COLUMN

SOLVING DAM PROBLEMS

Are We Nothing More than a Pair of Socks at Walmart?

by Gray McQuarrie

SUMMARY

As business leaders we need to give our engineers, managers and operations staff a greater purpose, and when we do develop innovative approaches, we shouldn't give them away for almost nothing. If not, we have no one to blame but ourselves for turning a high-technology industry into an undervalued commodity.

Are you about ready to throw in the towel because you can't compete with China? We have all heard that the labor rate in China is about $1.83/hr, and the average labor rate in the United States is $12/hr or more depending on the difficulty of the job and geographic location. Does this difference mean we are done with the manufacturing of PCBs in this country? I have heard all of the excuses. What we do here will immediately be translated over there. It is important to consider that when we stop innovating here, the innovation stops over there! Think about it.

The real reason I feel we can't compete is not because we are paying too much for labor, but we are paying too much for overhead: too much for our engineers, managers and operations people. Now, I am not saying we should reduce salaries. What I am saying is as business leaders we need to give them a greater purpose. In addition, when we do develop innovative approaches we shouldn't give it away for almost nothing. We protect it or we sell it and get fair value. If we don't do that, then we have no one to blame but ourselves for turning a high-technology industry, which is extremely valuable to the world, into a commodity that has as much worth as a pair of socks sold at Walmart.

So, what do we have to do to make money? In the next several columns, I will address this issue.

Let's begin with a few questions. Do you know what the true capacity of your plant is? Do you know what your critical WIP level is? Do you know your true rate of production? Do you know your plant cycle time? If you cannot answer all of these questions with a 'yes,' then the good news is you likely can make more money out of your plant than you ever thought. Don't feel bad if you don't know the answers, because you aren't alone. I would recommend you buy a textbook that we all need, *Factory Physics,* by Wallace Hopp and Mark Spearman. I thank my friend Tarun Amla at Isola for pointing me to this book. One of the things they say is, "It is just a matter of time before manufacturing practices will be guided by logical principles rather than emotional rhetoric."

So, let's stop the emotional rhetoric and get on with the science. We are going to start with a very simple model of a plant, dispense with all of the complications, the different part number routings and all of the fancy cost accounting systems. We are doing that because if we can't thoroughly understand a simple plant, we aren't earning our overhead dollars.

Imagine that we are a high-density complex fab where we work with a variety of different materials with very fine lines and spaces (approaching 1-mil lines in spaces in some areas of the designs), and we do military and medical work. In essence, our market hasn't been totally commoditized yet and we can get a good price per 18"x 24" panel, or in the neighborhood of $800 per panel on average.

Our simple plant is going to be one waiting queue and a simple conveyor belt. It takes eight days to travel from the beginning to the end of this belt. At the start of the day, we release jobs or lots of material to be processed. On

this day, there are 10 panel lots. The capacity of our conveyor belt, or really our plant, is 50 lots of material. If we put more than that onto the conveyor belt then we have stuff sitting in the hallways, accumulating in spare rooms and cluttering all of the space on the plant floor. This is a familiar scenario to all of us, I am sure. In our model, all of these extra lots will simply be in the waiting queue.

Also, at the start of the day, we release bags of money to pay for everything: what we have to pay to corporate, what we have to pay the suppliers, what we have to pay the bank and what we have to pay to keep the lights on. Therefore, we need to know how much money we need in the bag each day. Of course, no plant is perfect, so we have to consider the amount of scrap we generate.

To help us get at the answer of how much money we can make in this plant, I put together a simple discrete event model using ExtendSim 8 AT. The diagram is shown in Figure 1.

It doesn't look simple, does it? The green and yellowish diagrams are called blocks. With the green arrow block on the left labeled "starts," I can specify how many lots to start for the day. In addition, I start one bag of money for the day. Therefore, going from left to right the lots are created daily along with one bag of money. The money is sent to accumulate in the "Bags of Money Spent," where the amount we spend daily is multiplied with the bags to figure out total expenses. From that, we divide by the total number of good panels produced to figure out the cost per panel. See, not so bad. We store the panels in front of the conveyor belt to account for overflow. What is nice about ExtendSim is that when several panels come out we can compute the time it took the item to go from start, through the wait queue and then through the production belt. After noting the average cycle time, the lot is determined to be shipped or scrapped.

Consider this question. If it takes eight days to go on the conveyor belt and you have 0% scrap, how much material should you start if the plant has a capacity of only 50 lots? You don't want any accumulation of WIP so it would be 50/8, or 6.25 lots/day. That was easy.

Now, for a more difficult question. You have 30% scrap. In order to meet customer commitments you need a lead time of 15 days. You have made a commitment to your boss that you will meet a revenue target of $2,826,000 for the quarter and he expects a 10% profit, or $282,600 for the quarter. Your sales people

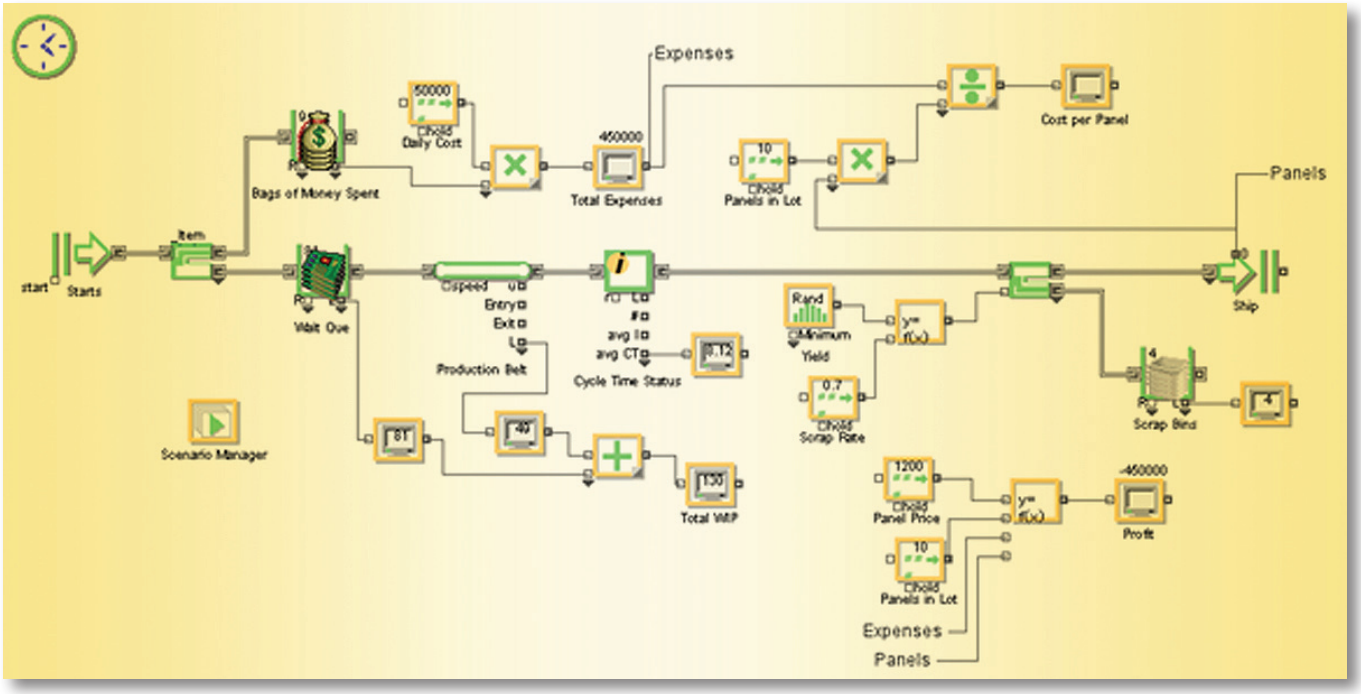

Figure 1.

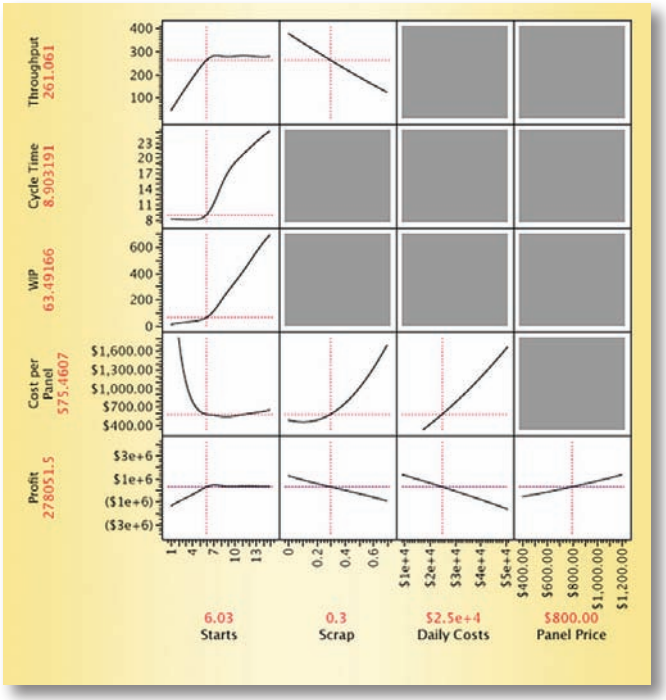

Figure 2.

have told you that you will lose 50% of your business if you don't drop the average price per panel in the shop to $600 per panel, or 20%. Your average daily costs are $25,000 a day. You work two shifts, or 16 hours a day, and there are 72 days in the 90-day quarter. If you need an extra day this will cost you $32,000 per day. In addition, if you need an extra shift this will make the day's expenses $35,000, or $10,000 to run the overtime shift (labor, materials, chemicals, et al.). How many lots do you need to start each day? Are you in trouble? If you are in trouble, what are you going to do?

One way to answer this question is to do a special kind of DOE on this simulation model. This was done averaging five days worth of results for 5,400 runs. Doing a DOE with a production simulation is very different from doing a DOE in the real world of production (a subject of a future column). The results were expected to be nonlinear. For example, as the number of lots increases, so does throughput until the plant becomes full, in which case starting more doesn't help. You go up linearly and then flatten out suddenly. This kind of modeling won't work for regression, so we used the neural net engine to derive the models by using JMP 8.

The nonlinear fit of the data is shown in Figure 2. We see we just meet our profit objective indicated by being even with the purple horizontal line shown on the profit row of graphs. This is achieved when we set starts to about six lots a day. As starts go up (look at the top graph on the starts column) the throughput increases until it reaches a maximum. If we were to start more material, we would start getting a higher cycle time, which could eventually exceed our lead time. We will talk in a future column about how as WIP goes up cycle time goes up, which means customer service and our ability to deliver goes down.

We are OK with regard to the profit objective and we know how many lots to start. The fact that the cycle time is eight days means we can meet the 15-day lead time. However, we have a problem. We only produced 261 good lots of material, or $2,088,000 of revenue. Our boss has promised the bank and the board that we were going to make about $2.8 million and this is non-negotiable. We are in trouble. What to do?

The standard reaction to this problem is ugly. This is where overhead costs are completely wasted. We start more material so we can get at that $2.8 million. We need 350 lots completed by the end of the quarter. Since we have 30% scrap we need to have started a total of 455 lots, taking into account the amount of time it takes material to go through the production belt (eight days or about seven lots per day). Will this work? No, because this exceeds the plant's capacity of just over six lots a day.

There is an even greater problem. The Sales Department says we will lose 50% of the current orders if the price per panel isn't lowered to $600 per panel. We have one way we can achieve this in the very short term and that is to lay off workers and pound suppliers to lower their prices. We would have to go from daily expenses of $25,000 per day to $20,000, which would mean a trimming of $360,000 for the quarter or $1,440,000 for the year. The tendency is to pass the buck to the supplier rather than put pressure on the expensive overhead to figure out alternative solutions. Now, I am in favor of working with

the supplier, but not as the only solution! If you tried to get there by firing the workers, at $12/hour, you would have to fire 26 workers. All of this is standard procedure, very ugly and fails to produce sustainable results for the long haul.

Nevertheless, even with these scenarios of firing people and beating up on your supplier, you are still in trouble. Why? Because none of these cost-cutting measures will improve throughput. You will still fail to meet the $2.8 million revenue target.

If we want to save our job, we have two choices. One choice is to reduce the scrap rate, and the other choice is to get the product through the plant faster. For this column, we will only consider reducing the scrap rate. Can we meet a revenue target of $2.8 million, profit of $280,000, lead-time requirement of 15 days and panel price of $600 per panel just by reducing the scrap rate, while we keep our daily costs at $25,000/day?

Figure 3 shows the situation. If you can get to a 19% scrap rate, the profit objective can be met with the $600 panel price, but not the revenue objective. You can run extra days or extra shifts to try to meet the additional revenue, but you are $934,000 short! You would need 34 more days' production. This could be achieved by working all 90 days, which would produce 18 more days' production and 32 overtime shifts. Now you have a problem, because all of this is going to come with extra costs and you have to check to see if you will meet your profit goal. Now we have about $938,400, which is a little bit over the target. It will cost $576,000 to run the extra days and $320,000 to run the extra shifts, which makes the total expenses $896,000! We made it.

Unfortunately, we are still not going to be in the clear here because we will likely get beat up on having way too high of a labor variance due to the extra overtime shifts and extra production days not budgeted for the quarter. The ultimate solution to this challenge is to make the product run through the factory much faster.

The Bottom Line

We are paying too much for overhead because we don't want to challenge conventional thinking, understand our operations more deeply using modeling, work collaboratively together and mastermind how to produce with higher yields and run product through the factory faster using whatever means and creative ideas we can generate. This will differentiate us from the competition, and when we do that and continue to improve that in our plants, we will be protecting our intellectual capital and not giving it away free. What is at threat is not just our ability to innovate in this country, but the entire world's ability to innovate if we continue to treat what we do as a simple commodity—like a pair of socks at Walmart. **PCB**

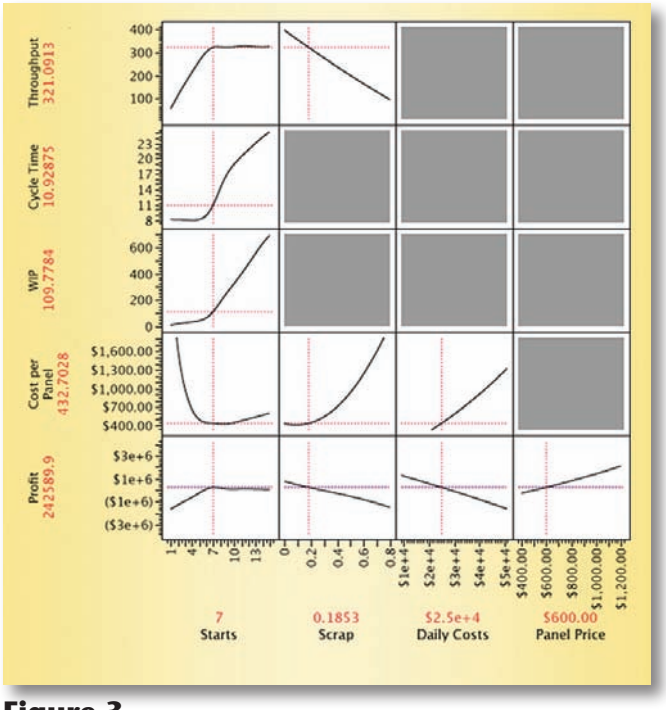

Figure 3.

Gray McQuarrie is the President of Grayrock & Associates, a team of experts dedicated to building collaborative team environments that revitalize businesses. McQuarrie is the primary inventor of the patent Compensation Model and Registration Simulation Apparatus for Manufacturing Printed Circuit Boards. For more information, visit www.grayrock.net, or email McQuarrie at gray@grayrock.net.