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FINANCIAL SIMULATION: COMBINING COST INFORMATION IN SYSTEMS ANALYSIS

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ABSTRACT

Financial simulation is partner to traditional simulation, where the results of selected scenarios are evaluated as a judgment criteria to determine the financial and manufacturing impact of these proposals. In this way, different alternatives and their impact on the bottom line can be evaluated and the results presented to senior management. Financial simulation enhances the manufacturing simulation by adding the cost estimates of the alternatives under study that will impact the final decision.

The authors will discuss how financial simulation is a Planning Tool; *not* an accounting package. Financial simulation will not provide either historical or current tracking of manufacturing costs. As such, this paper is intended for both simulationists and technical management, but not for the traditional financial analyst.

This paper will discuss what financial simulation *is* and *is not*, who should use it, and how to *effectively* utilize this technology. In addition, this paper will provide a brief description of the mechanics behind the financial models. This paper is not intended to be a tutorial describing in detail the specifics of doing a financial simulation.

1. THE NEED FOR FINANCIAL SIMULATION

Simulationists use the traditional parameters of simulation such as the cycle time, WIP, and utilization of resources within a manufacturing system to objectively judge alternatives under study. The goals of these studies are to improve or investigate the effect of proposed changes on existing manufacturing systems or to help both the simulationist and management to understand a proposed system. What is missing from the traditional analytical approach is the impact of these alternatives with regard to cost (see Figure 1). If cost analysis was performed as part of a project, it was usually done as a post process of the chosen manufacturing simulation alternative (see Figure 2). In this respect, the financial impact of the alternatives not chosen was never considered, much less discussed and recorded.

It is agreed that the traditional parameters can be directly related to the cost of a system. Reducing cycle time, effectively utilizing equipment, keeping WIP to a minimum will all likely reduce the cost of producing goods. What is not readily understood is the nagging question of how much the alternatives really cost relative to each other.

Final decisions regarding manufacturing systems are made by business executives focused on business metrics. All manufacturers must balance the cost of a product against its quality and reliability, and marketing's ability to sell the product at a price that will cover the cost of manufacture yet still return a profit. Because the industrial world works within these constraints, the simulationists must understand the impact of proposed changes not only with regard to the traditional parameters of WIP, cycle time, and resource utilization, but also with some regard for the financial bottom line.

A simulationist must focus on understanding the full system, not just the hows and why of the manufacturing process. Often it is important to understand how much money is tied up in the process, what is the carrying cost of a product while being transformed from raw material to finished product, or how much money must be spent initially and incrementally as a manufacturing process matures and the product changes. Having the cost information in addition to the traditional parameters will provide a better understanding of the system.

Take, for example, a simple change to a manufacturing process. If a decision is made to purchase a part instead of manufacturing it (a make/buy decision), this could impact the cost of the remainder of the products produced. How? Consider the cost of maintaining a flexible manufacturing line that is capable of producing all of the products. Now consider how each product is charged for the equipment and labor that it utilizes; the total cost of all the resources is allocated by some allocation algorithm over *all* the products produced . The cost for manufacturing one of the products may be judged to be too high, given the current way cost is allocated. But what is the impact on the final cost of the other products sharing that assembly line or plant when one product is removed from manufacturing and bought from a third party? The cost of the other products will increase to cover the idle time of the line caused by the removal of the product. If the cost of buying the product outside (purchase price plus the 'new' cost to build all the other products) is greater than the cost to build *all* products in house, then the reality is that the bottom line costs have increased.

2. WHAT IS FINANCIAL SIMULATION?

Financial simulation is the use of traditional cost metrics in addition to the use of manufacturing metrics. The analysis not only provides the WIP and cycle time metrics but also gives some indication of the dollar cost of the alternative.

Depending on how the financial side of the model is built, one could look at costs by sub-assembly, equipment, labor or any categories where sufficient information exists to describe the cost equations. It could even provide a cost breakdown for each component of the manufacturing system, provide information about the cost of carrying the raw material or even indicate when money must be spent to meet the requirements of the line for labor, equipment, and materials.

The financial simulation is performed to support the traditional simulation analysis and provides important additional feedback during the project. This feedback is the key to doing financial simulation. Both the feedback and the understanding of the effects exist as an ongoing concern while doing modeling. Traditionally, the 'solution' was determined via the standard metrics, and then this 'solution' was analyzed for the financial impact only after the simulation was completed for the project. This often resulted in solutions being chosen that optimized certain sub-systems, but not necessarily the whole system.

Financial simulation as the authors describe it is used as a planning tool providing additional information to make more informed decisions. It is not intended to replace current accounting systems which track the historical and current costs of the system. It does not generate the quarterly report or in any other way reflect the historical information used for accounting purposes.

3. WHO SHOULD PERFORM FINANCIAL SIMULATION AND WHY

The individual responsible for performing the traditional simulation of the manufacturing system (concerned with WIP,cycle times, and resource allocations) is also the person who should be performing the financial simulations (concerned

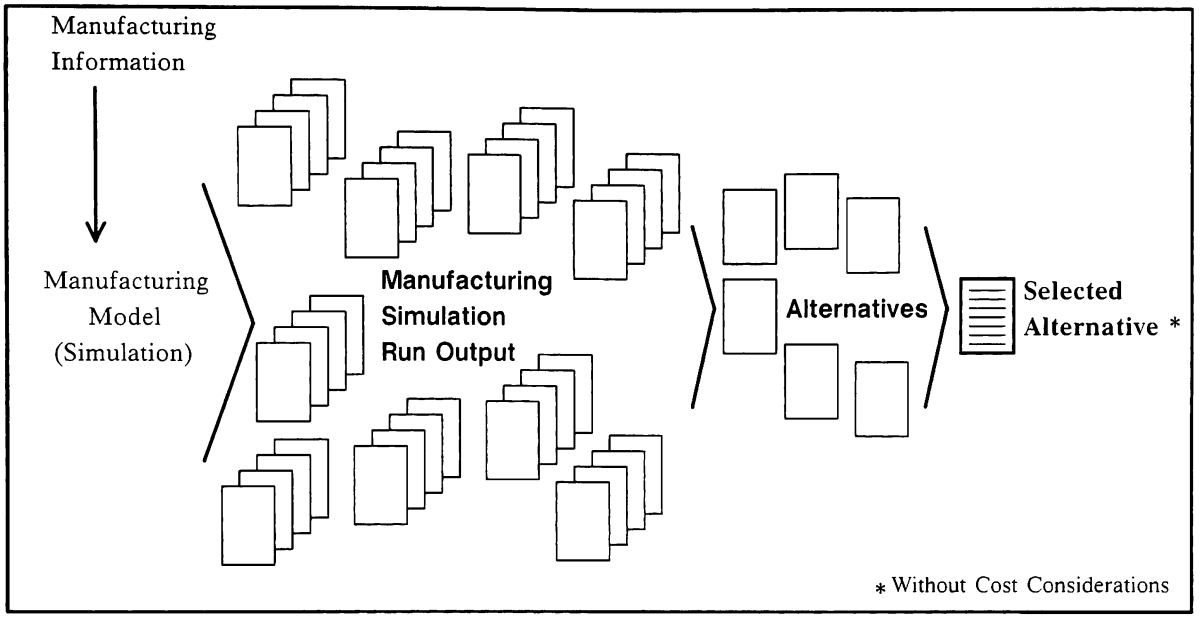

Figure 1. Modeling without cost

with the bottom line costs). The primary reason why simulationists should perform both tasks is because the behavior of the manufacturing system will directly affect the cost, and the cost will directly affect the chosen manufacturing operational procedures. For the cost aspects of the model to be accurate, it must be based on a model that accurately describes the system to whatever level of detail is required to obtain the traditional manufacturing information. Thus for the operational model toaccurately depict the full system, it must include costs.

Some suggest that financial simulation is just another form of financial analysis, and financial analysis is solely the role of the finance people. We disagree. The financial analysis done in conjunction with the simulation model specifically deals more with the components of cost and how the manufacturing system affects these costs and less with the larger questions such as the return on investment, though naturally the two are related. To obtain this cost insight, the knowledge of the manufacturing system must be fully understood and modeled. Thus the traditional analysis serves as a basis for the financial simu-

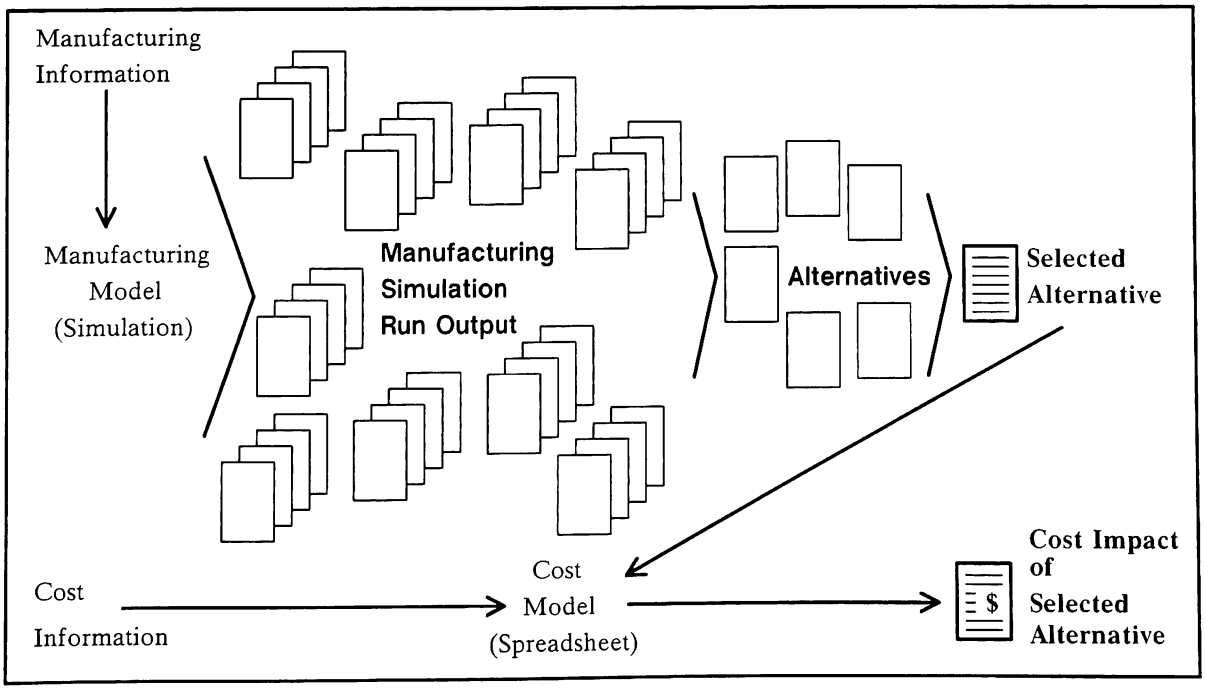

Figure 2. Modeling with cost added after the analysis

lation. The goal of performing the financial simulation is not so much to get the dollar figure, but to better understand the system and how changes can affect the cost. Again financial simulation is a planning tool, not a tracking or historical accounting system.

The results from financial simulations are rough cut figures, and are not intended to be used to create standard costs. Instead they are an additional objective metric for the judgment of an alternative. As rough cut or "ball park" figures they usually prove to be sufficient to pare down the alternatives. In this manner, a broader understanding of the system can be achieved. Perhaps one of the best results that can come from financial simulations, depending on how the modeling is done, is the understanding of not only how much will be spent, but more importantly, *how* it will be spent. In Manufacturing systems, cost is the major factor in any overall decision process; ignore it the business could suffer.

4. HOW TO PERFORM FINANCIAL SIMULATION: THE MECHANICS

The way to perform financial simulations depends greatly on the purpose for analyzing the model. If one is modeling alternatives of traditional manufacturing systems or determining the ramp up of a new product and cost is of importance then some type of financial analysis is of vital importance.

As with all modeling, information must be collected. When adding the financial model section to the simulation model, the new information which is to be added naturally pertains to cost.

The process of doing a financial simulation involves a number of steps, straight forward in principle but sometimes taxing in practice. The initial step is to build a standard simulation using any appropriate tools. Raw cost information is gathered, and the cost parameters and application rates are calculated. The final step is to run the simulation, and at each step, simulate the cost of each operation within the factory. The cost statistics of this simulation are then gathered and reported.

The data required from the initial simulation includes complete statistics for each operation; production, both good and scrap, WIP at each operation, and resource utilized at both setup and run. Only average values need to be collected, since financial simulation cannot be effectively run for each peak or valley of the data.

The second step of gathering cost information is the most difficult in practice. The costs for all direct production resources, materials, factory support used, capital depreciation rates and interest rates are necessary, and need to be in a form that allows the analyst to easily calculate the change in total cost as the factory model is changed. For example, "If one piece of equipment is added, how will the total cost of the factory change?" should be a straight forward calculation. Thus "RAW" values such as Labor $/hour and Labor fringe costs are the type of information gathered. "COOKED" or "CALCULATED" values such as "overhead $ per Labor hour for equipment depreciation" cannot be used. The calculation of these "cooked" values involves using a fixed value of a parameter (e.g. production level) which usually changes in the various scenarios, invalidating that "cooked" value.

The third step is to calculate total costs for each resource, material and factory support activity utilized. The total physical resources (e.g.number of machines, amount of raw material, etc.) needed have already been determined by the original simulation. By using the cost per resource parameters, and the results of the traditional simulation, a 'total cost' for the factory can be estimated.

The creation of total costs may not be sufficient for the analyst's needs. Estimated part costs and costs for individual steps are required in order to recommend improvements. To get these components of the total cost, it is necessary to allocate the costs to individual activities. Specifically, the cost for each resource, factory support activity, etc., must be allocated to individual operations. Usually this is done by determining a term such as Labor $/hour and Labor Overhead $/hour and then allocating the cost to the part based on the number of Labor hours used. The process of determining costs/hour is simple because the two factors needed are at our fingertips. For example, labor $ per hour is the total labor hours divided by Productive Labor Hours.

Once all cost terms have been reduced to a cost/piece or a cost/hour, the simulation is run and the cost for each operation for each part can be calculated as a side event. The costs for the operations are totaled to give the cost for the part. This step is repeated for each scenario.

In practice the actual steps involved are more taxing and involve many more decisions by the analyst than are portrayed here. Many of these steps have been automated and integrated so as to relieve the analyst of the mechanics of this process. This allows the analyst to focus on the information and the results and avoid getting lost in the details.

The only additional knowledge or insight that is required to do a financial simulation is an understanding of how the costs accumulate over the manufacturing process. For example, take a manufacturing line with a product mix of two, assume the equipment expenses are charged equally between the two products. But if the first product utilizes the line 25% of the time and the other the remaining time, then the actual price to manufacture the first product is greater than it should be since it 'carries' some of the burdened costs of the second and the second product is charged less than it should be. Additionally, if the first product is removed from this line, the price for the remaining product will increase as it covers the equipment cost for the first, which is no longer being manufactured. This happens even though there has been no change to the manufacturing process of the second product, in material, equipment utilization, or labor for the remaining products. Traditional simulation would not uncover this cost increase. Instead, it would favor this process alternative because it reduced resource utilization even though that utilization may be a "fixed" cost, that must be paid regardless of weather it is utilized or not. Financial simulation is performed specifically to detect these instances. Figure 1 shows the traditional manufacturing analysis which is judged by the traditional manufacturing metrics such as cycle time, WIP, and ultilization. In figure 3 the traditional metrics are also used but are augmented by cost information. The cost provides needed information to make a more informed decision.

The same questions can be asked for idle time, labor, and overhead. How is labor charged both during busy periods and during the idle time. How is the capital charged against the products? Is it split? The objective in doing this has always been to balance the cost against the other goals. As such trade offs must be made. Having the financial information is just one more piece of information that is of value when making that decision. Depending on background, the simulationists may not know the questions that should be asked. The project team should include those with financial knowledge, as well as detailed and operational knowledge of the system and simulation expertise.

Initial cost models used were developed in a spreadsheet and the information transferred from the simulation runs manually. This was important since it enabled us to learn what was and was not important as we co-developed the model and the spreadsheet. When we narrowed in on the process of transferring the information, the step was automated through the use of FORTRAN code and spreadsheet macros.

This was an iterative process with cost as one more set of information available to help decide where to go next. The results from the traditional simulation was fed to the spreadsheet financial simulation model, which when run affect the choice of the next 'alternative' to be run in the traditional simulation. Eventually, the two models, run concurrently, would converge on a solution.

5. RESULTS

Within Digital the application of this methodology has aided greatly in the planning of a new manufacturing process based on a new technology. The project team was composed

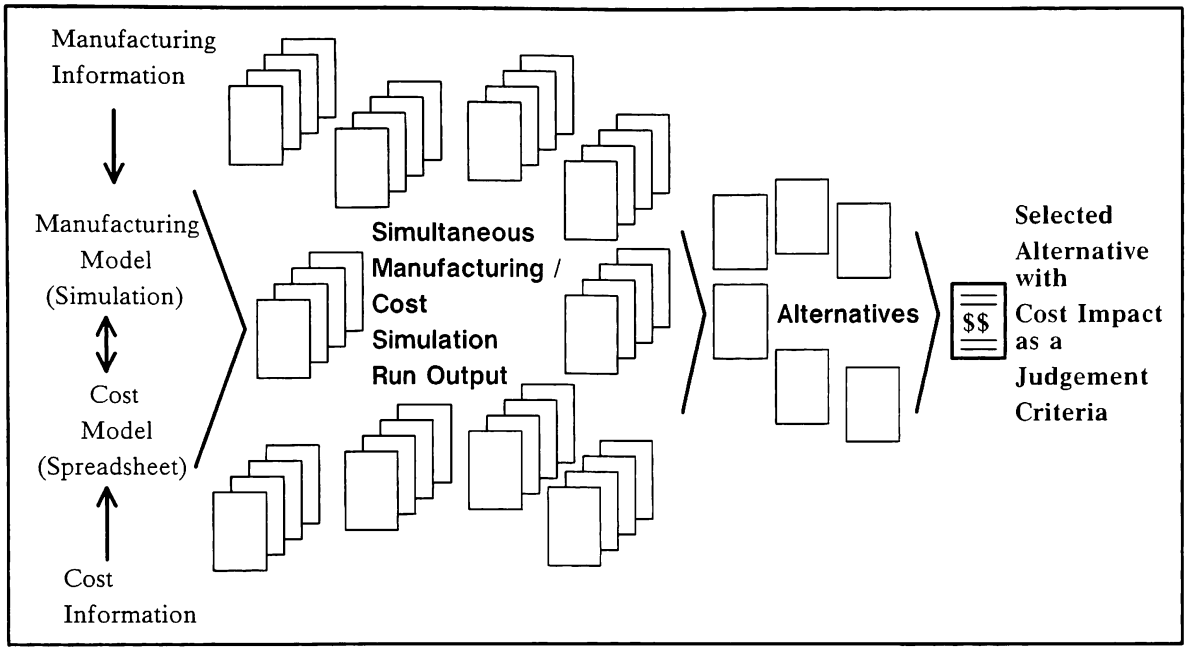

Figure 3. Modeling with cost as a judgement criteria

of people from various parts of the organizations and included the manufacturing engineers responsible for setting up the line and establishing the process. These people had the understanding of the basic cost structure and charging mechanisms for both existing and developing lines.

Our analysis, which included the traditional manufacturing analysis plus the cost analysis, helped in understanding the impact of change, some of which were advantageous by manufacturing standards, but detrimental when costed. Because the cost information was available during the analysis, the alternative was less appealing, as it should have been, which required continued investigation.

One such example involved the development of a new computer module. The engineering design called for option A, which was believed to result in a more reliable product. The Manufacturing process development group was able to develop a process for the option, however, it was not a repairable process. With the financial simulation tied to the manufacturing simulation, we were able to predict the cost impact of having a non-repairable device. The cost along with the benefits of option A were compared against the cost of option B which resulted in a repairable device. The benefits of option A were judged to be insufficient to justify the added cost to manufacture the product. Ultimately, the final process chosen resulted in a product which cost 35% less to manufacture than the original design, while having higher reliability. Without the use of financial simulation throughout the entire development process, this alternative might never have been considered.

Perhaps the most significant benefits to financial simulation is our ability to understand during the planning process, *how much* and *how* money would be spent for any given alternative under consideration. When models where cost information was used for planning and developing the line, was compared to the actual costs of the lines after development they proved to be within 5% to 15% of the modeling results. This allowed the developers to accurately predict and control the budget through all development phases into manufacturing. The fact that this cost information as well as the manufacturing information is available at the planning stages is one of the more readily remembered accomplishments of the simulation analysis.

6. CONCLUSIONS

The primary objective in performing any modeling is to find out something that was not known before, so that the decision made will be the best one that can be made with the information at hand. Presented here are both a method for performing financial simulation and the reasons why it should be undertaken. In a competitive environment, it is always advantageous to have more information. Financial simulation is just one more technique that can be used to better understand the overall system.

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