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## COST-TIME PROFILING AS A TOOL IN VALUE ENGINEERING

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### ABSTRACT

Fooks [2] introduces Cost-Time profiling as a procedure that ‘diagrams the accumulation of cash during each unit of time (days, weeks, months ) across the entire business cycle – from negotiating an order and entering it, to pre-manufacturing design and information gathering processes through manufacturing, to shipment and receivables. The cycle ends with the collection of payment.’ This paper aims to study the applicability of this tool to the larger value engineering process. Further, it is to be determined exactly which steps of the job plan can be aided by the use of this tool and how it compares with traditional tools.

### KEYWORDS

Cost-Time profiling; function; job plan

### 1. INTRODUCTION

The roots of Cost-Time Profiling lie in the late Westinghouse Electric Corporation. This process was developed as a means for accurately monitoring time-based inventory. Investment managers have often looked at investment as a static entity. However, when investment is viewed in this manner, it becomes very difficult to manage. A Cost-Time-Profile (CTP) provides a means for understanding the dynamics of investment. The foundation of Cost-Time profiling rests on the idea that any business activity can be viewed as an accumulation of cost over time. Figure 1 shows a typical CTP.

In a factory setting, the vertical line refers to material expense. However, in an office setting, it includes supplies, outside services and information. The assumption for the example presented is that the material cost is incurred instantaneously and is done at the start of the activity. Hence, all the material required for an activity must be ready at the start of the process and can be then released in a Just-In-Time (JIT) manner.

A horizontal line indicates waiting. The assumption here is that no cost is incurred while the item is waiting. The reason for this is because a CTP focuses only on direct costs. Thus, even though an item may be incurring indirect cost while waiting, it is not represented on the graph. However, it indicates the seriousness of waiting. Waiting increases the time that it takes

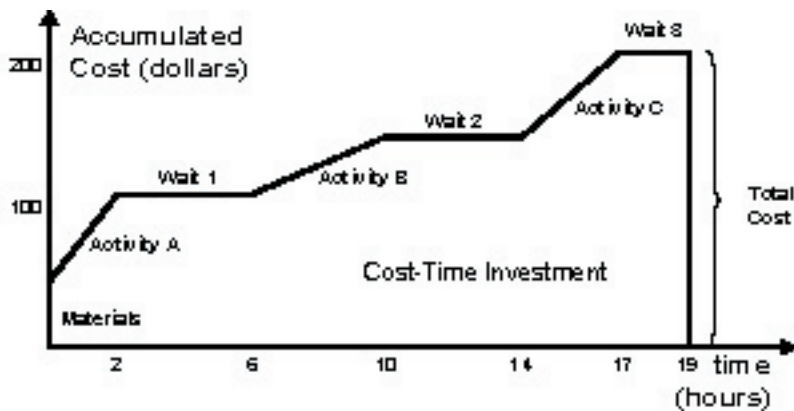


Figure 1. Typical Cost-Time Profile [2]

to recover the investment as it increases the time that it takes to get the product to the market. The diagonal lines indicate work done. It represents the dollars per hour of cost added over time. The steepness of the diagonal lines depends on hourly wages. The area under the graph indicates the level of inventory in the system. This includes raw material inventory, in-process inventory as well as finished goods inventory.

As indicated in the CTP, the total cost is simply the sum of the direct costs and can be visualized as the highest point on the graph. However, this total cost doesn't reflect the effect of time on the investment. The Cost-Time-Investment (CTI) is the area under the graph. It consists of cost and time dimensions. Its cost value can be obtained by multiplying it by the appropriate interest rate, for example, the Internal Rate of Return (IRR).

The Direct Cost is obtained as follows:

$$\text{Direct Cost} = \text{Total Cost} + (\text{Cost-Time Investment} * \text{Cost-of-Money-Rate})$$

A CTP can be built in two ways, namely a macro CTP and a micro CTP. Fooks [2] says, "The primary purpose of a macro CTP is to better understand the operations of a business, in order to select the most effective areas for improvement. Macro profiles are most useful in diagnosing where to go to work for maximum leverage and return." He proposes that a micro CTP be used when a certain opportunity for improvement is to be addressed. He says, "The purpose of detailed cost time profiling is to identify critical areas for study, to expose and understand improvement opportunities, to generate ideas to address those opportunities, and to develop projects and implementation plans to meet improvement goals."

## 2. BUILDING A COST-TIME PROFILE

Before a CTP can be built, certain information needs to be collected. Information regarding every activity in the process is to be collected. An estimation of all direct and indirect costs is required. Further, the start and end times for all activities are to be known. Presented below are the steps taken to create a macro and micro CTP.

## **2.1 MACRO COST-TIME PROFILE**

Constructing a macro CTP is a four step activity as follows:

- Obtain business data
- Develop a flow model for the business
- Build a CTP
- Validate the data

Data is obtained from sources such as the income statement and the balance sheet. In most cases, teams will only require gross inventory figures for work in process, raw material, shipping stock and receivables.

A flow model for the business shows how information, material and work flow in the operating unit from first concept of the product to when it collects receivables. Ordinarily, it would consist of R&D, business sourcing, pre-manufacturing, manufacturing and collection of receivables.

A common approach to constructing a macro CTP is to first construct profiles for the factory (visible inventory), then the office (invisible inventory) and finally the receivables. Once, these three profiles are made, they are merged to form the macro profile for the business.

## **2.2 MICRO COST-TIME PROFILE**

A CTP can be used at any level of detail. As discussed above, a macro CTP can be used to identify which areas need to be analyzed in greater detail. A micro CTP can then be used to collect process/activity costs over an elapsed cycle time for a given product or service. As with the construction of a macro CTP, the construction of a micro CTP is a four step activity as follows:

- Construct a flow diagram
- Develop cost data and prepare flow diagram with costs
- Develop elapsed time data and prepare Time-Cycle Chart
- Construct micro CTP

The flow diagram is used to identify all the activities of a process and to establish their sequential relationship. The boxes used to represent each activity provide the following data:

- Actual work time
- Cost data
- Cycle time (Total elapsed time)

The cost data needed will take the form of cost per activity (for each block of the diagram). This data is often obtained by examining the operating budget for the cost attributed to each function. Fooks [2] proposes the use of a cost-distribution form to aid in this process. The form consists of the following columns:

- Budget identification number
- Total monthly budget
- Number of work units processed per month

- Budgeted dollars per work unit per month (obtained by dividing the portion of the budget applicable by the number of work units processed per month).

### 3. APPLICATION OF CTP TO VE JOB PLAN

The Value Engineering (VE) job plan provides a systematic framework to carry out the VE study. It specifies the steps that can be carried out to maximize the effectiveness of the VE study. There are a number of job plans that have been proposed by a number of VE practitioners. However, for the purpose of this paper, the job plan put forth by SAVE International [3] will be used.

The job plan consists of the following steps:

1. Information Phase
2. Function Analysis Phase
3. Creative Phase
4. Evaluation Phase
5. Development Phase
6. Presentation Phase

The information phase consists of collecting information to determine project specifics and to ensure that the project is clearly defined. King [3] suggests that the total life-cycle cost of a product should be determined in this phase. The cost of each component in the product should be determined. Further, all costs should be classified as either fixed or variable. A Pareto chart is then used to identify the 'drivers of cost'. However, this method of cost analysis doesn't consider the effect that time plays in the investment of money. Further, it becomes hard to analyze a process using this approach. It is hypothesized that a CTP can be of great use in the information phase. It provides a visual, as well as a quantitative approach to the collection of process data. Further, it would be of interest to compare a Pareto analysis based on cost data with one based on cost-time data. If the results differ a lot, it indicates that time has a vital role to play and that a CTP would be an appropriate tool to use in the analysis process.

The function analysis phase in VE consists of first identifying the main function that a product/process has. Once the primary function is identified, it is then determined as to what steps need to be performed to attain the primary function. King [3] suggests that this analysis can be done effectively by using the Function-Analysis-System-Technique (FAST). This technique is useful as it visually highlights the interrelationships between the different sub-functions. It is hypothesized that the CTP can also be of aid to the value engineer in the function analysis phase. It would be of great interest to identify which cost elements of the CTP correspond with which functions in a FAST diagram. This would help the value engineer in the following ways:

- Identify unwanted functions that may have been missed in a FAST analysis.
- Determine which functions are eliminated when true JIT is employed
- Determine which functions are created/eliminated when a CTP is used to drive innovation

The creative phase of the job plan deals with the generation of ideas to serve the function desired and increase value. A CTP can aid in this task. Once a CTP for a process has been created, one can look to make improvements to the process based on the current profile. Rivera and Chen [7]

suggest that this may be done in the following ways:

- Reduce the cost of materials
- Release materials Just-In-Time
- Reduce waiting
- Reduce cost of activities
- Reduce duration of activities

These are illustrated in Figures II-VI.

Keeping these goals in mind, alternatives can be thought of to improve the profile. King [3] discusses some popular creativity techniques that include the Nominal Group Technique (NGT), Brainstorming, Gordon Technique, and Crawford Slip Writing. These techniques lead to generation of ideas to tackle problems. They are often time consuming and a lot of time is wasted on identifying which ideas are worthwhile and which are not. A CTP enables one to identify problem areas easily and then think of ways to solve them based on the guidelines provided by Rivera and Chen [7].

The purpose of the evaluation phase is to

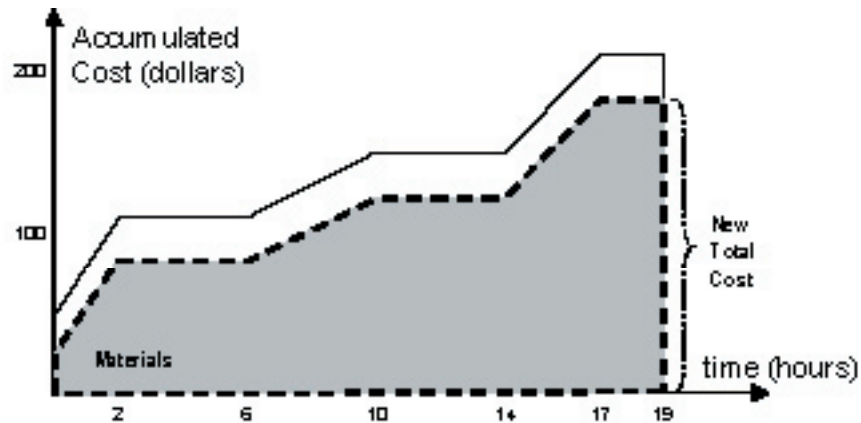


Figure II. Reducing Cost of Material [2]

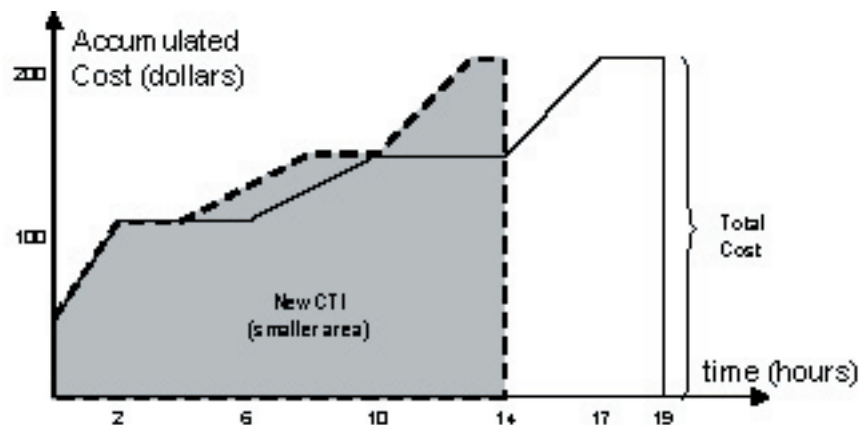


Figure III. Effect of releasing material J.I.T. [7]

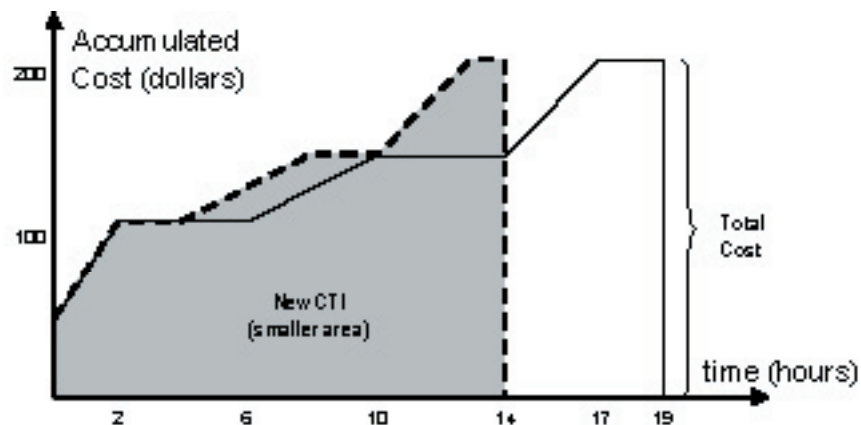


Figure IV. Effect of reducing waiting time [7]

decide which ideas from the 'creative phase' should be pursued. King [3] mentions several popular techniques such as:

- Individual Assessment
- Team Consensus
- PET Project Evaluation
- Idea Advocate Technique
- Numerical Evaluation

None of the above considers the effect of time in their analysis. These techniques rely on the experience of the value practitioner to rank techniques. Hence, the choice of ideas can vary with different value engineering practitioners. The common thread in the above methods is that they compare ideas

with one another to rank them. Several factors such as urgency, need, contribution, risk etc are considered when ranking ideas. However, value engineering literature fails to provide techniques that can be used to assess each idea on its own merit, hence eliminating the need for pair-wise comparison. Cost-Time-Profiling is one such tool that can be used to assess each idea on its own merit. It hypothesized that since Cost-Time-Profiling is not qualitative in nature, the results provided by this technique should be much more beneficial to a value practitioner than traditional techniques. Ideas that provide the greatest improvement in the CTP should be adopted.

Once different ideas have been evaluated, ideas can be classified into three categories:

- I) Ideas that can be presently implemented
- II) Ideas that can not be implemented at present, but may be feasible in the future
- III) Ideas that can not be implemented

Ideas in the first category are studied in the development phase of the VE job plan. It is determined as to how these ideas are to be implemented. The CTP can be of use in this phase as dif-

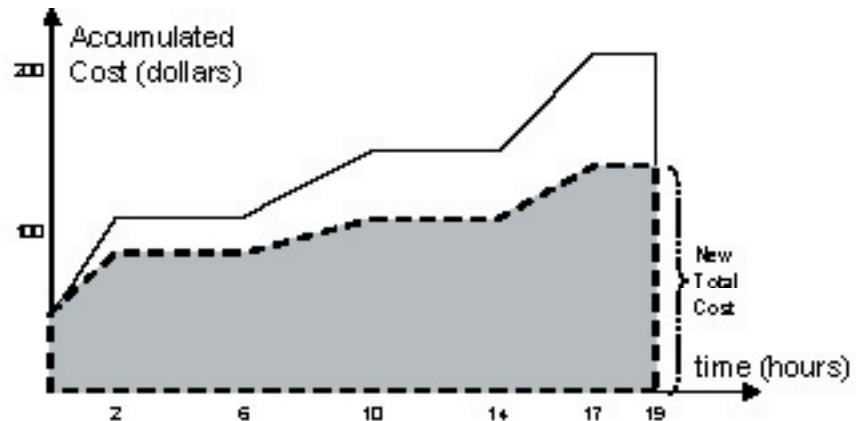


Figure V. Reducing Cost of Activities [7]

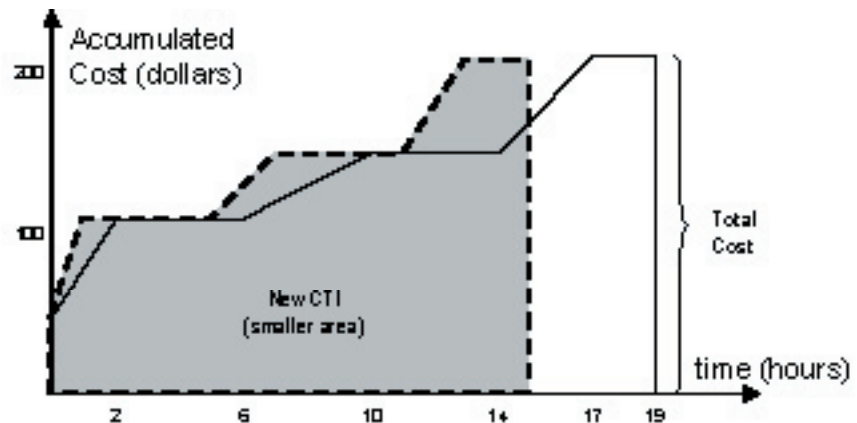


Figure VI. Reducing Duration of Activities [7]

ferent implementation strategies can be analyzed for their Cost-Time impact. Since a CTP provides quantitative data, an accurate estimate of the impact of different strategies can be obtained.

The presentation phase is when the value practitioner presents the results of the study to management. King [3] mentions that it is very important for the value practitioner to convince management that by adopting the changes proposed, cost savings are possible. The use of Cost-Time-Profiling provides the value practitioner with a tool with which he/she can convince management of potential savings. Since it provides a visual explanation along with quantitative figures, it makes it easier for the value practitioner to convince management of the feasibility and cost effectiveness of the ideas proposed.

## 4. CONCLUSION

This paper highlights the need and applicability of Cost-Time-Profiling in the field of Value Engineering (VE) and Value Analysis (VA). It has been discussed how a CTP can be used to evaluate any business activity. Differences between macro and micro Cost-Time-Profiling have been highlighted and their applications have been discussed. It has been shown how traditional VE tools fail to consider the effect of time in their analysis and how a CTP captures this effect.

It is hypothesized that this tool can greatly benefit the Value Practitioner in all phases of the VE job plan (as proposed by SAVE International). The primary advantages of this approach are:

- Helps the value practitioner understand the process
- Provides more accurate estimates of costs associated with process
- Enables the value practitioner to generate and evaluate ideas more easily
- Helps in effectively communicating proposals

These ideas need to be validated to determine whether the benefits theorized can be achieved in practice as well. It would be beneficial to adopt a case study and use Cost-Time-Profiling in addition to traditional tools to see what benefits can be gained.

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