CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Since the current deflection yoke process has not been set the standard time and its work elements have not been assigned to workstations appropriately, bottlenecks are occurred in the process that results in low line efficiency and productivity. Additionally, because the machines and some operations in the current process are located inappropriately, non-value-added movement occurred in the process. To solve the problems, the new system is developed based on the required capacity to improve assembly line efficiency and productivity. In addition, the new layouts are designed and proposed in order to be the alternatives for the company to make decision for implementation in the future.

The study starts from analysis of operation improvement, especially bottleneck operation. After the operations are improved, standard operation and time are set, new workstations are designed based on the required capacity by using assembly line balancing technique, and manpower is appropriately allocated into the new system.

After implementing the new system, the supply method of inspection (bottleneck) operation is changed which results in 10% reduction of its standard time. The equipment in subassembly operation is relocated which results in 19% its productivity improvement. In implementing the new assembly line balancing, the bottleneck problems are eliminated which results in average 12% line efficiency improvement and 15.5% productivity improvement in the assembly line.

For improving inspection operation, the bigger batch of the same characteristic DYs is provided to inspection workstations so that an inspector can use the first DY to be the guideline to inspection all the rest. After implementing the new system, inspection time reduced 10% in case of inspection DY for external customer and 16.7% in case of inspection DY for ITC. The current inspection manpower is relocated based on the improved inspection time that results in reducing cycle time of inspection DY for external customer from 18.33 sec to 14.4 sec. Consequently, the bottleneck problem due to inspection DY for external customer is eliminated. Finally, although new supply method relieves DY characteristic fluctuation that results in inspection time reduction, the problem of high inspection time seems to not be eliminated. Because the root cause of high inspection problem comes from ineffective coil winding operation, then, continuously controlling the machine to wind the coil to meet the specification should be the long term improvement which is discussed later in recommendation for improvement section.

For improving subassembly operation, all equipment in subassembly process is relocated in order to reduce unnecessary movement and all subassembly operators are assigned to work by using one-piece-flow concept that an operator does all operations in subassembly process. This concept eliminates line-balancing problem and allows all operators to do the tasks without idle or exceeds. After implementing the new system, the real non added value movements and idle time are reduced that results in 19% its productivity improvement.

After operation improvements are accomplished, all work elements are assigned into new workstations by using the assembly line balancing technique. According to required output 10,000 units per day, the cycle time is determined as 15.12 sec. All work elements in the assembly lines are assigned into each workstation until sum of the task time is equal to the cycle time, or no other tasks are feasible because of time or sequence restrictions. The balancing solution can be summarized as follows:

- **For all DY product types**
    - Assign the assembly tasks from separator assembling to soldering operation one by one to the workstations.

- Assign heat shrinking tube operation to withstand voltage checking workstation when produce DY assembled with terminal board & leads.
- Split inspection task 7 workstations when inspect DY for customer and 4 workstations when inspect DY for ITC

- **For specific DY product types**
  - Share bonding operation in packing operation when produce DY size 14"
  - Assign two magnet attaching task to withstand voltage checking workstation in case of producing DY 20" which is assembled with terminal board.
  - Assign one magnet attaching task to withstand voltage checking workstation and the other one magnet attaching task to inspection workstation in case of producing DY 20" which is assembled with terminal board & leads

After implementing the new system, average 12% line efficiency improvement derived from new balancing. To achieve output 10,000 piece DY/ day, although one more operators per shift are required to attach magnet in case of producing DY size21", the daily outputs increase with the rate higher than that of the manpower. So, it results in 15.5% productivity improvement of assembly line.

To propose new deflection yoke layout, the new layouts are redesigned and evaluated their effectiveness by using both quantitative and qualitative approaches. The advantage and disadvantage of each proposed layout are also compared in order to help the company to make decision for implementation the proper layout to suit to specific situation in the future. There are three alternative layouts designed to best fit for specific situations that can be summarized as follows:

Layout I is the process layout design. All processes are designed to eliminate all wasted aisle spaces and use only the essential space required by manufacturing areas. The advantages are that maximizing space utilization, low material handling by providing easier access of the materials and sub products to the next processes and also high flexibility and easier to handle breakdowns of equipment by transferring work to another machine or station. The disadvantages are that difficulties to capacity expansion, congestion between the processes, making supervision control the process harder, and having the possibility to face the problem of low product quality due to h-coil shape deforming.

Layout II is also designed as the process layout, but reduce level of congestion and increase the potential for capacity expansion. The advantages are that high flexibility and future expansion, better working condition because the machines are located in the position that allow the operator to work with the machines with only 90° body rotation, and reducing number of accident, scrap and spoilage due to difficult handling situations. However, the disadvantage is that still having the possibility to face the problem of low product quality due to h-coil shape deforming.

Layout III is the product layout design to respond demand that has large volume of production over a considerable period of time. The advantages are that minimizing operator manual material handling, decreasing scrap and spoilage due to difficult handling situations, low total production lead time, low work-in-process that result in high h-coil quality, simplicity of production control by providing smooth flow, and better working condition by eliminating congestion. However, the disadvantages are that low flexibility and high capital investment and may need some duplication of equipment.

Finally, the evaluation of the proposed layouts can be summarized as follows:

The proposed layouts	Layout#1	Layout#2	Layout#3
Range of capacity expanding (units/day)	8,000-10,000	10,000-13,000	10,000-13,000
Payback period	0.4 year	0.78 year	3.7 years
% Handling man-hours saving	65%	51%	99%
% Area saving	22.22%	12.35%	0.00%
The factor analysis rating	130	169	183

In summary, there is no good plant layout can achieve all the advantages. The alternative layouts will be best fit to different situations at specific period of time.

Recommendations for Improvement

For inspection process, continuously controlling the machine to wind the coil to meet the specification should be the long term improvement which benefit not only high product quality, but also ease for inspection that result inspection time minimization. The cause and effect diagram can be used to find the root cause of the problem. Additionally, SPC can be used to control the process, evaluate the process capability and also identify the suitable area needed to improve the quality of product to meet the specification more effectively.

Because subassembly operators are required to perform all tasks in the subassembly process, and some assembly operators are required to share in the tasks of adjacent operation. Multi skill training should be considered so that the operators can do the tasks efficiently and can also be rotated to work in other workstation without skill constraint.

The new process layouts proposed in this thesis are designed in order to reduce materials handling, increase effective space utilization, improve quality of the product, expand capacity, and so on. The design is based on the realistic constraint and the concept is that review the current layout, and then trying to relocate the machine and equipment to improve the effectiveness of layout. The disadvantage of this method is that the optimum solution cannot be solved. To improve the solution, some tools such as traveling chart should be used to analyze and layout design improvement.