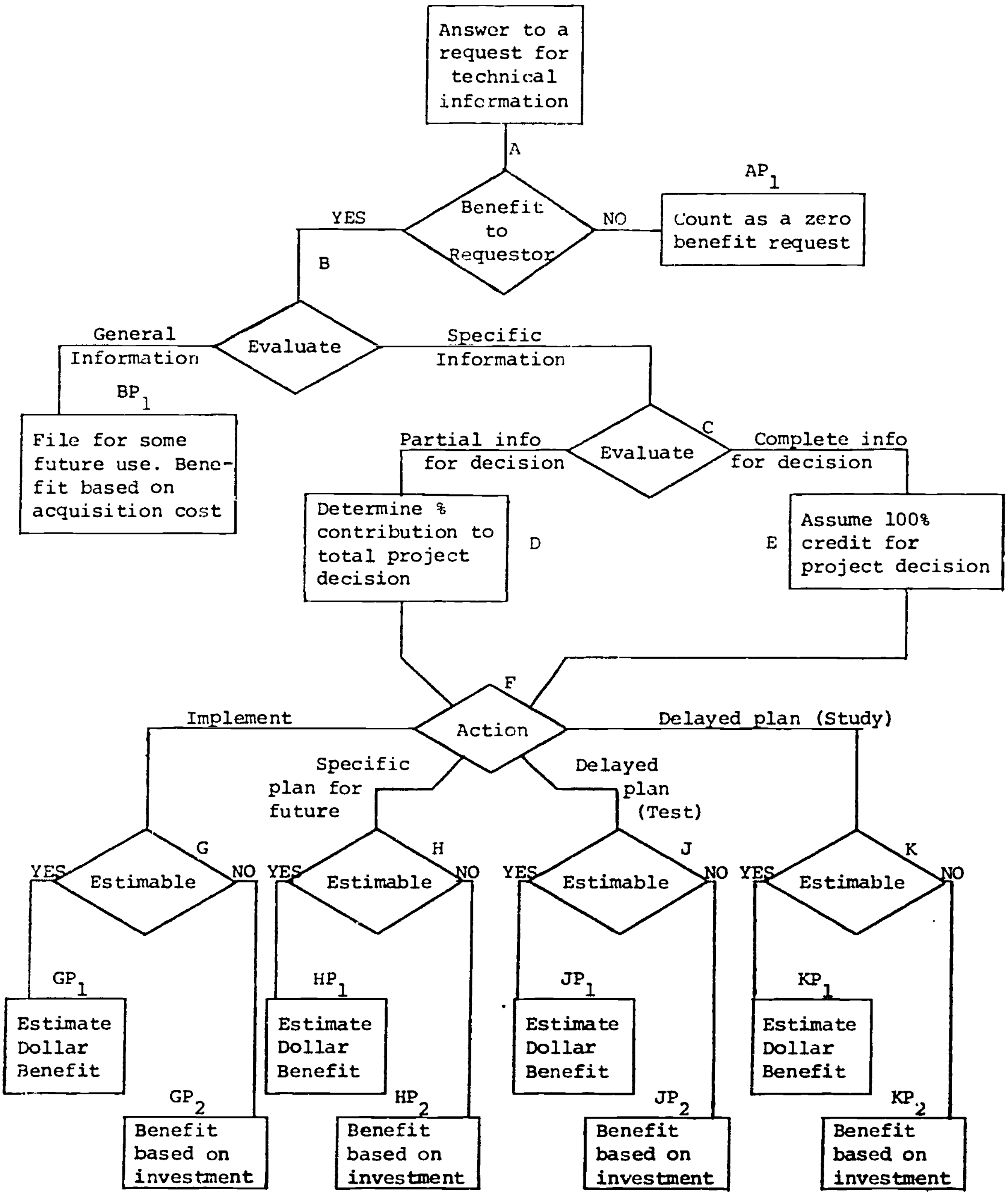

Figure 6. Benefit Evaluation Decision Model

Start at decision A, a series of decisions are shown that make it possible to evaluate the dollar benefit of the answer to a technical question supplied to an engineering organization by a research laboratory.

then the decision next in order on the decision model is B, "Is the information general so as to have no immediate value or is the information specific and useful?" If the information is general in nature it may be filed for use at some future date and the present value of the dollar benefit is assumed to be the acquisition cost. In contrast if the information is specific, then the path leads to decision C. At decision C the information must fall into one of two classifications, either partial information for a decision or complete information for a decision. When the information is partial, that is, when the information is only part of the total information used to arrive at a decision, then it is appropriate and necessary to determine the percent of contribution to the total decision. This process is shown as block D of the model. When the information is substantially complete and self contained in terms of influencing the decision then one hundred percent credit for the benefit is allocated to that information request. Block E shows this assumption.

Both of these information evaluation channels then lead to an action decision block F. At decision point F there are four alternatives. If the project was implemented then the decision route is to G where it is necessary to determine if the results were estimable. In many cases a specific dollar benefit can be assigned at this point of the analysis.

A project may be delayed, but with a specific plan for future implementation. This decision is represented by H. Some future action benefits can be estimated in terms of a dollar return, others are more intangible. This decision is made at point H.

The third branch of F is for those projects that have a delayed plan because testing is required. The estimate of benefit is based on the assumption that if the tests are successful, then the project will be implemented. If the project is implemented there should be a resulting benefit. For some projects the potential benefit, once the project is implemented can be estimated (decision point J) but for other projects the benefit may be only intangible such that it would be most difficult or perhaps impossible to assign a specific dollar value to the benefit.

The fourth and last choice, at action decision block F, is delayed-plan-study-required. This is similar to the delayed-plan-test-required except that a feasibility or economic study may be necessary in order to determine the worth of the project. As part of the study additional tests may be necessary and/or desirable in order to reduce the risk associated with implementing the recommendation. This branch has the lowest probability of resulting in a dollar benefit, because of the several uncertainties that must be considered. If it should be implemented, it, like the other decisions of decision block F, must proceed to the next level of decision (decision block k) in order to determine if the benefit is estimable and therefore a specific dollar benefit or if the benefit is intangible and therefore difficult to evaluate the benefit.

Perhaps the most important function of the benefit evaluation model, is to provide an organized system of classification or categorization of the benefits to answers to requests for technical information. When the categorization process is completed, then it is possible to continue toward the objective of determing the benefit derived from the recommendation. This requires the determination of the percentage of contribution of the recommendation to the final product decision, the assignment of probabilities to the likelihood that the project will be implemented and, a determination of the dollar base for each benefit. These issues will be discussed in the next few paragraphs.

Determining the Coefficients and Dollar Base

To use the benefit evaluation decision model it is necessary to (1) assign values to the factor, information contribution percentage (decision D) for each benefit that resulted from the use of technical information provided by CEL to (2) assign probabilities to the likelihood of implementation of expected actions (decision F), and to (3) determine the dollar base for each benefit that resulted from the use of technical information provided by CEL. A discussion of each follows:

1. Factor, Information Contribution Percentage

The coefficient for the factor, information contribution percentage, was assigned to each case on an individual basis. The total information available in order to make a decision on implementing a project was reviewed by the researchers. The factor coefficient was selected from the range of 0.01 to 1.0 based on the relative effects that the CEL provided information had on the selection of the most beneficial alternative available. Other considerations in the selection of a factor coefficient were the availability of the information from other sources and the relative benefit of the next best alternative that may have been selected had CEL provided information not been available.

2. Implementation Probabilities

Responses to requests for technical information which were considered beneficial (Decision A) were classified by the benefit decision model into one of the following categories which are listed in descending order according to the probability of implementation of the information provided:

Final Decision	Decision Model Path	Probability of Implementation value	Probability of Implementation range
1. Information has been implemented	A, beneficial B, specific info. C, evaluate E, action G, implement	1.0	
2. Specific plan to implement	A, B, C, F, H, planned for future	0.5	0.4-0.6
3. Implement if tests are successful	A, B, C, F, J, delay plan (test)	0.3	0.2-0.4

			value	range
4.	Implement if study indicates benefits are probable	A,		
		B,		
		C,		
		F,		
		K, delay plan (study)	0.2	0.1-0.3
5.	General information not specific to a project	A,		
		B, file for future use		

The probabilities shown were based on the experience of the researchers. It would be appropriate to adjust these probabilities depending upon the history of the organization and/or the experience of the researcher using the benefit evaluation decision model.

3. Dollar Base for Model Calculations

Projects with dollar savings specifically identified on the FY'74 questionnaire were classified as estimable. If the identified savings were of the one-time type (versus recurring), the amount so identified was used as the project benefit dollar base. The benefit credited to CEL assistance in such a case was the project benefit dollar base reduced by the factor for information contribution and the factor for implementation probability. If estimable identified savings were of the recurring type, the project benefit used was the present value of the first five years of savings. A present value factor of 3.935 for a steady cash flow throughout the year utilizing a 10% rate of return was used as the project benefit dollar base. Again, the benefit credited to CEL assistance was the project benefit dollar base reduced by the factor for information contribution and the factor for implementation probability.

Beneficial projects resulting from CEL supplied recommendations, which did not have specifically identified dollar savings, generally fell into areas where the benefit was in the form of improved operations, better morale, increased safety, improved quality, etc. In FY'72 and FY'73 surveys, benefits of projects of this type were left unquantified. With the exception of responses to requests which fell into the category, general information, each response to a request should have had an identifiable benefit even though it was not readily quantifiable in terms of direct dollar savings. Each response to a request for technical information could in some way be identified with an implemented or proposed project, the magnitude of which was normally relatively easily quantified.

The assumption accepted was that in order to commit funds to a project a decision maker must, whether he realizes it or not, expect a return in future benefit which is some percentage greater in present value than the initial outlay. This percentage may vary from decision maker to decision maker and will even vary with time under varying circumstances for any decision maker. Even though the investment return would be expected to vary, it is assumed that the decision maker (in any organization), who decides on implementation of a project based on supplied technical information, would be of a quality such that the results of their decision over the long run and on the average would yield a positive benefit. In the case of evaluating the output of CEL assistance, approximately 100 of 295 requests for information in the FY'74 survey fell into this unestimable category. The benefit then, for the projects in this category, was the project investment reduced by the factor for information contribution percentage and the factor for implementation probability.

Application of the Model to FY'74 Data

The FY'74 survey included 295 requests. FY'74 questionnaires were completed on each of these requests, 105 through the six EFD RDT&E representatives, and the remainder by researchers at the Naval Postgraduate School, Monterey, California, based on telephone interviews with the original requestor. Of these 295 questionnaires, 233 indicated that the requestor considered that he had received beneficial information. The remaining 62 questionnaires indicated that the request yielded no beneficial information. However, among these were 40 cases which indicated that there were extraordinary circumstances indicating that these cases should not be included as zero benefit requests, but rather should be eliminated from the sample for purposes of cost benefit analysis and study. Most common among these extraordinary cases were:

1. The request was merely a followup on a previous request. The benefits were totally included on the original request number and were listed on this one as zero to avoid double counting.

2. The lab had requested additional information on the problem from the originator but the information was not provided.

Table I shows the tabulation of the numbers of cases and the total benefits calculated for each code based on the code numbers assigned by Figure 7. This table shows three figures

Benefit Code	Probability of Implementation	Benefit Estimate
01	Information has been implemented	Estimable
02	Same	Not estimable
03	Specific plan to implement	Estimable
04	Same	Not estimable
05	Implement if tests are successful	Estimable
06	Same	Not estimable
07	Implement if study indicates benefits	Estimable
08	Same	Not estimable
09	General information not specified to a project	Acquisition cost

Figure 7. Benefit Codes According to Likelihood of Deriving Benefits

Code numbers are assigned to each benefit path of the model. These code numbers are used to identify the decision combination when specific dollar benefits are discussed.

for the benefits in each category. The three figures represent calculations based on use of the mean, the high, and the low values of the probability of implementation. Figure 8 shows the plotted values indicating the increasing uncertainty as the cumulative benefits progress to include more subjective estimates.

A Cumulative Benefit Curve

The curve, Figure 8, resulted from drawing smooth curves through the points derived from Table I. They represent graphically the fact that, as the benefits of a greater percentage of cases in the sample are quantified (a greater number of subjective estimates are included), the total estimate of cumulative benefits becomes more subjective. The vertical distance between the "high" and the "low" curves at any point on the horizontal scale represents the range within which the estimate could reasonably be expected to vary due to differing personal values of estimators or decision makers.

Although not by any means an analytical proof, the curve tends to intuitively verify the applicability of the model. As intuitively expected, the benefits from the highly intangible cases are less than those from the more tangible ones, as indicated by the decreasing slope of the curves. This intuitive approach is further strengthened by the observation that a decision maker will generally give less weight to the more intangible benefits when confronted with the choice of whether or not to spend today's very tangible dollars for future benefits.

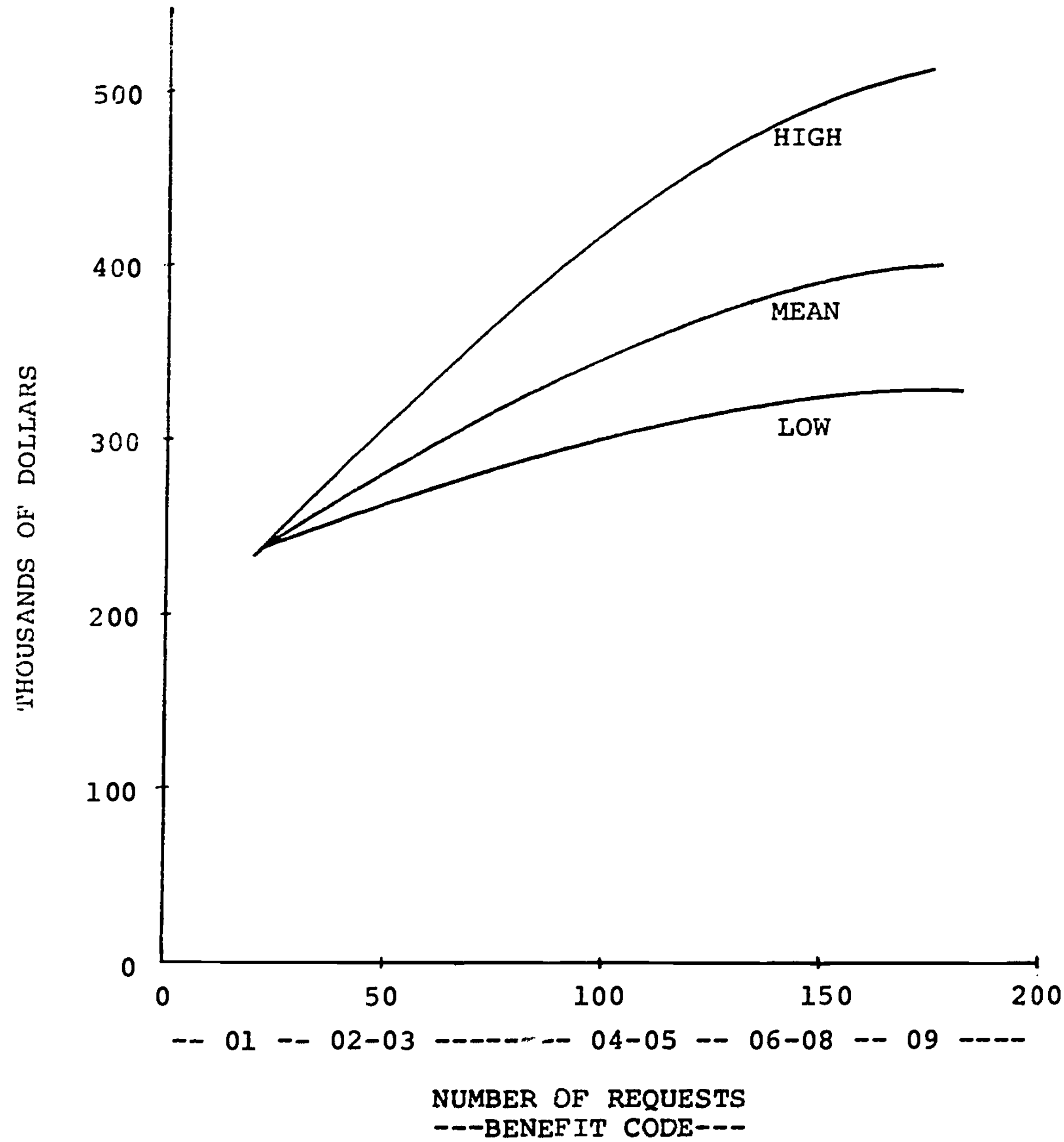

Figure 8. CEL Assistance Dollar Benefits vs Number of Requests with Requests Ordered According to Probability of Estimate

This figure shows the curves of quantified benefits utilizing high, mean and low probability of implementation. The slope decreases and the range of accuracy widens as greater numbers of requests in the sample are quantified.

Benefit Code	Number of Requests	Value		
		Low	Mean	High
Not counted	40	--	--	--
Zero benefit	22	0	0	0
01	27	$254,361	$254,361	$254,361
02	51	9,260	18,525	37,051
03	6	15,399	19,250	23,099
04	38	11,816	29,540	70,896
05	8	41,690	62,534	83,379
06	8	3,485	10,455	27,880
07	1	236	472	708
08	12	532	2,130	5,890
09	82	--	unquantified	--
	295	$336,779	$397,267	$503,264

Table I. Quantified Benefits for FY'74 FESO Operation

Dollar benefits are shown according to benefit code (see Figure 7). The dollar benefits are calculated using the Benefit Evaluation Model.

For the purposes of the analysis made throughout the remainder of this study, the benefit value utilized will include Benefit Codes 01 through 08 only and will be based on mean factor values.

A Comparison with Past Years' Surveys

The FY'74 survey methods, in large part, have resulted from experience gained by FY'72 and FY'73 surveys. Many questions have been changed to some degree each year in an effort to obtain better data. One disadvantage of the continuous change is the fact that the figures are not strictly comparable from year to year. This comparison is necessary, however, in order to show trends over time.

Data from the FY'74 survey is similar to that of the earlier surveys in all areas except the dollar value estimates of benefits. The major differences between the FY'74 and earlier data in the area of quantifiable benefits is shown below:

FY'72 and FY'73 Surveys

1. Only readily estimable cases which had been implemented were included.
2. Of the total Shore Facilities requests received 40% were surveyed.
3. Where annual savings were identified, the project benefit was calculated as five times the annual savings.
4. The total project benefit was used as the benefit of CEL assistance.

FY'74 Survey

1. Any benefit which could be reasonably quantified was used. Projects with future implementation potential were included and the benefits thereof were reduced by applying a probability factor.

2. All Shore Facilities requests were surveyed.

3. Where annual savings were identified, the present value of five-year savings was used.

4. An information-% - factor was applied to the project benefit to arrive at the benefit contribution.

The dollar benefit figures computed by FY'74 survey methods must be adjusted to be comparable to the earlier survey figures for purposes of examining trends.

The cases in the FY'74 survey which were classified into Benefit Code 01 are only partly equivalent to the cases quantified in the FY'72/FY'73 surveys. The quantified benefits applicable from this code totaled $66,662.[1] Adjusting this figure downward by a factor of 0.4 to $26.665 compensates for the 40% sample of the FY'72/FY'73 surveys. Further adjusting upward by dividing by .37 to $72,068 compensates for use of the information-% factor in FY'74. Approximately 83% of the readily estimable savings in the FY'74 survey were of the annual recurring type. The resulting adjustment for use of the present value factor (472,068 × 3.9 × 5 × 0.83) yields $76,688.

By a similar method, the FY'72 and FY'73 survey data can be adjusted to reflect results as if the FY'74 method was applied to all three years. Figure 9 shows a graphical comparison of all three years utilizing both the FY'72/FY'73 and the FY'74 survey methods. The extraordinary cases have been eliminated since it is inappropriate to include them in projections either backward

[1]This figure excludes one project, quantified at $187,000. This project is considered extraordinary and not of a recurring type and should, therefore, not be included at this point.

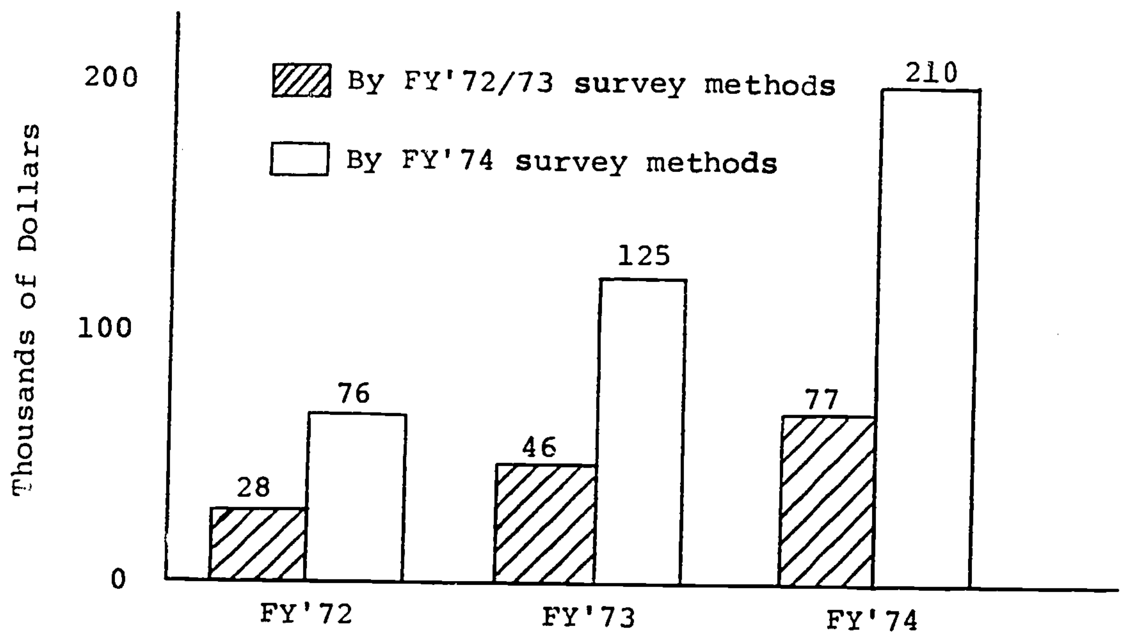

Figure 9. CEL Assistance Benefit Trends (Thousands of Dollars)

The bar graph shows the CEL assistance benefit using (1) estimates of the requestors and (2) using estimates from the Benefit Evaluation Decision Model.

or forward. It should be noted, however, that over the long term extraordinary cases of this type may constitute a significant portion of relaized benefits.

Benefit Analysis Using Selected Topics

This study evaluated only 295 requests of the total 396 that the FESO office recorded during FY'74. With respect to the total requests the analysis represented 75% of the CEL assistance effort. The value of the benefits attributable to these 295 requests, as measured by the model amounted to $395,269 (see Table 1). Of the total cost of the CEL assistance for FY'74 only the portion of the total cost applicable to the 295 requests would be appropriate for a cost/benefit analysis. These costs are:

273 short-term requests	$48,841
22 job order requests	$66,346
FESO administrative expenses, proportioned as to total assistance requests processed 295/396 × 41,494 = 30,911	$30,911
	$146,098

Evaluation of the CEL assistance program within the framework developed above indicates that there was a present value return of $2.72 for every dollar spent ($397,267/$146,093).

The primary purpose of the CEL assistance, as discussed previously was to provide a rapid response to requests for assistance from field operating units. The rapid response requests were recorded separately. If these short term rapid response requests only were considered, then the appropriate costs should include direct expenditures for the 273 short-term requests, plus an appropriate proportion of the administrative costs. Expenditures for these short-term requests totaled $77,447 (i.e. $48,841 = [273/396 × $41,494]). The dollar value of the benefits from these 273 requests was $184,444. The return of the CEL assistance program for these short-term requests was $2.38 for each dollar spent.

When the dollar benefit of each project can be determined it is then possible to construct charts for analysis purposes. For the CEL assistance these data were used to construct the following:

1. Comparison of costs and benefits with respect to project type, i.e. paints, pavement, pollution corrosion, etc.

2. Comparison of cost and benefits by benefit code, i.e. implemented, specific plan for future implementation, etc.

3. Comparison of cost and benefit by user group, i.e. EFD's, PWC's, OICC's, etc.

4. Comparison of cost and benefit by originator, i.e. civilian engineer, military engineer, technician, scientist, etc.

Other comparisons meaningful to a specific organization or evaluation problem should be obvious depending on the needs and/or objectives of the study.

Summary and Conclusions

This longitudinal study of a classical organization with a specific structure to promote technology transfer and utilization has carried the cost/benefit analysis beyond the usual comparison of number of requests, response time, and estimate of tangible benefits. A benefit evaluation decision model was introduced that provided a means for categorizing technical information and/or technical recommendations. The model considers both tangible and intangible benefits. After the technical information and/or technical recommendation is categorized and a dollar benefit base assigned, the dollar benefit is adjusted (1) according to the percent of influence it had upon the final technical project, and (2) according to the likelihood that the project would be implemented. Dollar values derived from the model are then used to determine cost/benefit by several comparisons. For example, when the model was used to evaluate requests for assistance from CEL, technology transfer and utilization program showed a return of $2.72 for each dollar spent.

Other comparisons, meaningful to a particular organization are suggested.

It is believed that this study demonstrates that it is possible to meaningfully quantify in dollars a significant portion of the benefits of technical information and/or technical recommendations that are often identified as intangible.

This benefit evaluation decision model should be particularly useful in evaluating the benefits of technology transfer and utilization programs in other organizations.

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