READY-MIX CONCRETE COMPANY: AN EXPERIENTIAL EXERCISE IN MANAGEMENT THEORY

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ABSTRACT

This experiential exercise proposes a learning environment based on a physical representation of material covered over the span of one semester in a Management fundamentals class. The method of acquiring knowledge during this exercise is from taking an activity and turning it into an experiential learning exercise producing tacit knowledge. This exercise was originally designed for an entry-level course in Management fundamentals; however, it could easily be adapted for courses in Cost Accounting, Production and Operations, Human Resource Management, and, perhaps many more. The calculations and discussions go only an inch deep, due to the introductory nature of the course.

INTRODUCTION

Over the past ten years, I have been using the following exercise in my classroom to get my students engaged with the subject matter. It was never my intention to offer this exercise for more than what it is—a fun, easy-to-setup, interesting practicum that gets the students off the bench and into the game. Professors who observed this simulation, encouraged me to share this exercise with others in the field because it can be so easily adapted to illustrate so many different Management ideas. For, as my students have discovered, Yogi Berra was right, "You can observe a lot just by watching." (Berra, 2008)

This exercise utilizes students to staff a production line producing a product—Ready-Mix concrete. Initially the production line is divided into six (6) work stations (see figure 1), and each student is given a specific task to perform to produce the final product. They must work under a set time constraint, and initially, work under a direct Supervisor. The duration of the simulation will run between 1-1½ hours, but can be shortened to fit into a 50 minute period (explained later with the third production run).

THE SIMULATION

LEARNING OBJECTIVES

This exercise provides a physical demonstration of the following management principles:

- The four (4) functions of Management: Planning, Organizing, Leading, and Controlling (Fayol, 1930)
- Efficiency and Effectiveness (Gilbreth, 1911; & Kanigel, 1997)
- The Value Chain and its analysis (Porter, 1985)
- Job design and analysis, job rotation, job enrichment, job enlargement (Hackman & Oldham, 1980)
- Re-engineering (Hammer & Champy, 1993)
- Empowerment(Conger & Kanungo, 1988)
- Self-Directed Work Teams (Osburn, et al, 1990)
- The Learning Curve Affect (Hall & Howell, 1985)

Schedule the simulation after the explicit material, on the preceding topics, has been covered.

SUPPLIES NECESSARY

Ready mix concrete consists, for the purposes of this demonstration, of three components: sand, Portland cement, and an aggregate (usually gravel). I have substituted readily available materials that will make the exercise easier to setup; and, in some cases, materials are much lighter by weight for handling purposes. For this demonstration I have found that the following items are the best substitutes: (see table 1)

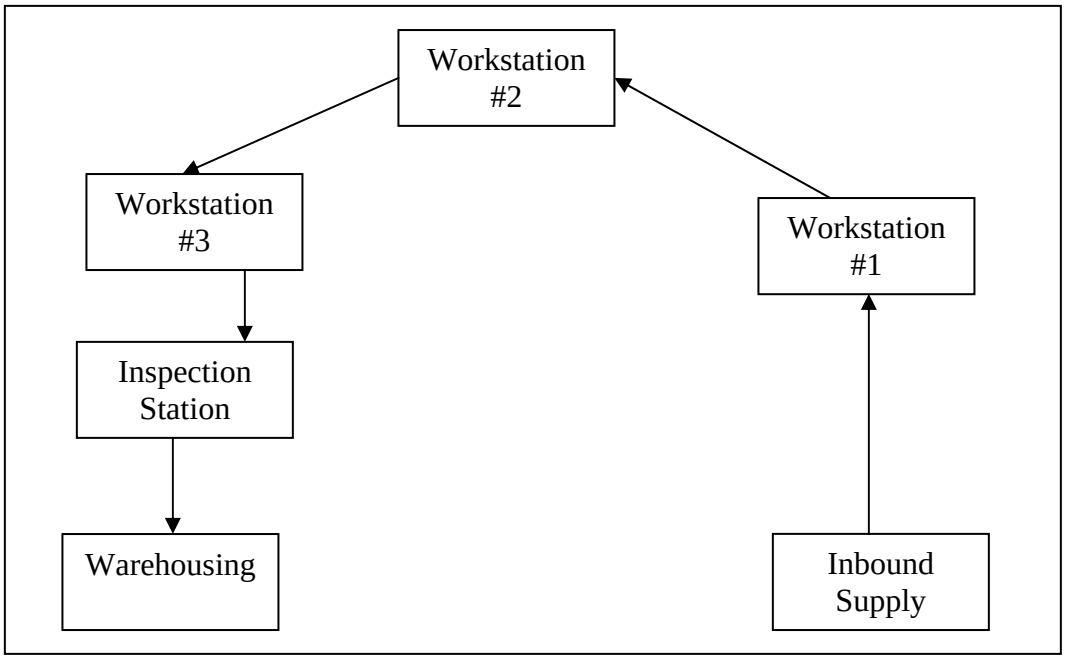
SETTING UP THE DEMONSTRATION

The production line consists of the following work stations: In-bound supplies; work station #1; work station #2; work station #3; inspection; and warehousing. For the first production run, set up three (3) workstations, one for each raw material, by

Supplies Needed
Table 1

Ingredient	Substitute	Amount	Purpose
Portland Cement	Flour	5 pounds	Main ingredient`
Sand	Sugar	5 pounds	Main ingredient`
Aggregate	Pinto Beans	5 pounds	Main ingredient`
Large Mixing Bins	Plastic Lasagna Pans	3 (w/lids)	Bulk storage
Concrete Bags	Plastic Storage Bags (1 quart size)	@ 120	Store final product
Scoopers	Plastic Spoons (reg. tableware)	3	Loading bags

Typical Classroom Arrangement
Figure 1



placing each of the lasagna pans on a separate table. Fill each lasagna pan with one of the ingredients; then, set up a separate "In-bound supply" table somewhere in the room separate from the production area. Do the same with the warehouse for storing finished goods. You should set up all work stations as far apart as your classroom will allow (20-30 feet). I put the inbound supply and warehouse at the back of the room on opposite sides (see figure 1).

EXPLANATION OF EXERCISE TO CLASS

I explain the exercise to my class as follows: "Welcome to Nichols' Ready-Mix Company. My name is Charles Nichols, and I am the owner and founder of this company. We are a national distributor of Ready-Mix Concrete to both retailers like Home Depot and Lowes, as well as end users such as General Contractors. We are expanding our operations, and I need to staff a new facility here in [your classroom city] as follows: (see table 2)

"Concrete consists of three basic ingredients: Sand, Gravel, and Portland Cement. Each bag of Ready-Mix Concrete contains these ingredients in the following ratio: 1 part cement, 2 parts gravel, and 3 parts sand. The production line works as follows:

1. The supply attendant assures that all workstations are supplied and ready for action. Then the supply attendant returns to the warehouse and issues one bag to the supply runner who transports the bag to the first Work-In-Progress (WIP) runner stationed at the first workstation (the cement). The supply runner then returns to supply and picks up another bag. Repeat.
2. The first WIP runner then hands the bag to the worker at the first station, and then returns to the supply runner for more bags. (repeat)
3. The worker at the first station puts one scoop of cement into the bag and hands it off to the second WIP runner.
4. The second WIP runner hands off the bag to the second work station, the sand, and then returns to the first

Workers Needed
Table 2

Position	Wage/hour	Location	Job Class	DL/IL/OH *
Supervisor	$12.00	N/A; moves around	Management	OH
Supply Attendant	$6.00	Inbound Supply	Clerk	IL
Supply Runner	$6.00	Between Supply/WKST #1	Material Handler	IL
Warehouse Attendant	$6.00	Warehouse	Clerk	IL
Warehouse Runner	$6.00	Between INSP and WHSE	Material Handler	IL
(3)Workstation Positions	$6.00	WKST 1, 2, & 3	Laborer	DL
(2-4) "WIP" Runners	$6.00	Between WKST 1, 2, & 3	Material Handler	IL
Inspector	$12.00	INSP Station	Inspector	OH

*DL = Direct Labor; IL = Indirect Labor; OH =Overhead

workstation for more WIP. (repeat)

5. The worker at the second workstation puts 3 scoops of sand into bag and gives it to the third WIP runner.
6. The third WIP runner hands the bag off to the third workstation, the aggregate, and returns to the second workstation for more WIP. (repeat)
7. The worker at the third workstation puts 2 scoops of aggregate in the bag and hands it off to the Inspector
8. The Inspector either accepts or rejects the bags at his/her discretion. Accepted bags are given to the warehouse runner, rejected bags are sent to rework.
9. The warehouse runner hands the bag off to the warehouse attendant who puts the bag into finished inventory.

"You will have two (2) minutes to see how many bags of concrete you can produce. The only ones that will count toward your total will be the ones actually in the warehouse ready for shipment. Are there any questions? Good luck! Now who wants to volunteer to participate?"

RUNNING THE EXERCISE

THE FIRST PRODUCTION RUN

I try to select students who might need some help with participation. I also pick someone that I know will be animated and vocal as the Supervisor. I assign each volunteer to a specific task, after he/she has signed a payroll roster (this helps me remember who participated). I instruct the Supervisor in private to be a really Theory X kind of manager, i.e., pushy, critical, loud, etc. I instruct the Inspector in private to examine each bag carefully and occasionally to loudly reject some of the products. I instruct the remainder of the class to cluster into groups of 3 or 4 and watch the process, and then look for ways to improve it. Then, when everyone is in place, I set a timer for two minutes and begin the exercise.

As the exercise begins, I wander around at the front of the class, talking on my cell phone to imaginary customers about orders. I prod the Supervisor to keep production moving. The workers do the best that they can and usually the entire class really gets into the competition. When the timer goes off, I tell them to stop production and then have a student from the class count the bags in the warehouse. Most groups will produce between 15-20 bags on the first production run.

EVALUATING THE FIRST PRODUCTION RUN

I tell the workers to take a break (have a seat), and then we discuss what just took place. I begin with a discussion of efficiency and effectiveness. Explaining the only way we can measure these items is to establish a baseline for production and use this as a benchmark for future production runs. Effectiveness is defined as the meeting of objectives, which sometimes excludes quality, and we will then set out to establish future production quotas once benchmarks are established. Efficiency is discussed as the production of products at continually lower costs while maintaining the ratio of inputs vs. outputs. Finally, we discuss the Control function of management and why it is important for managers to understand the cost of production and the need to measure both efficiency and effectiveness.

I then determine the unit cost of all bags produced. We do this by enlisting the help of the class in determining what costs were involved in producing the concrete. I project a spreadsheet (see figure 2) on the screen and integrate "spreadsheet thinking" as I ask the students to come up with cost items to fill in the appropriate cells on the spreadsheet. You could, however, simply list the cost on the board. Keep the cost simple (for example, using $6 per hour because it works out to $0.10 per

Excel Spreadsheet for Calculating Cost
Figure 2

	Bags Produced	Bags Rejected		Unit Cost
Simulation #1	**0**	**0**		$ -
Cost Component	**Unit Cost**		**U/Meas**	**Total Cost**
Variable Cost:				Total Cost
Sand (3)		0	ounce	$ -
Aggrigate (2)		0	ounce	$ -
Portland Cement (1)		0	ounce	$ -
Bags Consumed		0	each	$ -
Sub Total:		**0**		**$ -**
Labor: (rate/hour)	Rate/Minute	**# of Workers**	**Minutes**	Totals
Workers ($6)	0.10		2	$ -
Inspector ($12)	0.20		2	$ -
Supervisor ($12)	0.20		2	$ -
Sub Total:	0.50	0.00	6	$ -
Fixed Cost:				
Admin O/H				$ -
Grand Total Cost:				$ -

minute, etc.). Take this opportunity to discuss variable costs vs. fixed costs. Usually students come up with labor cost and material cost first. I try to use the actual cost of the material. I tell the class to assume that each scoop of the ingredients is one ounce. Then I will tell them that I purchased a bag of flour and it cost X and weighs Y. I then ask them to tell me how much this is per ounce (TIP: figure your cost before class begins, just in case your class is mathematically challenged). Repeat this for all material cost, i.e., bags, sand, cement, aggregate, etc. Then, figure labor cost at ten cents per minute for workers and 20 cents per minute for the Supervisor and Inspector. Add in some Administrative overhead. This can be any amount. Use $1 or $10, it does not matter, just be consistent.

At this point, I will ask if we have missed anything. Some minor things may be suggested by students, like providing benefits for workers, and you can decide to add this or not. I consider this a part of overhead. One important cost that tends to be overlooked is the cost of producing the rejected bags. This leads to a discussion of Quality and how maintaining quality at the source can reduce operating cost.

DISCUSSION OF POSSIBLE PROCESS IMPROVEMENTS

Once the unit cost of production is established, I then ask the workers to meet together and the class groups to meet and discuss what measures could be taken in order to both improve the process and the quality of the product and, at the same time reduce unit costs. Usually, the students will pick out the obvious flaws in the production process, i.e., the long separation between supplies, the workstations, and the warehouse. So, we physically move the supplies into place near the first workstation, and then move the warehouse close to final inspection. This opens a discussion into job design and analysis. During this discussion I ask the class what other things could be done. I specifically ask about the size of the work force. Most agree that with the work process more centralized, we do not need the "Runners." I make a big deal about firing these people to initiate a discussion of Human Resource Planning.

I then ask the class if this workforce could operate as a self-directed team. We have previously discussed teams in my class, so this gives an opportunity to review and reinforce learning on this topic. It is generally agreed, and I usually insist that we fire the Supervisor. Since he was such a pain, everyone is glad to see him go. Now I turn to the new "Self-directed" team and ask them if there is anything that they would now do to improve the process. Usually there might be some small adjustment. We also establish production goals for the next run. Once those are complete, I let them proceed with the second production run.

EVALUATING THE SECOND PRODUCTION RUN

Run the production line a second time for two minutes. Once the second run is complete, unit cost is recalculated. With lower labor cost and less WIP travel time, unit cost usually goes down even while producing more bags. Quite often though, overall cost might remain the same, or even increase slightly. This, of course is due to increased use of variable cost of goods. However, unit cost will go down. This phenomenon is discussed and then I turn the discussion to "Process Improvement."

I ask the students once again to meet in their groups and try to determine if this process of making concrete can be improved. First, within the constraints of the classroom setting, and then, if they could move this into a modern plant. Let the students' imagination work here and record responses either on the board or on newsprint. Suggestions will be something like providing scoopers that are exactly the correct amount so that only one scoop is necessary for each product. This will improve the queuing at the three scoop location. This also leads to a discussion of how this "improves the process." Other suggestions might include totally automating the plant or eliminating the inspection function. TQM is now discussed and the fact that having Quality at the source of production could eliminate the additional inspection step. Another possibility for cost savings is to eliminate the warehouse operations. This leads to a discussion of "Just-in-Time" inventory/manufacturing. Finally, we discuss the possibility of eliminating any more personnel. Usually, this is rejected by the class. We are now set for the next production run.

THE THIRD AND/OR FINAL PRODUCTION RUN

Once all suggestions have been discussed and recorded, you are now ready for the third production run. Depending on time remaining, you have two options:

1) Proceed with production as previously discussed and then go through another analysis. Take the opportunity to rotate the workers to new positions and discuss Job Rotation, or even take the opportunity to change the work force and discuss the learning curve. If you have the time to do this, it will enhance the outcome and provide for more discussion material. After doing the third run, then proceed to the second option, below.

2) If time is short, then open a discussion of "Process Re-engineering." This can be demonstrated, in its most rudimentary form, by challenging the students to a little contest. Tell them that you can run this operation with just two employees and with no loss of production and with no increase in cost. Most students cannot see how this can be done. I demonstrate this by first moving two tables together. Then I ask the students, "How can we now balance the work load and eliminate bottlenecks?" Usually, someone suggests that the bags come pre-opened, thus eliminating this step. This can open up a discussion of the Value Chain and the importance of good supplier relations. Also, an automated system that could take the final product from the worker's handoff right to the distribution system (this can be simulated by having the worker literally throw the bag onto another table). Finally, I suggest that we really do have only two work stations needed, each with three scoops. One is the sand alone (three scoops) and the other is the aggregate plus the cement (two scoops plus one scoop). We now set up the production line with the sand on one table with the open bags to the left, and the cement and the aggregate on an adjacent or even the same table (literally a handoff) and the distribution table to the right. This is a good time to discuss Job enrichment and empowerment.

At this point we run the production line one last time (you will need to keep extra supplies on hand for refills). Students are usually amazed that the two people can pretty well match the work done previously, and how the unit costs have really gone down. At this point we wrap up our discussion. There is usually some discussion as to how long the two workers could keep up the pace, and when would they ask for more money since they were now doing the work of ten (10) people, or were ten (10) people doing the work of two (2)?

CONCLUSION

I have found that my students really get into this exercise. I always get comments along the lines that they have heard all of these terms before, but now they can actually see them in practice and more clearly understand their meaning. There are few moments more enjoyable than to see the "light" come on in a student's eyes and realize that this student has really, finally understood both theory and application of concepts related to research topics. Isn't that what real learning is all about?

Lastly, tidy up the classroom, time permitting. This can facilitate a discussion about whether workers should clean up their own messes or whether you should hire janitors, or should you out-source?

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