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Abstract

A focused study of the results of productivity improvements in a hand assembly area using partial productivity (human productivity) as a measurement tool (Sumanth 1994). This study describes the hand assembly area as it has evolved, and problems with material flow and productivity. It then describes the focused improvement efforts and resulting improvements. Due to limitations of available information (financial) and to the nature of the improvement effort, human productivity is the only measurement used. The company faces stiff competition from low priced foreign labor on hand assembly operations, but prefers the control gained by keeping these operations in the US, for proximity to other processes, and further development. Since this study covers only human productivity over a five month period, and there was no real change in wages or benefits during this period, no deflator was used.

Description of the Environment

This production area is a complex assembly area dedicated to a single product line. The process has nine (9) to sixteen (16) operations, several with multiple stations, and the product has three major variations. Some elements of the production line are automated, but most are hand assembly. The assembly process is as follows:

1. B-Block manufacture. This component is produced on an automated machine. (two stations)
2. B-Block insertion
3. Cut and form Array
5. Array Insertion in PCB (2 stations)
6. Load pallets for Wave Solder (2 stations)
7. Wave Solder. This is an automated operation.
8. PCB separation
9. Print housing (2 stations)
10. Assemble PCB to housing (3 stations)
11. Test (4 stations)
12. Top Shield Assembly (4stations)
13. Bottom Shield Assembly (4stations)
14. Bag
15. Pack

The assembly process may run any one of the three products, (shielded, unshielded, or universal), or it may run any two of the products simultaneously. The line generally is staffed by twenty one people. Where there are multiple stations, they may or may not be manned depending on workload and attendance. It was noted that the flow of work in this area was chaotic, and the workload was uneven. Productivity improvements were also desired for competitive reasons.

The Improvement Process

The improvement tool used is known as standard operations (Shingo, 1982 and Ohno and Mito, 1986). Its objectives are as follows:

- Regulate production to match customer demand.
- Establish standard WIP quantities
- Balance line
- Improve workflow
- Pace production
- Improve flexibility
- Employee involvement in the improvement process and control over adjustments.

The goal of standard operations is 100% labor productivity. Since the time required for different operations usually varies greatly, and we tend to give each worker one operation, the workload is usually greatly uneven. Labor productivity is improved by giving some workers multiple operations and balancing the workload (in terms of time).

One key to standard operations is synchronizing production to TAKT time rather than worker cycle time for all operations. TAKT time is defined as <u>Total daily operating time</u> over <u>Total daily requirement</u> (customer requirements). Total daily operating time is usually further reduced to shift time. Worker cycle time is the total time required for a batch of product to complete one cycle of the process, including walking, load/unload, inspect, and etc. This is the time to make one complete piece in the one piece flow system, or to complete all of the operations in for one unit of the standard quantity in a batch system. If it takes one worker 30 minutes to run a standard quantity through all operations, that is the cycle time. The number of required workers is obtained by dividing worker cycle time by TAKT time. If worker cycle time is 30 minutes, and there are 7.5 available hours on the shift, and customer requirement is 15 standard units per shift, only one worker is required for the process. If customer requirement is 30 standard units per shift, two workers are required and the work is redistributed, and so on. These two measurements are synchronized by adjusting the number of workers, and redividing the labor. This gives us our desired flexibility.

In our case, we used a twenty four hour day, and our customer requirements were 59,000 pieces per day. Dividing the total time in seconds by the demand, we get a TAKT time of 1.464. Our worker cycle time was measured at 23 seconds. Dividing this by the TAKT time yields the required number of workers needed to meet customer demand. The number derived from this formula is 15.7. We therefore staffed the process with 16 workers.

Standard Work In Process quantities are determined by the minimum number of on-hand parts for a worker to complete a work sequence. In our case, it is determined by standard tote quantities, since one piece flow is not practical due to batch requirements of automated operations.

The improvement process begins with a meeting of all employees involved in the assembly process. The standard operations methodology is explained, and workers are assured that they will have final say over the times used, and workplace configuration. They are also assured that no one will lose a job as a result of improvements. All operations are then timed, including time for movement, inspection etc.

On the floor, workers are timed and the sequence of operations is documented, noting which operations must be sequential, and which operations may be simultaneous.

Back in the conference room, the workers examine this information. The first focus is to remove unnecessary movement, and creating a flow that will allow one worker to do multiple operations. This usually results in a new layout. Then the desired cycle time is calculated based on customer demand. Operations are then combined, so that the workload for each person is roughly equal. This may require additional training so that every worker is capable of doing every job. A pacing board is then developed that will be updated hourly by the workers indicating actual hourly production. This number can be readily compared by the workers to the hourly requirement which is adjusted each shift as necessary by supervision. If the requirement changes, workers are added or shifted elsewhere, and the work is redistributed. It is important to note that the focus of this exercise is not speeding up the individual operations, but eliminating the waste that occurs between operations.

Since the results of this improvement effort will effect the human productivity element, and will not effect material, capital, energy or other productivity factors, we will use only the partial productivity measurement for human productivity. Also, since we are seeking Work In Process (WIP) quantities as near a one piece flow as possible, WIP is not significant, and is not counted in output.

Results

This improvement event was held in June. Human productivity has steadily increased since then, with the exception of October (see figures 1 & 2). Data for October was contaminated by a significant change in labor reporting. The event resulted in a new layout for this production area. The old layout (figure 3) shows the lack of any planning or logic for workflow. The new layout (figure 4) greatly reduced the amount of material movement required. The U shaped cell allows for flexibility in assignment of workers to operations as customer demand fluctuates. The pacer board has been maintained and utilized well on first shift, although it has not been utilized as well on the off shifts. This is attributed to the fact that the first shift was more involved in the changes, and thus feels more ownership. The workforce required for this production

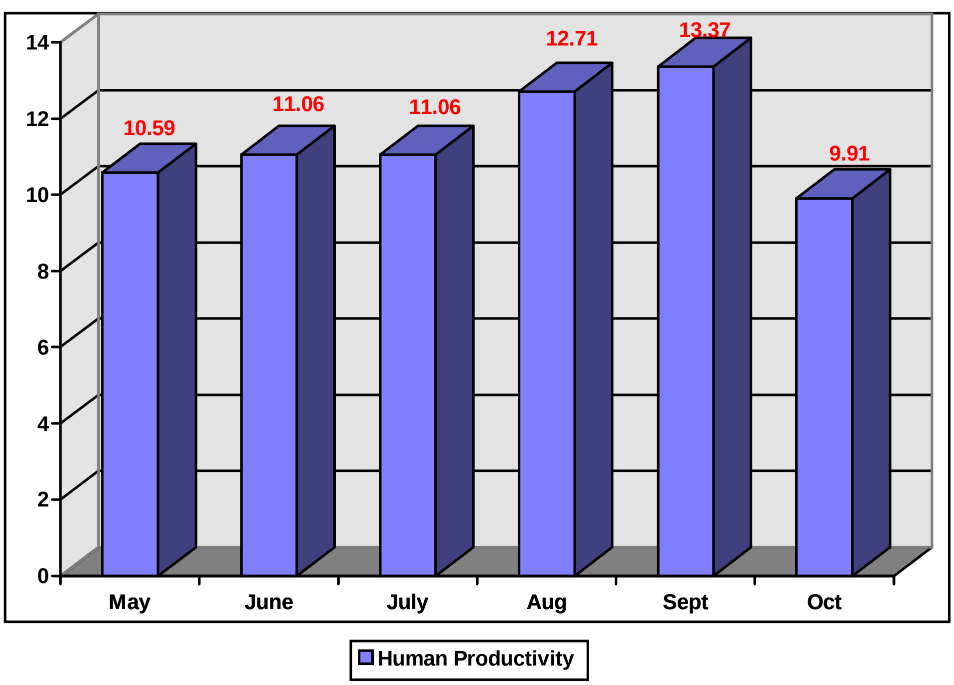

Figure 1. Human Productivity
Note: October measurement is contaminated due to changes in labor reporting.

	Cost of Labor	Total Output.	Human Productivity
May	$134,962	$1,429,690	10.59
June	$134,057	$1,482,934	11.06
July	$131,638	$1,456,175	11.06
August	$133,000	$1,691,634	12.71
September	$138,000	$1,845,328	13.37
October	$157,211	$1,558,469	9.91

Figure 2. Human Productivity data

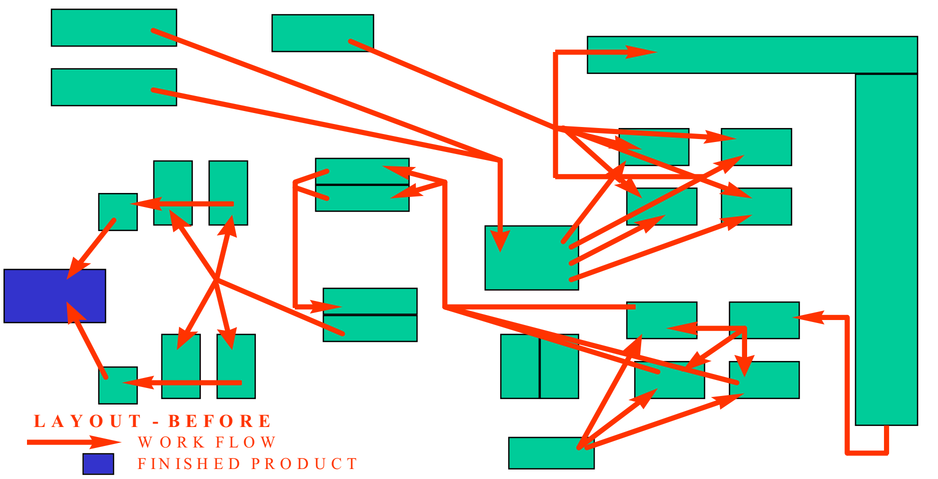

Figure 3. Layout (before improvement)

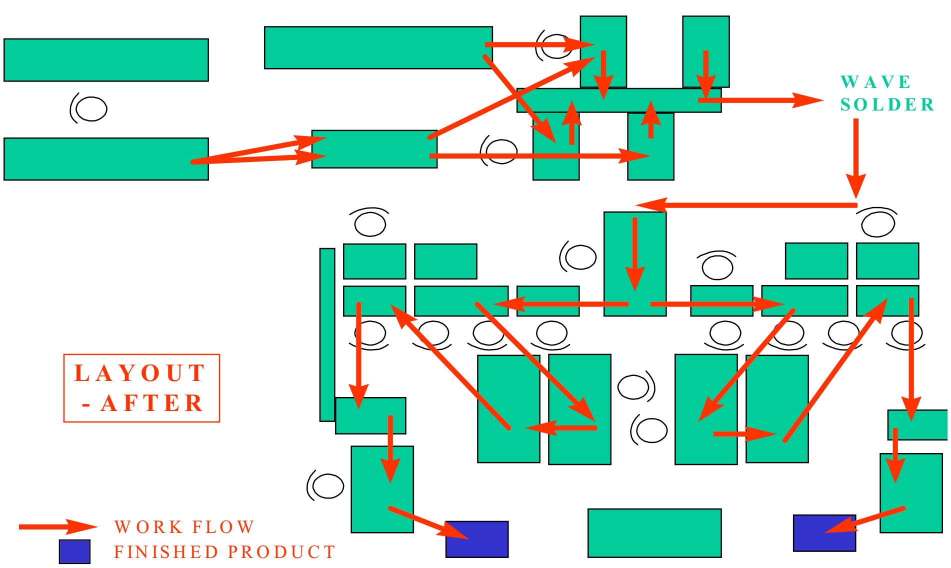

Figure 4. Layout (after improvement)

line has been reduced from an average of twenty-one workers in May to sixteen presently, while the workload has increased approximately 20%. It should be noted, that no workers were let go as a result of this improvement effort. Excess workers were reassigned to other areas. Since sales are growing in nearly all areas, it is easy to assimilate these workers, and still realize the benefit of the productivity gains. The gains simply lessen the number of new workers that we will need to hire. Additionally, if the productivity gains allow us to be more competitive, we will get more business, so there is still a need to expand the workforce. This improvement process has since been implemented on two other lines. Results of these efforts are not yet available. Application of this process to more hand assembly areas is planned.

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