TRAINING AND DEVELOPMENT RESEARCH CENTER

Project Number Eight

FORECASTING THE FINANCIAL BENEFITS OF QUALITY-BASED ELECTRONICS MANUFACTURING TRAINING

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Chapter 1

Introduction

American industry is confronted by numerous challenges including product quality and reliability. Schedule adherence, cost improvement, and increased productivity are business issues beyond product quantities that present additional challenges. One way to achieve the required and expected quality, plus meet the business challenges, is through accurate, comprehensive, and timely training (Control Data Corporation, 1983).

In their zeal to overcome problems and maintain the status quo of production, managers often ally themselves with solutions before defining the problem and thinking about the available options. For example, managers will treat symptoms or short-term organizational problems and disregard long-term consequences so as to keep their product in production. Ignoring training needs and maintaining unreliable buddy-system training are two such examples.

The inclination in American industry is too often reactive rather than proactive. Poor or incomplete analysis of the human resource needs of the firm leads to misguided, incomplete, inaccurate or, inappropriate training that can result in negative financial consequences to the firm (Nickols, 1979). This study deals with the issue of taking a proactive stance related to training innvestment decisions in a high technology manufacturing firm. Specifically, the focus is on forecasting the financial consequences of training program options for personnel who manufacture sophisticated electronic equipment. The forecast is done using the Training Benefit Forecasting Method (Swanson & Geroy, 1984).

Purpose of the Research

The purpose of this study was to validate the Training Benefit Forecasting Method (TBFM) in a quality-based electronics manufacturing organization.

In the previous TBFM studies, the employee performance goal of the training focused on quantity of completed units of work or productivity with an assumed level of quality of workmanship. This study had a primary focus on quality as it relates to hand assembly of electronic printed circuit boards with a focus on defect rate rather than finished products. It also used management and salaried personnel in lower level positions than used in previous studies as forecasters. These people had no regular financial accounting duties. Due to the specialized nature of the product and the work, the training options considered variations on formal and informal in-house training and custom designed training from an external training consultant.

Significance of the Research

The rule rather than the exception in manufacturing is to focus on training costs and ignore the benefits (Head, 1985; Spencer, 1984). Answers to questions such as what will it cost and how much did we spend last year, are generally the basis for decisions of whether to train. Cost-benefit analysis not only views the cost of training, but compares it to the economic gains resulting from the training. Little has been done to address the need for methods to aid managers in forecasting the economic return on training programs. This study will add to that body of knowledge (Geroy & Swanson, 1984).

Definitions

The following are definitions to commonly used terms within the TFBM.

Benefit Forecasting - increases in performance values, minus the training costs, divided by the number of days required to reach the criteria performance level or goal performance level.

Costs - Staff time, trainee time, consultants, materials, space, etc. needed to complete the training process steps; needs analysis; work behavior analysis; design, implementation, and evaluation of training (Swanson & Geroy, 1984).

Performance Units - the measurement used to determine and evaluate the trainees' progress toward the goal performance level. In this study, the units are defects per day.

Performance Value - the worth of performance units represented in dollars.

Chapter 2

Review of the Literature

Training

There are two major types of training --unstructured and structured (Cullen, Sawzin, Sisson, & Swanson, 1976). Unstructured and on-the-job training usually result in the trainee acquiring questionable job-related knowledges and skills. Structured training takes place through a systematically developed educational program, and more often than not results in mastery of the established objectives. This study embraces training options that fall into both the structured and unstructured training categories.

When considering costs related to training, the following factors are relevant: cost of (1) initiating the training function, (2) servicing and coordinating the training function, (3) the fixed training capital, (4) the working capital, providing instruction, giving instruction and the wages of trainees, and (5) the net of trainee output value.

In regard to benefits the following are considered: the nature of the benefits, measurement of benefits and benefits of reduced labor turnover (Thomas, Moxham, & Jones, 1969).

Evaluation of Training

Evaluation of training has long been a problem for persons involved in the production and delivery of training (Parker, 1984). The thought of being accountable for their training results is a threat to training personnel. Evaluation or measurement of learning success is not new, as the formal educational system has been measuring or evaluating student learning for centuries. Business is no different, except the measurement of success is ultimately in dollars and cents (Swanson, 1982). A number of factors contribute to business success --one of them being the knowledge and skill of the workforce obtained through training.

Training can be thought of as a processing system which converts input into output. The trainees or students are the inputs. The outputs are employees whose abilities have been developed or refined through training. In this way training contributes to the larger organization (Smith, 1980). Evaluation has two roles to play in determining the contributions. The first is to continue or discontinue a program based on its contribution. The second is to decide which aspects of the program should be revised (Smith, 1980). "Evaluation cannot be carried out until resources have already been committed to and at least partially consumed in activity. Evaluation, therefore, is always after-the-fact; it provides hindsight. What is required in order to make sound judgments regarding training activities is foresight analysis" (Nickols, 1979, p.54). To do this, Nickols recommends building forecasting models and analyzing them.

Different evaluation approaches have been discussed in the literature. Barta (1982) identifies and ranks three in order of desirability as: return on investment (ROI), benefit-cost, and payback period. Brown (1980) selects four research designs for evaluating training: before and after design, control group design, reversal design, and multiple baseline design. He favors multiple baseline design for two reasons. This method involves collecting two or more sets of baseline data and the intervention is staggered, being introduced in a step-wise fashion across the baselines. Three types of multiple baselines are introduced: across behavior or performance variables, across subjects or groups, and across settings or locations.

Numerous evaluation models and studies have been conducted with the desire to cost-justify training programs. Thomas, Moxham and Jones (1969) studied costs and benefits related in their 1965 Yorkshire study. Through an enhancement in the training system, benefits were realized in positive changes in average performance levels, average retention time and a reduction in the length of the training period.

Another evaluation option, presented by Swanson and Geroy (1984), is forecasting training costs and benefits.

Cost-benefit compares 2 or more alternatives when all the costs and benefits are measured in monetary terms. Other analyses are cost-effectiveness (when the focus is on outcome) or cost-utility (when the focus is on utility or value of outcomes). All are comparing 2 or more programs. This concept is reinforced by the philosophy that Nickols (1979) promoted concerning the need to have foresight, plus the statement made by Thomas, Moxham, and Jones (1969) regarding knowing more about opportunity costs to improve decision making.

Most of the evaluation models discussed thus far reported in the literature, focus on after-the-fact summative evaluation with no mention of pre-design or pre-planning types of evaluation (Parker, 1984). Including these two factors in the design of training could prevent embarrassing and costly errors in selecting and implementing inappropriate training programs.

A goal in training is to positively impact employee performance. Training can maintain or enhance employee morale, eliminate or reduce scrap and rework, and provide greater insurance of a quality product, all of which translates into reduced costs and improved profits (Control Data Corporation, 1985).

Cost-benefit analysis is important justification for training in a profit-based organization. It has the ability to answer primary economic and managerial/organizational questions (Swanson & Geroy, 1984). In many organizations and especially in a manufacturing environment, cost-benefit is really the bottom line.

A forecasting model has a proactive approach in identifying and selecting the most appropriate program to meet a training need. Industry takes this approach when decisions are to be made concerning new product development, purchase of production equipment, expansion or relocation, acquisition of other businesses, and other strategic decision making. An investment of time, money, and resources in a strategic decision involving training should merit the same planning. "Bosses of training participants usually do not have sufficient data on which to make a judgment as to program impact on unit productivity. Consequently, they do not commit to supporting that which can produce significant results for them" (Coffman, 1979). It is for this reason that financial benefit forecasting is potentially the most effective tool for the training profession. It forecasts the results of training in terms that an economic institution can understand.

Training Benefit Forecasting Method

The training cost-benefit literature is dominated by cost analysis information (Head, 1981; Head, 1985; Kearsley, 1982 Spencer, 1984). Little is known about benefit analysis and less about forecasting benefits. The

Training Benefit Forecasting Method (TBFM) (Swanson & Geroy, 1984; Geroy & Swanson, 1984) is similar to general economic forecasting reported in the literature. Within the TBFM, two primary concepts are key. The first, "Performance value, is basically the financial worth of performance units in an enterprise. In its simplest form, benefit forecasting requires that the increases in performance values, minus the training costs, determine the resulting benefits. When the net performance value exceeds the cost, the training yields a benefit. If costs exceed performance value, no benefit results" (Swanson & Geroy, 1984, p. 7). The second important concept is, "In analyzing costs, care must be taken to include all costs attributable to a specific training option. Costs are calculated for staff time, trainee time, consultants, materials, space, etc., needed to complete each step in the training process; needs analysis, work behavior analysis, design of training, implementation, and evaluation" (Swanson & Geroy, 1984, p.8). The organizational environment and performance are different from one company to another. In the validation of the TBFM, the performance value has been productivity based. Also, because the various training options required different amounts of time to reach the performance goal, per day benefits were calculated. The question remains as to the range of the TBFM's versatility.

Summary

Other cost effectiveness studies have found that training does produce benefit and in most cases economic benefit to the organization. None of the studies, other than that of Swanson and Geroy, have considered forecasting training benefits. A forecasting model to determine the economic benefits of training should be able to capture all costs and performance values to accurately determine the benefits.

The forecasting model should be adaptable to a variety of business and industrial environments. The TBFM appears to have many of these attributes, yet has not been validated in a quality-based manufacturing training situation using lower levels of management and training personnel as forecasters.

Chapter 3

Procedures

This Training Benefit Forecasting Model (TBFM) validation study was conducted in the Computer Systems Manufacturing Operations, a Division of Control Data Corporation, Arden Hills, Minnesota.

The specific focus of this study is to answer the following research questions:

1. Does the Training Benefit Forecasting Method reliably predict the financial benefits of quality-based electronic manufacturing training?
2. Does a structured in-house training program have the greatest financial benefit for quality-based electronic manufacturing training?
3. Are managers and trainers who have limited financial accounting duties capable of understanding and predicting the costs and benefits of training using the TBFM?

Within the structure of financial benefit analysis, determining the performance value was the crucial and most difficult task. Performance value is the financial worth of performance units in an enterprise. Financial benefit forecasting requires that the increase in performance value minus the training cost, and the resulting benefits be determined. When the performance value exceeds the cost, the training yields a benefit. If the cost exceeds the net performance value, no benefit results (Swanson & Geroy, 1984).

The study included approximately 75 people involved in the manual production of printed circuit boards in Control Data Corporation. These people are from the same department. The training objective within this area was to assist new and existing employees who are to perform soldering work to achieve an identified level of quality in the shortest time period. In the past, unstructured on-the-job training was conducted. The company decided that this might not be the best method for training employees, and the training department was contacted to identify and select an alternative training method. In a response to this need, five training options were reviewed; a content matrix of these options is found in Appendix A:

Training Situations and Options

Option 1 - No Training

The employee receives no training, but is placed on the job and is expected to perform.

Option 2 - Unstructured

The employee receives an orientation to the organization. They receives no basic soldering training but receives informal, unstructured on-the-job training.

Option 3 - Semi-Structured

The employee receives formal orientation and structured basic soldering skills training and receives informal unstructured, on-the-job, product specific training as in Option 2.

Option 4 - Structured

The employee receives formal orientation and structured basic soldering skills training, and also receives formal structured, on-the-job product specific training.

Option 5 - Commercial

Development and delivery of a training program, which meets quality and task specification of the job, is purchased from an outside vendor.

Data Collection and Appraisal

Data collection using the TBFM had two phases. The first phase was to determine the actual datum -- costs, performance values, and benefits. These data were collected and calculated by the researcher and the training department in cooperation with the manufacturing and the accounting departments. The costs for the commercial training option, provided by an external training consultant, are represented in Appendix B. These data serve as the base against which the forecasters' predictions were compared.

The second phase was the generation of the data by the forecasters. They independently forecasted the costs, performance values, and benefits for each of the five training options. They used identical forms as the researcher and had access to the resources that were available to the organization prior to committing to forecasting. The forecasters were expected, through their use of the TBFM forms, to make calculations and select the training option that predicted the greatest benefit.

The following information represents, in summary, the sequence of events as they took place in the study.

An outline (Appendix C) was produced to serve as a guideline for providing background information regarding the rationale for the study. It aided in providing an explanation of the five training options as presented to the cost-benefit forecasters. The information fell into three categories:

1. Information to be provided up-front.
2. Information provided only upon request.
3. Information that will not be provided under any circumstances.

Six people were recruited to participate as forecasters for the study; two middle managers, two first line managers, and two training people who were actively involved in similar printed circuit board assembly manufacturing training. The forecasters had no knowledge of the actual findings of the study prior to completing their forecasts.

Formal contact with persons selected to be forecasters was made in a meeting. It was at this time, general information regarding the study was provided. A memorandum was sent to all forecasters informing them of a group meeting. Four of the six invited forecasters attended the meeting. It was during this meeting that they were briefed on the study, and provided background information and hard copy material (Appendices D,E,F).

The background data provided is as follows:

1. There is a positive attitude by upper management toward training and a perception that training could increase quality (through reducing defect rates) and productivity.
2. The focus of the forecasting was to be quality --defect reduction-- oriented in regard to the soldering work performed on AUX printed circuit boards.
3. Inline, quality assurance, and test data indicate that assemblers are still making errors or causing defects in workmanship. New assemblers are producing the most defects.
4. The requirement for high quality products at lower costs has forced the organization to pursue alternative methods of training to the one now in place.

5. The desired outcome of the training is the reduction of the number of defects and thereby improving profitability.

6. A copy of an article using the Training Cost-Benefit Forecasting Method was provided (Appendix G).

7. The forecasters were instructed to contact the researcher with questions or concerns at any time.

Along with the above information, they were given time to review the printed forecasting material they had received and ask questions. The forecasters were requested to complete and return to the researcher their predictions within two weeks and with that, the meeting was dismissed.

Chapter 4

Results

Within the procedures of the study, forecasters were to use the TBFM to predict the benefit of five training options and select the option with the most economic benefit. The results were used to answer three research questions:

1. Does the Training Benefit Forecasting Method reliably predict the financial benefits of quality-based electronic training?
2. Does a structured in-house training program have the greatest financial benefit for quality-based electronic manufacturing training?
3. Are managers and trainers capable of understanding and predicting the costs and benefits of training using the TBFM?

The researcher expected that each of the research questions would have "yes" for an answer. This was not the case. The following are the general findings of the study as they relate to the three research questions.

In terms of the first research question, the TBFM has the potential to predict the financial benefits of training based on quality criteria, but not as it exists or with the information provided in this study. The results produced by the forecasters and the researcher were markedly different. The performance value has significant variation among the forecasters, possibly indicating different perceptions of quality as it relates to performance value. The statements presented on the Performance Value Calculation Work Sheet (Appendix D) were not quality oriented, but lent themselves more to productivity, by design. This is evident in points "a,b,c,e,g" on the worksheet.

In response to the second research question, the study did not provide conclusive evidence that a structured in-house training program was of greatest financial benefit. The forecasters' results indicate three of the four projected that in-house training provided the most economic benefit. However the results of the researcher and one other forecaster do not indicate that this is the case. These results do not provide conclusive evidence to affirm this hypotheses.

In response to the third research question, the study demonstrated that first line managers and trainers who have no regular financial accounting responsibility cannot use the TBFM as it exists to predict costs and benefits when the focus of the study is quality oriented. A number of indicators make this apparent. The excessive amount of time needed to complete the projections and the range of performance values and costs indicate the difficulty experienced in using the tool. The verbal feedback indicated a high degree of frustration in trying to adapt the tool to quality as a basis for economic measurement of benefit. One of the primary concerns was accountability of their work as forecasters. It was felt by the forecasters that, in an effort to be as accurate as possible, committing to numbers in the prediction was associated with being accountable for their forecasting results. To the forecasters the exercise was more than testing the model in their environment; it was a test of their perceived ability as a manager or training person that went beyond their own training or job responsibility. It could be for this reason why the amount of time was necessary for the forecasters to complete their work was taken. Also contributing to the amount of time could be the complexity of translating the TBFM to a quality-based application.

On the designated day for completion and submission of the predictions, none of the forecasters had finished the task. None of the four had contacted the researcher for clarification or assistance. During this time the corporation was confronted with personnel cutback issues that caused a high degree of preoccupation with business matters. A follow-up memorandum was sent that evoked inquiries and questions from forecasters. Through conversation and review of written forecast progress, some difficulties became apparent in the attempt of these people to apply the Training Benefit Forecasting Model (TBFM) in a quality --defect reduction-- oriented program. They are summarized as follows:

1. Two forecasters attempted to use the case study (Appendix G) that was provided as a model, as the content for the forecasting model. They were unable to make an application of the TCBM in a quality-based environment without the intervention of the researcher.
2. On the Performance Value Calculation Worksheet, (Appendix D) "a" through "g" were extremely difficult to arrive at when relating the model to defect reduction as opposed to increased production rates. The issues surfaced in the forecasters' inability to think about or process negative numbers. Three of the four forecasters were unable to complete these points. It was only after conversation with the researcher that the forecasters were able to make the calculations and proceed.
3. Two forecasters started to calculate the benefits from a quantitative unit of work perspective, stopped work and contacted the researcher for guidance. They realized that they were being led into a quantitative perspective by the existing TBFM forms.
4. The forecasters expressed frustration with the forms and were inclined to quit the study. The method of measuring quality was expressed in the

organization as defect per board whereas the performance value calculation requires unit of measure over a period of time. This produced conflict within the forecasters.

The TCBM forecasting group was instructed to complete their individual financial benefit projections within fourteen days. The four remaining participants turned in their forecasts from twenty-five to thirty-two days. The performance value forecasts developed by the members are represented on Table 1.

Table 1

Performance Values as Calculated by Forecasters

	TRAINING OPTIONS				
FORECASTERS	Option 1	Option 2	Option 3	Option 4	Option 5
1	$-9,321,000	$-156,000	$-144,000	$ 40,000	$ 40,000
2	$ 1,236,000	$963,000	$654,000	$ 553,500	$553,500
3	$ 170,943	$ 59,734	$ 17,195	$ -	$ -
4	$ -13,000	$ -15,500	$ -22,500	$ -8,500	$ -8,500

The greatest range of performance value among the forecasters within any one option was -$9,321,000 to +$1,236,000. The least was +553,500 to -$6,500.

The performance values, costs and benefits provided by the researcher were approximated by the training department in cooperation with the manufacturing and accounting departments. The performance values established by the researcher are presented on Table 2.

Table 2

Performance Values Calculated by the Researcher

Option 1	Option 2	Option 3	Option 4	Option 5
-$31,113,720	-$20,768,880	-$13,735,708	$293,523	$184,780

The calculations for these performance values are presented in Appendix H. It is important to note that the value of each unit of measure, in this case defects which is a cost, is represented as a negative dollar value.

None of the forecasters subtracted his/her estimated costs from his/her estimated performance value to determine the relative benefits of the training options. They had apparently lost sight of the forecasting purpose to decide on the best training option. The researcher processed the numbers and then asked the forecasters to select the best option. These financial benefit calculations are presented in Appendix I. Also presented in Appendix I are the financial benefit results as calculated by the researcher and the training department.

Upon completion of the forecasting work by the four volunteers, each was interviewed by the researcher. The following is a summary of their reactions to the TBFM as applied to this study:

1. The model as it exists, with the information presented, was very difficult to translate from a unit of work productivity perspective to a defect reduction, quality application. This new

perspective required forecasters to think in negative or "low score" numbers as a way of expressing positive results.

2. The TBFM could be made to be more "cookbook" like in presentation. Choices should be provided to ranges of the data, rather than having persons potentially make absurd estimates at criteria like a unit of measure, performance goal, and value of each unit of measure.
3. On the Performance Value Calculation Worksheet, (Appendix D) the information required for (a) and (b) should be reversed to make an easier and more logical progression through the model.
4. Not one forecaster made the simple benefit calculation (Appendix J) or used this data to make a training option decision (Appendix K). They appeared to have been overwhelmed by the challenge of completing the performance value and cost calculations. Also having calculations for options all contained in one form may have created confusion for the forecasters. A more linear format of information presentation would reduce the information overload.
5. The training bid cost provided by an outside consultant (Appendix B) for the commercial training option was $21,800. Within this amount 256

hours of design and development, at $50 per hour, are considered. The consultant proposed that a 15 day training program would enable the trainees to reach a performance goal of 2 errors per day. This is a design and development to delivery ratio of 2.1 : 1, which is extremely low. A conservative rule-of-thumb is 10 hours of training design and development to 1 hour of delivery. Although the consultant trainer presents a low cost training program and should have been purchased (assuming that the consultant was reputable) it was realistically under-estimated by $50,000. Therefore, it is not an accurate representation of the costs for commercial training. In this study the inaccurate but actual bid cost of $21,800 for the commercial training option is used.

All forecasters felt, upon completion of their work, that structured training (i.e. in-house produced structured training or commercially produced training) would provide a financial benefit to the organization. This was in direct opposition to their forecasted data.

Recalculation of each forecaster's work was made by the researcher to correct for their internal inconsistencies. These calculations involved the reworking of the Performance Value Calculation Worksheet (PVCW) to arrive at a new net performance value gain for each option.

The existing cost totals from the Cost Analysis worksheet were subtracted from the net performance value gain to arrive at a benefit amount for each option (Appendix L). In recalculating the raw data, the researcher conferred with the forecasters to clarify their input data. In doing so, the forecasters gained a better understanding of the forecasting procedure and the researcher better understood the logic and limitations of the TBFM.

In recalculating the data, the resulting benefit amounts indicated that structured training (in-house structured and commercial) provided the greater benefit over unstructured. In four out of five forecasts, including those prepared by the researcher, structured training, in-house or commercial training produced the greatest benefit.

In reconstructing the events of the forecasters, combined with their debriefing, some concerns with the TBFM became evident.

1. Without coaching the forecasters were unable to use the methods as designed, for quality (defect based) calculations. Whereas in other TBFM studies this was not the case.
2. The forecasters, using the Performance Value Calculation Worksheet (PVCW) (Appendix D), were uncertain about determining the units of measure and performance goals in the method. The requirement of the method to determine performance

goal (unit of measure per period of time) was unfamiliar to them, in that it is not used in the routine work environment.

3. In determining the time to reach goal (d) on the PVCW, most forecasters expressed a need for a reference point from which to start.
4. The area which provides the greatest degree of variation was the estimate of the current level of worker performance (e) on the PVCW. The forecasters felt that more clarification was needed to produce an accurate representation for each option.
5. Of all the calculations based on formulas, the estimated performance level during training was not performed correctly by half of the forecasters.
6. The formatting of the worksheet in Appendix D, as presented in this study, appeared to generate confusion due to the excessive number of cells in areas a, b, c, e, h and the lack of space in which to write the forecast data.
7. The number of training options presented in the study are greater than those presented in previous studies possibily causing additional confusion. A separate worksheet for each option should be used (Appendix M). This would require the forecaster to perform calculations for each option before moving on to the next option.

Chapter 5

Summary and Discussion

The intention of this study was to test the adaptability of the the Training Benefit Forecasting Method (TBFM) to a training situation in a quality-based electronic manufacturing environment. The goal of the training was to reduce the number of defects produced during the manufacture of a specified printed circuit board and therefore reducing production costs. This is in direct contrast to the previous TBFM validation studies where the training goal was to increase the level of production (Swanson & Geroy, 1984; Geroy & Swanson, 1985).

Within the procedures of the study, forecasters were to use the TBFM to predict the benefit of five training options and select the option with the most monetary benefit. In doing so they were to answer three research questions:

1. Does the Training Benefit Forecasting Method reliably predict the financial benefits of quality-based electronic training?
2. Does a structured in-house training program have the greatest financial benefit for quality-based electronic manufacturing training?
3. Are managers and trainers capable of understanding and predicting the costs and benefits of training using the TBFM?

The researcher found, along with the forecasters, that the TBFM is adaptable to a quality orientation but not without some form of assistance. The assistance could be in the form of a consultant or written matter in the form of a users' guide. It is recommended that a guide be produced and provided to users of the model to enhance the use and accuracy of the tool. Within the guide would be options and examples of applications of the forecasting method in a quality environment (Appendix N).

Factors which would enhance the performance value calculation worksheet would be to:

1. Reverse the data required for (Appendix D) "a" and "b" to enhance the logical progression of concept development.
2. Revise the formula for calculating (l) (Appendix D) The formula for net performance value gain should read: [k - (c x d x e x f)]

This change in the formula was discovered by one of the forecasters as he was making his calculations. The rationale was that in the calculation of (k) which was derived through [c x j x f] "f", the number of trainees, is a factor. The original formula for (l) which reads [k - (e x c x d)] does not consider "f" as a factor. What this does is deflate the net performance value by not considering the performance value generated by all the workers participating in the training, as does the formulation for "k". Results and comparisons for the two different formulas are represented in Appendix O. The differences in results are significant. In the case where reduction of defects or errors is the training goal, the closer the resulting value is to zero, the more desirable the training option for this worksheet.

The Training Benefit Forecasting Method is an important tool helping decision makers to determine the benefits of structured training and in taking a systematic proactive approach to valuing and selecting training options. The Training Benefit Forecasting Method which should be relatively simple to use, is not easily understood by nonfinancial personnel in training and first line management as applied in a quality-based defect oriented manufacturing environment.

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Appendix A

Content Matrix of Training Options

		Training Content			
		Orientation	Basic Soldering	Unstructured OJT	Structured Product Specific
Training Options	1 No Training				
	2 Unstructured	X		X	
	3 Semi-structured	X	X	X	
	4 Structured	X	X		X
	5 Commercial	X	X		X

Appendix B

Commercial Cost Estimate for Training

COST ESTIMATE FOR TRAINING PROGRAM :
SOLDERING TECHNIQUES FOR PC BOARDS WITH MOUNTED COMPONENTS

Analysis	Design	Development	Field Test	Delivery
Evaluation of present training & training needs assessment 10 hrs	Identification of non-training problems affecting training 6 hrs	Consultations with CDC experts & decision on the FORMAT of curriculum 10 hrs	Preparation of a plan & monitoring instruments 8 hrs	40 trainees/year : 8.50/hr(25 overhead) 40 hrs training: 13,600(overhead not included)
Task analysis 24 hrs	Objectives & outline development 24 hrs	Writing learning materials 110 hrs (about 80-100ps, incl. Evaluation instruments: cogn.,psychom., affective)	2 observation visits by developer 8 hrs	1 instructor: 10,00/hr(30 overh.) 20,800/year
Review by CDC expert & revisions 6 hrs	Review by CDC & revisions 10 hrs	Review & revisions 10 hrs	Revisions 10 hrs	Copies of learning package: (written & AV) 5.00 & 30.00, needed: 15 written: 75.00 2 AV : 60.00 = 135.00
		Delivery prep.: Plan & instructor's training 20 hrs		
Subtotal: 40 hrs	Subtotal:40 hrs	Subt.: 150 hrs	Subtotal: 26 hrs	

One 10 min. video tape done outside

Script & story board:	1,000.00
Shooting,narrator, editing:	8,000.00
Total about :	9,000.00

TOTAL for: Analysis, Design, Development, Field Test prep.& revisions & consult.: 256hrs,50/hr,	12,800.00
TOTAL for one minute video tape:	9,000.00
FOR FURTHER EXPLANATION see the notes attached.	21,800.00

Appendix C

Outline For Presenting Forecaster Information

Information Provided

- rationalization for investigation of alternative training options.
- overview of the study
    * forecast the cost-benefit for AUX board training
    * determine the utility of the Training Benefit Forecasting Method
- identification and definition of the 5 training options
- 40 workers are to be considered in each situation

Provided Only Upon Request

- units of measure
- definition and clarification of worksheet points
- the performance goal of training (2 errors/day)
- the evaluation period length (90 days)

Would Not Be Provided

- value of the units of measure
- time to reach goal performance by option
- all other information not covered above

Appendix D

Performance Value Calculation Worksheet

FORECASTER____________________

DATE____________________

S1 AUX BOARD SOLDERING
PERFORMANCE VALUE CALCULATION WORKSHEET

	NO TRAINING	UNSTRUCTURED	SEMI-STRUCTURED	STRUCTURED	COMMERCIAL
(a) What is the performance goal of the training?					
(b) What units of measure will be used to describe performance?					
(c) What is the value of each unit of measure?					
(d) What is the estimated training time to reach the goal?					
(e) What is the current level of worker performance?					
(f) How many workers will participate in the training?	40	40	40	40	40
(g) What is the estimated performance level during training?					
Will trainee produce during training? ____ NO = 0 ____ YES = $\frac{a + e}{2}$					
(h) What is the length of the period being evaluated (the longest "d" of all options under consideration)?					
(i) What is the estimate of the total # of units (b) that will be achieved during training? (d x g)					
(j) What is the estimate of the total performance for the evaluation period? [(h-d) x a] + i					
(k) What is the value for the total performance for the evaluation period? [c x j x f)					
(l) What is the net performance value gain? [k - (e x c x d)]					

NOTE: IN THE CASE OF THIS STUDY, THE VALUE OF THE DOLLAR WILL REMAIN CONSTANT.

Appendix E

Cost Analysis Worksheet

FORECASTER ____________________

DATE ____________________

COST ANALYSIS

	OPTION:	NO TRAINING	UNSTRUCTURED	SEMI-STRUCTURED	STRUCTURED	COMMERCIAL
1. Needs analysis/planning						
Staff		$ ______	______	______	______	______
External consultant costs		______	______	______	______	______
Materials		______	______	______	______	______
______		______	______	______	______	______
______		______	______	______	______	______
	Subtotal	$ ______	______	______	______	______
2. Work behavior analysis						
Staff		______	______	______	______	______
External consultant costs		______	______	______	______	______
Materials		______	______	______	______	______
	Subtotal	$ ______	______	______	______	______
3. Design						
Staff		______	______	______	______	______
External consultant costs		______	______	______	______	______
Materials		______	______	______	______	______
External support costs		______	______	______	______	______
	Subtotal	$ ______	______	______	______	______

(Table continues)

FORECASTER ______________

DATE ______________

COST ANALYSIS

	OPTION:	NO TRAINING	UNSTRUCTURED	SEMI-STRUCTURED	STRUCTURED	COMMERCIAL
4. Development						
Staff	$	______	______	______	______	______
Materials		______	______	______	______	______
External support costs		______	______	______	______	______
______________		______	______	______	______	______
	Subtotal $	______	______	______	______	______
5. Implementation						
Trainee'(#10)		______	______	______	______	______
Facilities		______	______	______	______	______
Tuition/fees		______	______	______	______	______
Staff		______	______	______	______	______
Materials		______	______	______	______	______
	Subtotal $	______	______	______	______	______
6. Evaluation						
Staff		______	______	______	______	______
External consultant costs		______	______	______	______	______
______________		______	______	______	______	______
______________		______	______	______	______	______
______________		______	______	______	______	______
	Subtotal $	______	______	______	______	______
	Total costs $	______	______	______	______	______
	Cost per trainee $	______	______	______	______	______

Appendix F

Training Option Information Sheet

TRAINING OPTIONS

No Training -The employee is placed in the job, provided with process, parts,and tools with instructions to start work and build the board (consider this as a hypothetical situation).

Unstructured Training - The employee is placed in the job and provided with on-the-job unstructured training.

Semi-structured Training - The employee is provided with structured orientation and basic solder training and then provided with unstructured on-the-job training.

Structured Training - The employee is provided with structured orientation, basic soldering skills training, and structured job specific training.

Commercial - The employee is trained to specifications through a training program provided through a consulting/training organization outside of the corporation.

Appendix G

Journal Article Illustrating TCBM Use

Forecasting Training Costs and Benefits In Industry

Increasingly, industry and indeed nearly every organization faces the realization that training employees—the human resource— is a critical component of success. Since employee training is a major investment, a concern for evaluating training programs in terms of economic efficiency exists.

Economically driven organizations will choose programs which have the greatest benefit return on the costs. For human capital investments, this requires accurate cost-benefit evaluation of training which includes all the available training options.

A simple but powerful tool is needed by decision makers. The tool needs to be easy to use and not require the user to have an economics background in order to produce useful data. The most often used cost-benefit analysis tools are designed to address capital investments and do not lend themselves to human capital.

Recently a cost-benefit model was developed at the University of Minnesota Training and Development Research Center. This model was presented by Richard A. Swanson and Gary D. Geroy in a paper entitled "Forecasting the Economics of Training" (1983).

The purpose of this study was to further validate the cost-benefit forecasting model. Additionally, the validation focused on the knowledge-based technical expertise in an actual manufacturing enterprise.

Background Discussion

Employee training takes place in two general ways, formal or informal. Many workers increase their productivity by learning new skills and perfecting old ones while on the job through informal means. This on-the-job training called unstructured training (Cullen, Sawzin, Sisson, & Swanson, 1976), takes place without benefit of a specific program and often takes place alongside an experienced worker who simultaneously continues to perform his or her regular duties. In their article, "Training, What's It Worth," these same authors define formal training as "structured training" in which training of a new worker takes place through a systematically developed educational program. They further submit that "Whether or not structured training is a frill or a needed production tool can only be assessed if its relative cost effectiveness is known" (p. 12).

Support of training comes about from training's ability to contribute to organizational objectives, not because training is inherently good or will satisfy employees. Cost-benefit analysis compares the cost of developing training programs to the economic benefit or gains from conducting training. It is important that "justification of training should be in organizational terms" (Monat, 1981, p. 47). Thus, cost-benefit analysis "is particularly useful in answering managerial/organizational questions" (p. 48).

In this analysis, the focus is to treat the benefits as the change in results from training and the cost as the change in economic sacrifice.

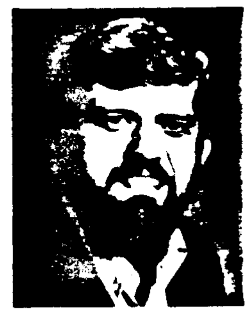
Cost-Benefit Modeling

Little has been done to address the need for formalized, proven models to aid management in showing a return of training programs. Those investment return models which have been suggested are the same as those used to address capital improvement investments. However, unlike capital improvement investments, investments in people do not readily adapt to depreciation scheduling.

A model for forecasting the economic benefits of training needs to include facility to identify and summarize the costs associated with the training as well as provide assessment of the value of the resulting performance for a specified time period. To this end, the Training Benefit Forecasting Method (TBFM) provides for valuing of performance as a key element leading to a benefit determination. Benefits are viewed as the performance value resulting from training minus the costs incurred to achieve the performance change.

> Performance value is basically the financial worth of performance units in an enterprise. In its simplest form, cost-benefit forecasting requires that the increases in performance values, minus the training cost, and the resulting benefits be determined. When the net performance value exceeds the cost, the training yields a benefit. If the costs

Gary D. Geroy



Richard A. Swanson

The authors wish to acknowledge the Onan Corporation of Minneapolis, Minnesota for their support of this research effort.

Mr. Geroy, Research Assistant, and Dr. Swanson, Professor, are in Training and Development Research Center in the Department of Vocational and Technical Education at the University of Minnesota, St. Paul, Minnesota. Dr. Swanson is a member-at-large of Epsilon Pi Tau.

exceed the net performance value, no benefit results. (Swanson & Geroy, 1984, p.7)

Economic Foundations of the Model

Basic to the Training Benefit Forecasting Method is the acceptance that benefits accrue from human capital. It is precisely this basic acceptance and desire to maximize the firm's investment, capital and human, with which contemporary industry is grappling. Most firms are looking to the human capital side of their enterprise for significant gains, and training is a partial key in unlocking the benefits.

Structured (formal) and unstructured (on-the-job, trial and error) training have costs. Because an industry does not support a structured training program does not mean that they have escaped training costs. They may escape structured training development and delivery costs, but the costs of unstructured training generally involve a number of inefficiencies such as extended time to become competent, low production, and waste.

Training costs appear when any of the following situations exist:

1. A new employee arrives on the job performance site.
2. An experienced employee is transferred or promoted to a different job, which requires the acquisition of additional skills or knowledge or a change in attitude.
3. An experienced employee's job is modified and performance of the job required transfer of skills, knowledge, and perhaps different applications of subject-matter expertise.
4. An experienced employee has a loss in knowledge and/or skill.

Within the TBFM, performance value is defined as the "financial worth of performance units in an enterprise." The TBFM stresses that this is not always as obvious as one might first think, but remains the critical task in each analysis effort.

Cost-Benefit Forecasting

In its simplest form, cost-benefit forecasting requires that increases in performance values, minus the training costs, and the resulting benefits be determined. When the net performance value exceeds the cost, the training yields a benefit. If the costs exceed the net performance value, no benefit results. The central core of the model is two critical analyses. — the analysis of costs and the analysis of performance value.

> In analyzing costs, care must be taken to include all the costs attributable to a specific training option. Costs are calculated for staff time, trainee time, consultants, materials, space, etc., needed to complete each step in the training process; needs analysis, work behavior analysis, design of training, implementation, and evaluation. (Swanson & Geroy, 1984, p. 8)

The parameter of the TBFM is defined by the period of time that the analysis will address. Making valid comparisons of alternative training options requires the analyst to set a base time period to be used in calculating performance values for each training option. This time period is set at the *longest* period of time required by any of the training options under consideration to bring trainee performance up to the performance goal level.

Validation Study Setting

The validation study of the TBFM was done in a manufacturing organization. The Onan Corporation, located in Minneapolis, Minnesota, is a supplier of diesel and gasoline engines to industrial equipment manufacturers, a major supplier in the electric generator set market, and a participant in the growing market for electronic power conditioning equipment and uninterruptable power supplies for use primarily in the computer industry.

Target Training Program

The specific program addressed in the study was the Geometric Dimension and Tolerance training program conducted at Onan in 1983. A total of 136 employees participated in the program. The program was delivered on-site at Onan by a local vocational and technical school and participants attended sessions which were scheduled before and after normal work hours. The actual costs of this training program are summarized in Table 1.

Table 1

Cost Analysis

	Actual Costs
Total Cost of Training	$10,959.00
Total Number of Participants	136
Cost Per Participant	$80.50

Target Population and Training Problem

The 136 participant population was made up from members of several different departments with diverse responsibilities within Onan. The focus of this study was the population of participants from the Experimental Machining Department.

Prior to submitting a request for training assistance from the training department, the manager and work group identified two problems. Generally, they had difficulty reading and interpreting blueprints as they were received from the engineer group.

Additionally, they felt that they lacked credibility with the engineering group. The machinists suggested that they lacked the theoretical background and formal methodology training to calculate changes in dimensioning to engineer-prepared designs. They also admitted that their "gut feelings" about whether or not a required operation would work or not, were ignored by the engineer group until a unit was completed and proven unsatisfactory or procedures which were called for in the design could not be carried out on existing equipment.

The manager and workers in the Experimental Machining Department suggested to the training department that a training program in geometric tolerance techniques would enable them to understand the engineer-prepared work drawings. This would result in less time in clarification as well as reduce scrap and labor due to misinterpretation. Additionally, they submitted that they would be able to calculate engineering-acceptable work drawing changes that would reflect procedural or layout modifications required to insure production feasibility.

The objective of the group was to significantly reduce the amount of shop time spent on wasted prototype production involving projects with problems and to identify those prototype projects with potential machining problems *before* set-up, jig making, and machining. This would be achieved by application of geometric and tolerance skills in pre-production review of drawings, for feasibility and by post "first-piece" production application of these skills in developing procedures and layout modifications to address problems identified during first prototype effort.

The group anticipated that 90% of the potential problems could be identified and resolved in the pre-production review and that the prototype machinists would be able to resolve those problems that were revealed during the first machining effort.

Study Procedures and Data

The early activities associated with the study took two routes: (a) the industrial work group receiving the training, and (b) the individuals selected to initiate and apply the TBFM.

Discussion with the industrial work group centered on the identification of specific data that represented both prior and current work activities associated with prototype machining. The group identified two specific projects whose problem resolution procedures were directly influenced by the training the involved machinists received.

The other focus was to select individuals who would initiate and apply the TBFM. Four individuals were identified and agreed to participate in this study. They represented management, training, and manufacturing engineering backgrounds. None had been exposed to either the TBFM or the Geometric Dimension and Tolerance training program.

As a group they were presented with the model during a briefing of the study. Additionally, they were provided with the prior training background information summarized in the preceding section and the summary of data from the experimental machining group. At no time were they informed of any of the outcomes of the training that had been identified and discussed by the experimental machining group.

After reviewing the problem and training options available, the four forecasters applied the TBFM and made predictions regarding the training cost, net performance value, and resulting benefits. All forecasters predicted in this situation that there would be a benefit from investing in training. The ratio of benefit to cost prediction ranged from 7:1 to 22:1 with two forecasts agreeing on 11:1 (Table 2).

The analysis of the actual performance value of the training outcome focused on two workers from the target group whose job performance was directly related to course content knowledge and skills acquisition. The result was the identification of two specific projects which had problems in layout and procedures that were treated with the newly acquired skills. The performance

Table 2

Per Worker Benefit Forecasts

	Forecasters 1	2	3	4
Performance Value	$ 1,458	$ 1,008	$ 700	$ 1,232
Costs	66	81	81	95
Benefit	$ 1,392	$ 927	$ 619	$ 1,137
Ratio	(22:1)	(11:1)	(7:1)	(11:1)

value focused on the value of the acceptable units produced in the saved time which was in keeping with the goal of the training.

The analysis of the actual cost-benefit is shown in Table 3. The data validate the

Table 3

Performance, Cost, and Benefit Analysis

	Net Performance Value	Training Cost	Benefit
Drive Disks	$ 2,476.80	$ 80.50	$ 2,396.30
Transmission Adaptor	$ 12,820.80	$ 80.50	$ 12,740.30
Total	$ 15,297.60	$ 161.00	$ 15,136.60

predictions made by the forecast group would be that a benefit derived from the training investment. Although there are differences between the values of the predictions and the actual performance, all predictions were consistent regarding whether there would be a benefit to the training investment and as to the decision to implement the training.

Figure 1

Net Performance Value Calculation Worksheet

(a) What is the performance goal of the training? ________

(b) What units of measure will be used to describe performance? ________

(c) What is the value of each unit of measure? ________

(d) What is the estimated training time to reach the goal? ________

(e) What is the current level of worker performance? ________

(f) How many workers will participate in the training? ________

(g) What is the estimated performance level during training?
Will trainee produce during training?
____ No = 0
____ Yes = $\frac{a + e}{2}$

(h) What is the length of the period being evaluated (the longest "d" of all options under consideration)? ________

(i) What is the estimate of the total number of units (b) that will be achieved during training? (d x g) ________

(j) What is the estimate of the total performance for the evaluation period?[h - d x a] + i ________

(k) What is the value for the total performance for the evaluation period? (c x j x f) $ ________

(l) What is the net perfor ance value gain? [k - (e x c x d)] ________

Verbal feedback from participants in the forecasting group indicated some difficulty with the part of the model that dealt with the calculation of performance values and the determination of what, if any, net change occurred as a result of the training. However, all participants felt the model was usable and useful. The response to the difficulty encountered was to develop a performance value calculation worksheet (Figure 1).

Conclusions

The validity of the Training Benefit Forecasting Method was supported by this study. Independent forecasters were able to accurately predict that there were short-term financial benefits for Onan Corporation to invest in the Geometric Dimension and Tolerance Training Program using the TBFM. These forecasts, when compared to the independent audit of actual costs and benefits proved to range from being on-target to conservative estimates.

Some difficulties in using the model did occur and resulted in a revised calculation worksheet for the forecaster.

References

Cullen, J.G., Sawzin, S.A., Sisson, G.R., & Swanson, R.A. (1976). Training, what's it worth? *Training and Development Journal, 30* (1), 12-20.

Monat, J.S. (1981). A perspective on the evaluation of training and development program. *Personnel Administrator,* 26 (7), 47-52.

Swanson, R.A. & Geroy, G.D. (1983, August). *Economics of training.* Paper presented at the 12th International Conference of the International Federation of Training and Development Officers, Amsterdam, Netherlands.

A Cost-Benefit Forecasting Case Study

In this real-life case study employees of a manufacturer of specialized circuit boards for electronic equipment have been trained by an unstructured on-the-job method. The firm's circuit board assembly workers read at an average level of seventh grade, and they all experience difficulty in understanding the English language. Approximately forty (40) working days are required for a new assembly worker to reach the acceptable performance level of three good circuit boards every two days. Each circuit board is valued at $600. Assembly workers are paid $9 per hour. Once workers reach the performance goal level, they generally experience a rework rate of one (1) circuit board out of eighteen (18) because of poor soldering or incorrect positioning of one or two installed parts. Management is considering designing or contracting for a training program to decrease the time required for new assembly workers to achieve the current acceptable level of performance. They are considering the use of a commercially available ten-day training course at a cost of $1500 per trainee. This course provides training in basic soldering technique, component identification, blueprint reading, instrument calibration, basic circuitry design, theory and practice, and systems diagnostics.

Additionally, management hired a training consultant to do a training needs assessment and propose content for an in-house training course as a possible alternative to meet the manufacturing skill needs of the company. The consultant submitted a report and a bill for $2,200. The consultant recommended that in order to meet the manufacturing skills needs of the company, the training should cover basic soldering techniques, identification of components for the circuit board, and electronic circuitry blueprint reading. He further recommended that the workers be provided with job aids to help them in identifying correct components and proper installation. The consultant recommended that the job aids should be 8" x 10" color photos of correctly built circuit boards. He felt this would facilitate workers' continued learning of the proper identification and placement of components. The consultant also recommended that the total training time would need to be eight working days at the conclusion of which the new assemblers should be able to produce at the rate of three boards every two days at the current quality level. Management believes that development and delivery of the in-house training course could be handled by the in-house training staff and the chief electronic engineer. Temporary clerical support will be hired to assist during the analysis, design, and development steps.

Management must decide whether ten new employees will receive the in-house training, whether they will attend the commercially available training course, or whether they will be trained on the job as in the past.

Table 1

Cost Analysis Categories

Cost analysis categories	Guidelines/Examples
Staff	Wages of clerical/secretarial, hourly or salaried subject matter experts, trainers or other employees involved in the training effort.
External Consultants	Fees and associated expenditures for externally hired subject matter and training design experts involved in the specific training effort.
Materials	Items which will either become a permanent part of the specific training effort or which will be consumed in the training related effort.
External Support Costs	Professional, skilled, or semi-skilled labor or services required to support any or all aspects of the training effort.
Trainee	Wages, mileage, lodging, and meal expenses associated with trainee

(table continues)

Cost analysis categories	Guidelines/examples
	attendance of training effort.
Facilities	Expenses associated with room or equipment rental, utilities, or facility modification directly related to the specific training effort.
Tuition/fees	Expenses directly related to school tuition, fees, books and materials, and lab costs associated with a given training effort.

Appendix H

Calculations of Performance Value Provided by Researcher

Response to Produce Data (see Appendix A for detailed information) — Results by Option

	Option 1	Option 2	Option 3	Option 4	Option 5
(a)	2 Errors per day for all options...				
(b)	Errors (E) or defects for all options...				
(c)	$-11 for all options...				
(d)	90 days	60 days	40 days	25 days	15 days
(e)	1652 Errors per day (EPD) for all options...				
(f)	40 Workers for all options...				
(g)	827 EPD	827 EPD	827 EPD	0 EPD	0 EPD
(h)	90 days for all options...				
(i)	74430 E	49620 E	33080 E	0 E	0 E
(j)	74430 E	49620 E	33180 E	130 E	150 E
(k)	-$32,749,200	-$21,859,200	-$14,599,200	-$57,200	-$66,000
(l)	-$31,113,720	-$20,768,880	-$13,872,320	$397,100	$206,580

Training Options

1. No Training
2. Unstructured
3. Semi-structured
4. Structured
5. Commercial

Appendix I

Cost-benefit Analysis Results

TRAINING OPTIONS

FORECASTERS	Option 1	Option 2	Option 3	Option 4	Option 5
1	$-9,321,000	$-156,000	$-144,000	$ 40,000	$ 40,000
	$- 7,300	$- 6,245	$- 2,717	$- 1,339	$- 21,800
	$-9,319,300	$-162,245	$-146,717	$ 38,661	$ 18,200
2	$ 1,236,000	$963,000	$654,000	$553,500	$553,500
	$- 448,400	$-160,664	$-124,554	$-162,858	$-21,800
	$ 787,600	$ 802,336	$ 529,446	$ 390,642	$531,700
3	$ 170,943	$ 59,734	$ 17,195	$ -	$ -
	$- 34,631	$- 23,548	$-17,546	$- 15,906	$-21,800
	$ 136,321	$ 36,186	$- 351	$ -	$ -
4	$ -13,000	$ -15,500	$ -22,500	$ -8,500	$ -8,500
	$- 18,580	$-12,760	$-16,720	$-17,874	$-21,800
	$ -31,580	$ -28,260	$-39,220	$ -26,374	$-30,300

Benefit calculated by researcher

-$31,113,720	-20,768,880	-13,872,320	379,100	206,580
- 0	- 0	- 136,612	-103,577	-21,800
-$31,113,720	-20,768,880	-14,008,932	293,523	184,780

Appendix J

Training Cost-Benefit Model

Performance Value

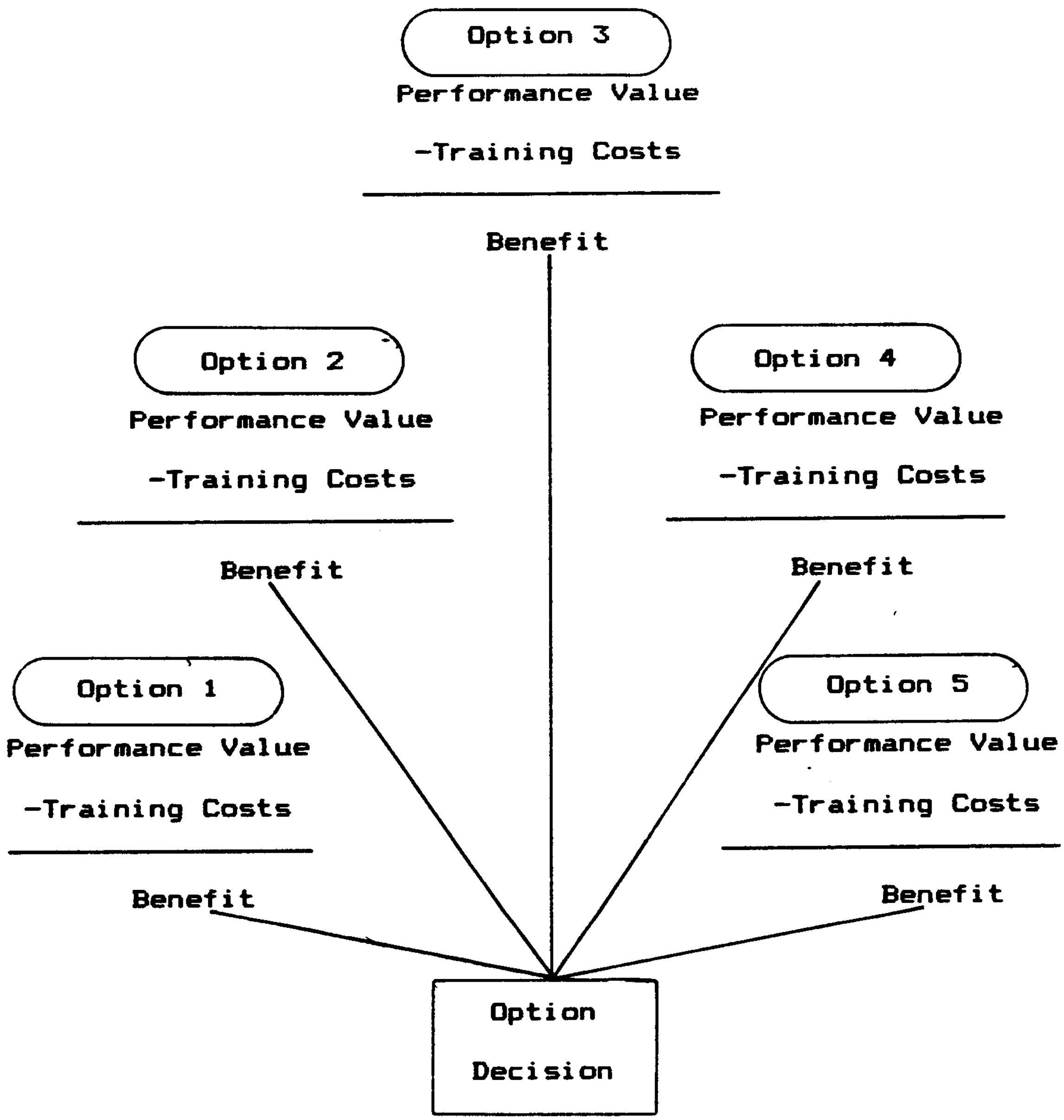
\- Training Costs

Benefit

Appendix K

Cost-Benefit Forecasting Model (TCBM)

Option Decision Method



Appendix L

Recalculation of Cost Benefit Analysis Results

Formula: Net Performance Value Gain
- Training Cost

Training Benefits

Training Options

FORECASTERS	1	2	3	4	5
#1	-$1,831,760	- 296,640	- 34,560	-6,080	-6,080
	- 0	- 0	- 27,169	-13,390	-21,800
	-$1,831,760	- 296,640	- 67,729	-19,470	-27,880
#2	-$1,236,000	-963,000	-654,000	- 67,500	-67,500
	- 0	- 0	-124,554	-162,858	-21,800
	$ -1,236,000	-963,000	-769,544	-230,358	-89,300
#3	$ -27,884	-18,221	-13,922	- 549	- 549
	- 0	- 0	-17,546	-15,906	-21,800
	$ -27,890	-18,225	-31,468	-16,455	-22,349
#4	$ -25,025	-20,600	-18,750	-8,900	- 8,900
	- 0	- 0	- 4,720	-7,200	-21,800
	$ -25,025	-20,600	-23,470	-16,100	-30,700

Benefits calculated by researcher

$-31,113,720	-20,768,880	-13,872,320	397,100	206,580
- 0	- 0	- 136,612	-103,577	-21,800
$-31,113,720	-20,768,880	-14,008,932	293,523	184,780

Appendix M

TRAINING BENEFIT FORECASTING METHOD

CALCULATION PACKAGE

FORECASTER________________________________ DATE_____________

TRAINING OPTION____

PERFORMANCE VALUE CALCULATION WORKSHEET

Forecaster ______________________ Date ____________

Training Option ______________________________________

(a) What units of measure will be used to describe performance? ____________

(b) What is the performance goal of the training? ____________

(c) What is the value of each unit of measure? ____________

(d) What is the estimated training time to reach the performance goal? ____________

(e) What is the current level of worker performance? ____________

(f) How many workers will participate in the training? ____________

(g) What is the estimated performance level or how much of any measurable units will the trainee produce during the training? ____________

No = 0

Yes = $\frac{b+e}{2}$

(h) What is the length of the period being evaluated (the longest "d" of all options under consideration)? ____________

(i) What is the estimate of the total # of units (a) that will be produced during training? (d x g) ____________

(j) What is the estimate of the total peformance for the evaluation period? [(h - d) x b] + i ____________

(k) What is the value for the total performance for the evaluation period? [c x f x j] ____________

(l) What is the gross performance value gain? [k - (c x d x e x f)] ____________

TRAINING COST ANALYSIS WORKSHEET

Forecaster ______________________________ Date ____________

Training Option ____

1. Needs analysis/planning
   - Staff ____________
   - External consultant costs ____________
   - Materials ____________
   - ____________ ____________
   - ____________ ____________

   Subtotal $____________

2. Work behavior analysis
   - Staff ____________
   - External consultant costs ____________
   - Materials ____________

   Subtotal $____________

3. Design
   - Staff ____________
   - External consultant costs ____________
   - Materials ____________
   - External support costs ____________

   Subtotal $____________

4. Development
   - Staff ____________
   - External consultant costs ____________
   - Materials ____________
   - ____________ ____________

   Subtotal $____________

5. Implementation
   - Trainee ____________
   - Facilities ____________
   - Tuition/fees ____________
   - Staff ____________
   - Materials ____________
   - ____________ ____________

   Subtotal $____________

(worksheet continues)

6. Evaluation
   Staff ______________________
   External consultant costs ______________________
   ______________________ ______________________
   ______________________ ______________________
   ______________________ ______________________

Subtotal $______________________

7. Total costs Total $______________________
   (sum of all subtotals)

Appendix N

A Users' Guide to the Training Benefit Forecasting Method

I. Introduction
   A. Method background
   B. Various applications
   C. Capabilities of the method

II. Definition of Method terms

III. Using the Performance Value Calculation Worksheet
   A. Purpose of the worksheet
   B. What do each of the points require for data and how to calculate
      1. Quantitative applications
      2. Qualitative applications
   C. Examples of applications and calculations
      1. Quantitative
      2. Qualitative
   D. Interputation of the results

IV. Using the Training Cost Analysis Worksheet (TCAW)
   A. Purpose of the worksheet
   B. What do each of the points require for data and how to calculate them.
   C. Example of application and calculations
   D. Resource guide for information
   E. Interpretation of the results

V. Using the Training Benefit Worksheet (TBW)
   A. Purpose of the worksheet
   B. What do each of the points require for data and how to calculate them.
   C. Examples of applications and calculations
   D. Interpretation of the results
      1. Quantitative application
      2. Qualitative application

VI. Resources

Appendix O

Net Performance Gain (NPG) by Formula, Based Researcher's Calculations

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Origional formulation for (1) [k -(e x c x d)]

	Option 1	Option 2	Option 3	Option 4	Option 5
NPG	-$31,113,720	-20,768,880	-14,008,932	397,100	206,580

Formula for (1) with recommended change:

[k -(c x d x e x f)]

	Option 1	Option 2	Option 3	Option 4
NPG	$-32,670,000	-21,753,600	-14,476,000	-18,114,800
cost	- 0	- 0	- 136,012	- 103,577
	-32.670,000	-21,753,000	-14,612,612	-18,248,377

	Option 5
NPG	$-10,837,200
cost	- 21,800
	-10,858,200

In applying this formula to a quality oriented application, the closer the benefit value is to zero the more desirable the training option.