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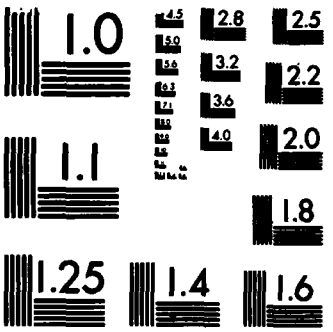

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A Commonsense Approach to Cost/Rate Analysis

by

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A Commonsense Approach to Cost/Rate Analysis

R. Wayne Knox

The premise of this paper is that cost/production rate analysis is an individualistic issue that demands a determinative, non-statistical treatment, and that cost/rate statistics are certainly not now, and may never be, appropriate to measure the cost/rate effect.

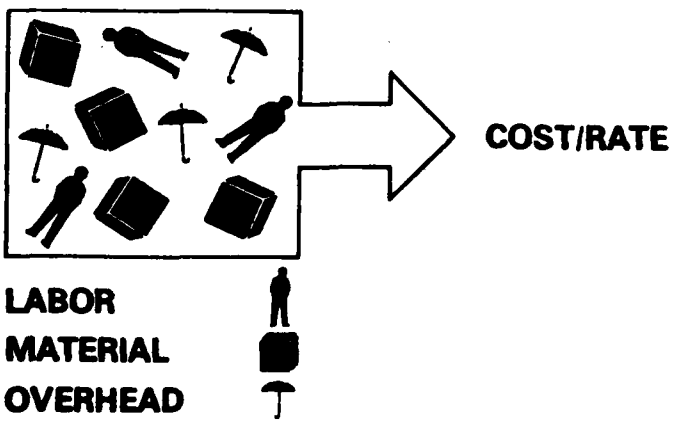
BACKGROUND

Cost/rate analysis, one of the two basic analyses that constitute production cost estimating, is receiving more and more high-level attention. Unfortunately, there is widespread misinterpretation, misuse, and superficial treatment of cost/rate methodologies. Some of this arises from analysts selecting from the methodologies available without recognizing the limited range of applicability or the fact that some are underdeveloped or unverified theories. Realizing this and faced with his own specific need for a valid methodology, the author developed a new determinative, nonstatistical equation and approach to cost/rate analysis.

THE PROBLEM

The problem (that obstructs and almost defies a valid methodology) is that the production cost formula is a virtual Rubik's Cube of interdependent and unpredictable factors (e.g., the degree of labor union resistance to labor force cutbacks, resulting from a falling production rate). In addition, the number of factors is perhaps limitless and the values of some seem indeterminable. It is no wonder that the problem is difficult to understand and difficult to measure. The effect of these factors usually creates a confused and disorganized perspective in one's mind. Figure 1 portrays this confusion.

Figure 1



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THE OBJECTIVE

In the final analysis, the objective became one of creating a commonsense approach that is:

- o General in application (i.e., can be applied to all programs);
- o Practical (i.e., uses a limited number of parameters/factors);
- o Accurate (i.e., clearly measures those factors selected); and
- o Valid (i.e., includes enough of the cost drivers to measure most of the impact).

APPROACHES

The approaches to determining the cost/rate effect can be classified as either statistical or deterministic. In this portion of the paper, I will focus on the potential deficiencies of the statistical approaches to cost/rate analysis, and as a consequence reveal the need for a deterministic approach. It will be my conclusion that the deterministic approach rather than the statistical approach should form the basis of cost/rate analysis; the strongest rationale is that cost/rate analysis is an individualistic issue that demands an individualistic treatment. No broad-sweeping wholesale statistical approach will do.

Statistical Approach

Statistics are useful at capturing the essence of major cost issues and using probability to predict the future outcomes of such issues.

However, as useful as statistics are, they have important limitations. Just one is the cause-and-effect relationship. No statistical technique (e.g., r^2 correlation) that measures the relationship among variables (e.g., production rate changes and cost) can prove a cause-and-effect relationship.

A practical example of the above limitation might help. Let me preface the example by stating that a high r^2 value derived from correlating production rate and cost may be caused by other variables (e.g., design changes, inflation). That is, these other variables may be producing variations in production rate and/or cost. My example is that classical case of deriving a high correlation between the average pay of clergymen and the average price of liquor. One would not want to conclude that the changes in the clergymen's pay caused the change in the price of liquor. It may in fact be another variable, perhaps the cost of living in general, that caused both to fluctuate similarly. This is the type of problem that plagues statistical cost/rate models.

It is also important to keep in mind that there are other potential problems with statistical approaches. One of them is constructing a universe that is composed of entities of similar characteristics. Another is choosing a large enough sample to provide a fair representation of the universe. Still another is obtaining valid data. And finally, aside from these problems of developing a valid model, is the problem of developing a user-friendly statistical model. Exponential mathematics and three-dimensional graphics can be difficult to comprehend and apply. All of these are significant problems that currently seem endemic to cost/rate statistics.

Determinative Approach

The determinative approach is basically an approach that leaves nothing to chance or probability. It involves selecting discrete factors that have a cause-and-effect relationship between production rate and cost. In the case of my model, I chose fixed cost and business base. I believe that most of the discrete factors that affect the cost/rate relationship can be represented within the framework of one or the other of these two factors, in either a direct or indirect way. For example, labor union resistance to reducing the work force (in the face of a reduced production rate) can be represented in terms of how much of the labor production cost is fixed.

Definition of Fixed Cost. The fixed cost used in the model is more expansive in scope than most definitions of fixed cost. It is more than just fixed overhead cost. Labor and material costs, which also have a fixed characteristic to them, are also included. The labor union example above is just one illustration of this fixed characteristic.

Significance of Cost Elements. Figure 2 provides a feel for the extent of fixed costs. These are notional percentages and as such do not imply that it is not possible to find percentages outside the ranges indicated. In addition, the ranges are broad in nature, which is to say that a fixed cost percentage of 20% is more likely than the upper bound of 50% indicated in Figure 2.

Figure 2

SIGNIFICANCE OF COST ELEMENTS

	NOTIONAL %				
	% OF TOTAL COST		% FIXED		TOTAL FIXED
	10-20	x	0-25	=	0-5 %
	40-80	x	0-25	=	0-15%
	40-80	x	0-50	=	0-30%
	100				0-50

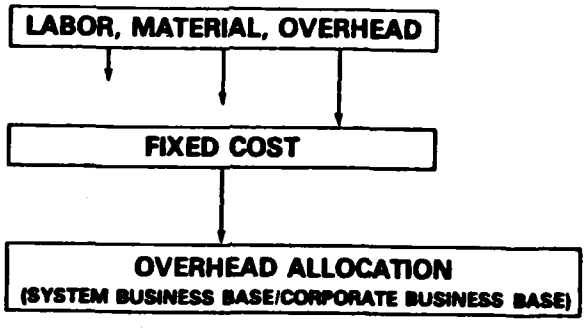
Duration of Fixed Costs. One also has to consider that labor and material fixed costs remain fixed for a shorter period of time than overhead fixed costs. Certainly, employees can be laid off and materials contracts terminated faster than capital equipment can be amortized.

Corporate Business Base. The business base effect is another concept I use in my model. This is a concept that was part of my early iterations on a more simplistic model back in 1981, and one that is excluded in all of the current models I'm aware of. Simply stated, the corporate business base concept recognizes the fact that fixed costs often are not borne by one product alone. That is, they are not all system specific. There are some common fixed costs. Therefore, any change in production rate affects all the products, not just the one whose rate is being changed. Consider the case where a particular product is 75% of a plant's business base and the fixed costs are allocated on the basis of business base (as often they are). A rate reduction of 40% will produce a net effect of 30% for that particular product because it experiences only 75% of the burden (i.e., 75% x 40% = 30%).

Graphic Representation of Fixed Cost and Business Base. Figure 3 illustrates how labor, material, and overhead contribute varying amounts of fixed cost, and how this fixed cost is adjusted by the amount of corporate business base. This concept of fixed cost, adjusted by the corporate business base, is the conceptual basis for the model described in the following section.

Figure 3

COMMONSENSE APPROACH



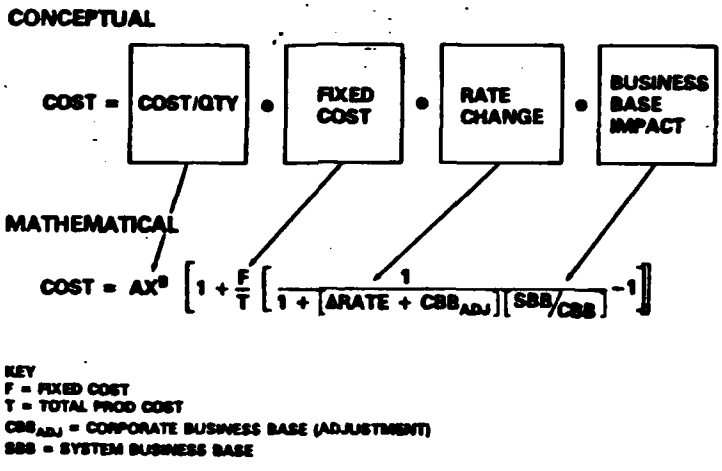
NEW COST/RATE MODEL

The proposed cost/rate model works as an adjustment to the cost/quantity curve. Thus, the cost/quantity curve is first calculated using any new quantities and then adjusted using the cost/rate mathematics. The cost/rate mathematics include the production rate change as well as the concepts discussed earlier (i.e., fixed cost and business base).

The translation from concepts to mathematics is illustrated in Figure 4. There is also a more pure version of the model that uses AX^b to represent only variable cost (and not aggregate fixed and variable cost as is common in DoD).

Figure 4

CORPORATE BUSINESS BASE



Example

Though this paper does not permit time and space for a mathematical proof, I will show an example of how the mathematics work. Figure 5 uses the following inputs for the first year costs (i.e., $COST_1$): a) the fixed cost is 15% of the total production cost; b) the production rate is reduced by 50%; and c) the system business base is 75% of the corporate business base. (Corporate business base is defined as only that portion of a corporation's business base that is related to, in a manufacturing or an accounting sense, the system business base). In Figure 5, costs for the second and third year are the results of a changing business base assumption.

Figure 5

NEW COST/RATE MODEL

MATHEMATICAL EQUATION

$$\text{COST} = Ax^B \left[1 + \frac{F}{T} \left[\frac{1}{1 + \left[\Delta \text{RATE} + \text{CBB}_{ADJ} \right] \left[\frac{\text{SBB}}{\text{CBB}} \right]} - 1 \right] \right]$$

EXAMPLE

$$\text{COST}_1 = 15\% \left[\frac{1}{1 + \left[-50\% + 0 \right] \left[75\% \right]} - 1 \right]$$

$$= +9\%$$

$$\text{COST}_2 = +4.4\%$$

$$\text{COST}_3 = -0-$$

[1] 1ST YEAR ($\text{CBB}_{ADJ} = 0$)

[2] 2ND YEAR ($\text{CBB}_{ADJ} = 25\%$; $\frac{\text{SBB}}{\text{CBB}} = 40\text{-}50\%$)

[3] 3RD YEAR ($\text{CBB}_{ADJ} = 50\%$)

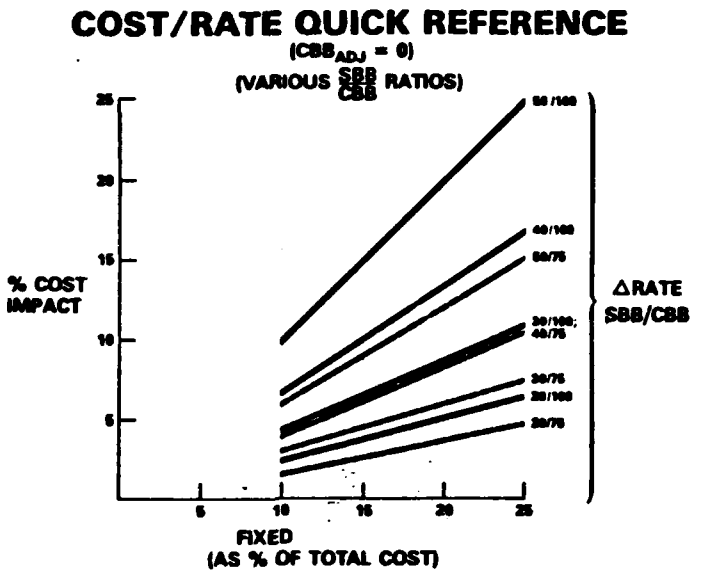
Miscellaneous Considerations

There are a number of factors that the analyst should consider when determining the model's input values. First and foremost is the scope of application. As a practical rule of thumb, the model's applicability probably decreases rapidly beyond a 50% decrease, or a 100% increase, in production rate. Such factors as the production facilities capacity and size of the labor force partly determine the scope of application. There are also considerations such as the duration of the rate change. For example, a one-year reduction in production rate will most likely result in a less severe labor force layoff than a three-year reduction resulting from a three-year multiyear procurement. Other considerations include, but are not limited to, the general state of the local and national economy as well as the labor union vs. management relationship.

Quick Reference Chart

Figure 6 is a quick reference chart for gauging the cost/rate impact using various assumptions for fixed cost (see x-axis) and for production rate changes combined with System Business Base/Corporate Business Base (SBB/CBB) ratios (see various graphical lines).

Figure 6



FUTURE WORK

Future work should include the development of data bases, for selected contractors, that will permit analysts to gauge the amount of fixed costs and business base. The business base is partly determined by a corporation's cost accounting system. In addition to data base development, there should be additional work on determining how corporations react in various scenarios (e.g., a strong labor union, weak economy scenario). Such studies might parallel the large body of research conducted on human behavior.

SUMMARY

Due to the statistical failings of existing statistical models, the determinative approach becomes the most practical, commonsense approach to cost/rate analysis. The most striking advantages of the determinative approach are that the analyst knows "what" (e.g., fixed cost) is being measured and he/she measures the "what" more accurately through the use of contractor-specific data.

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