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CELL DESIGN MITIGATING WASTE

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ABSTRACT

The strategy for the factory with a future is the use of integrated manufacturing production systems (IMPSs). This strategy is based on L-CMS (linked-cell manufacturing system). In modern manufacturing environment, linked-cell manufacturing system (L-CMS) is greater importance in batch-type production and job shop to make economic advantage to mass production. This system provides for the continuous flow or smooth movement of parts through the plant.This study considers machine grouping problems in cell load variation and cellular movement by using a mathematical model and other type of manufacturing control such as automate and robotize and etc. manufacturing is the economic term of the making good and services attainable to gladden human needs. The manufacturing processes are incorporation to type of a manufacturing system. The production system comport the manufacturing system and services the manufacturing.

INTRODUCTION

In modern manufacturing environment is organize by marketing, shorter product life cycles, fast move, fast changing customer parts needs and large product variety.This used to preempt a competitive response and use the better of efficient resource utilization. This idea open into the picture themethod of link-cell manufacturing system (L-CMS) which has received attention of researchers to providing a cell formation technique such as maximization the output and maximum extent with minimization of cost and also to control of the production process.Link-cell manufacturing system (L-CMS) act as an agreement between job shop production and flow line production. Those are resulting of direct application of group technology philosophy. In that group technology, parts have similar processing such as tools, routes, machines and geometrical shapes can be classified into part families.Machine cells comport of functionally different machine types by using each machine cell processes with one or more parts families.By reorganization of functional shop processes can find the many benefits such as decrease in production setup and manufacturing time, labor of process inventories, material handling and production costs as well as improvements in machine operation.The cell manufacturing system (CMS) is a complete production of part by using the several strategy, and are focus on production control,

machine maintenance, computerization and automation of production to solve the problem and solve the waste of production to complete a machining of part. [4]The first strategy to use is a creating cell that means a group of processes designed to make a flexible way in family of parts. This strategy helping to run more than one process at the time, and the worker can run different type of process in cells.The second strategy can be use is the rapid exchange of dies and tooling or resolve or decrease of setup of the parts. This is the important point of manufacturing process to minimize the cost, reduce time of complete finish machining time, fast moving production part to the cell. This is rated system to control the manufacturing cell in production process of a part.Next strategy to use the identify maintenance and machine dependability in the production process. This is provide reducing setup time and reduce the speed of equipment and also run the process at close to full capacity.Level and balance is next strategy to look at the manufacturing process control. This can be help to organize the lots of production of parts.That means cut the big lots of the produce to some small lots with the same amounts.Kanban is the complete production control link in the cell as a next usable strategy is to control of the production process. This is structure of the layout of the manufacturing system show that

parts how can run the through the plant.The next strategy can be use the integration of inventory control into the manufacturing system this is systematically minimize lot sizes and WPI (work-in-process). The worker on the floor automatically controlling the inventory levels in their work area. Know time to check the integrated manufacturing production system (IMPS) of the company to create low cost, and fast delivery manufacturing system. This is point of manufacturing system to move the parts smoothly from start to finishing the parts and make sure the system working fast and smooth in the manufacturing cells. The Automate and Robotize the manufacturing system is the next thing to solve the manufacturing problems. This is great idea to run the manufacturing process and minimize the error of the parts, also fast running with best quality of the part. These are show the high quality of the part to short time of production and can be lower cost of product. With this type of production system can be minimize clamping, loading, unloading, inspection and setup and moves faster of the other manufacturing system.

First Creating Cell

Creating cell can be first thing need to find and solving the possible problem. This is important to know what the production control is running to complete the machining of the part. In the cell they are running the family of the parts in flexible way that means if they need run some different operation to a part with the couple different machine. [6] They need to make sure all machine is set in close as possible and put on one cell. That is helping to run the different operation with the less worker and minimize the parts movement between those operations. Save time and cost of the parts. The figure 1 show the set of the cell for one family of the parts and how to run the operation of a part in the cell.
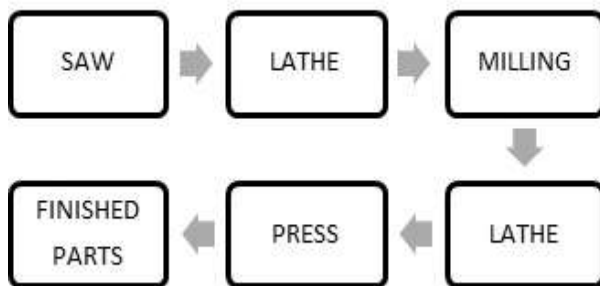

Figure 1. Show one cell and how to run operation of the parts.

That is very important how we need run the parts and how many operation we need to runs. In depend on operation we can find the set of the machine in the cell. The figure 2 this is a good example to find the different set of machine in a cell. In this operation we chose the shorter move of part in to the cell.
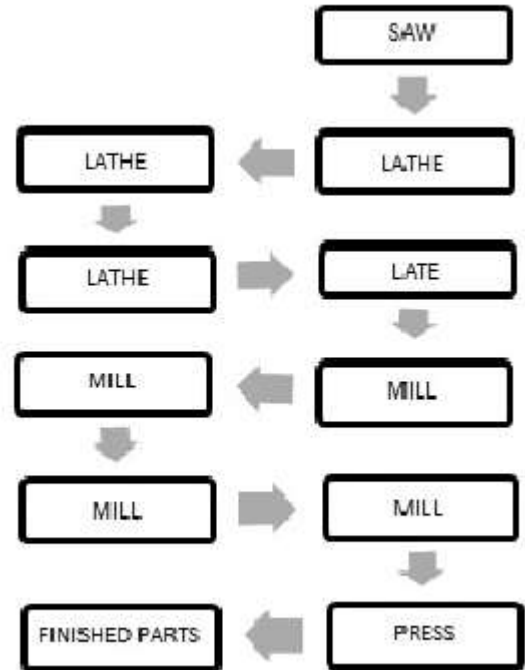

Figure 2. Show more cell to run the family of the parts.

By look at the figure 1 and figure 2 can find the how much is important to make the good processing and how they created the cell to run the part in production. That depend on parts family they need to figure how to design the cell to make sure parts moving short distance and less operator to run less cost and less time to make a production in the floor.

SetupCost

That is very important to minimize the time of the work at any possible operation to reduce of part cost in manufacturing production. One of strategy can using SMED (single-minute exchange of dies). In SMED system they use four stage to complete the setup time with reduce of the time. In figure 3 show the four stage of SMED system the first was preliminary step this time start to run current method is study and analyze. Stage second start internal and external setup separation. Stage third converting internal and external setup.In stage fourth all examined and adjustment of setup are eliminated. These four stage help us to make sure we have

minimum of time for setup, fast production, fast tool change and etc. After this four stage machine and operator ready to start the production and make parts.
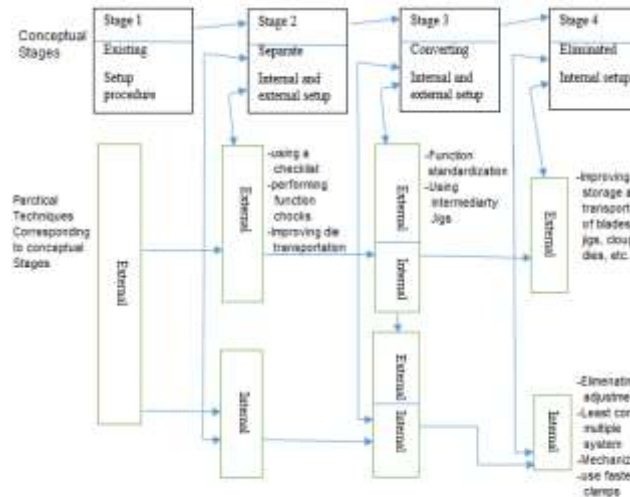

Figure 3: SMED conceptual stages and practical techniques.

The SMED system works for any process, themethod example of the dies setup is shown above. The next problem solving is milling process. In this type of machining they usesame method and have four different phases. The figure 4 shows classified of SMED system. In this type of work process we have some different point to look at such as tool change time, fixture or vises (part holder to the machine), time of load a part to machining and unload the finish machining part, cleaning fixture or vises after and before loading a part and etc.
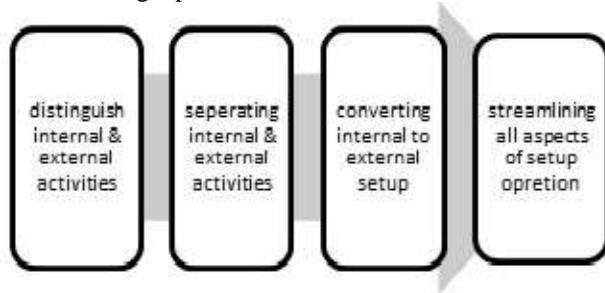

Figure 4: SMED classified into four different stages.

The internal activity is:[1]

1. Unloading good part.
2. Removing chuck from bed.
3. Lifting for stand loading and unloading of part.
4. Cleaning.

5. Measuring and adjusting chuck to part size.
6. Loading.
7. Setup time (component dialing and reference).

The external activity is:

8. Waiting for crane.
9. Waiting for cutting tools and drawings.
10. Searching for clamps and do clamping. [1]

Those are identifying setup activities in milling process and need to minimize time as short as possible. Some times by using quick change fixture can be minimize the load and unload the fixture to the machine. And can be use the two or three or more ready fixture reduce the part loading/ unloading and save more time and less waste of time to change of part. The figure 5 show the type of quick change fixture.
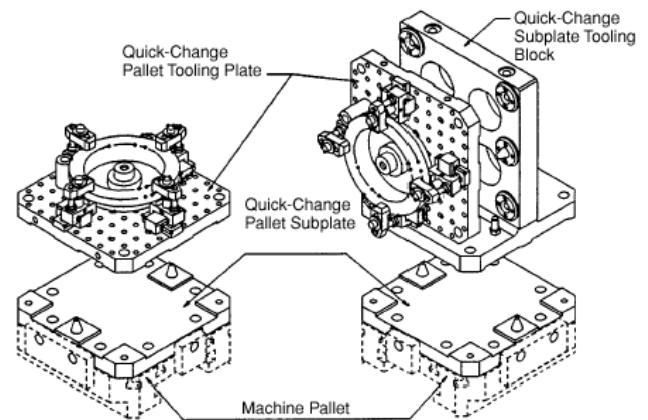http://industrialcontrol.carrlane.net

Figure 5: Show the type of quick change fixture.

With this type of fixture can reduce the loading and unloading and cleaning between them. That is more time saving and less cost of the other type of fixture. They need reduce the setup time before starting production and less cost on part operation too. Other thing is should be help to minimize of cost in production is training the operator and showing them how they can use and work with this type of technology. By using the better tool and correct option of tool can be reduce of setup time and finally less cost of setup time.

Maintenance and Machine Dependability
The maintenance program can be fixed by giving operator training and tools to suitable maintain material. Operator by doing that strategy can be

reduce the speed of equipment and also run the production at less than full capacity. [1] This is best strategy because have a place for everything as needed and put those thing in correct place so tools is ready to use at next time. And also each operator have responsible for the cleaning of the workplace and the equipment. With IPM (integrated preventive maintenance), worker are need to became more informed of the behavior of their equipment. Scheduling PM (preventive maintenance) is time to use in start and ends of each shift to repair and maintenance. This is helping operator to more familiar with the equipment and run the process are in better control with IPM's machine and also tool records. That improved the flexibility, reliability, safety, and production capability. This is one of the medium strategy to use in manufacturing process to make sure all tools and machine working properly and always ready to use. By this strategy can reduce time to find the tool and also working safety.The point of maintenance program is to make sure all machines and operators can working correctly and don't have any problem. But if they find any problem such as machine or tools can be fix soon as possible. The other thing is use machine dependability by this thing can use a machine with some different parts. This is help to minimize the setup time and reduce the speed of equipment and also run a process at close to full capacity. Finally can say by maintenance program and machine dependability can reduce the cast of the production by make sure machine run good and also fast change the pert as you customer wishes. There are good point of the manufacturing systems use on production times.

Level and Balance

The cycle time (CT) is also one of the important part of the IMPS (manufacturing production systems). That can be helping to organize the lots of production of parts. we have many different of customers working for hem and each one have own lots of parts for that risen we cannot run one big lots, and forget the other customer parts. The best idea is making the small and equal lots from big lot and make the better responsibility to all customer. [1] [2] The other benefit to use the small lot is easy to move the parts in to the floor and also easy to control the part too. That was best idea can be use and safe the time to find the where are the part and how many need to machining and how many was finished parts. We have many point to look at and make the fast production. One of the important point is minimize the time. That can be saving the time by using U-shape design. With this design they need to make

place of between machines closely as possible that is help to move the material between machines (move to next operation of part). In cells use the small simply of equipment can fix the time between machining time on the cells. The figure 6 show the U-shape design. This is a rule of working for family of parts first one small lot can be run and then change to other same lot of parts family's.For example if we have family of parts such as part A and part B, first need to run small lot the part A and then change to run same small lot of the part B.
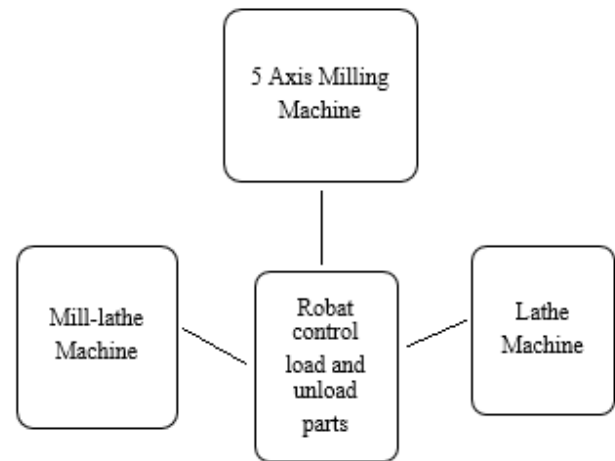

Figure 6. U-shaped milling and lath cells.

There is show the how can make cell of the milling or lathe in machining area. That can be run by the one operator or robot. It is minimize the person to run the part by different operation on that part. That is very useful strategy using on the cell and can be helpful to run the family of the part fast, easy to control, minimize the time moving the part from one operation to other and also minimize to use the operator (that mines one operator can be run two or three or more machine). Minimize to setup the machine because same time can be setup the two or three or more machine and ready to run all machine.Other helpful strategy is worker location, in this strategy we have internal customer. The next operator is the customer, that miens if we have first operator A and then move to operator B and also go to operator C. the operator C is a customer of the operator B and also operator b is the customer of the operator A. that is very important principle of the integrated manufacturing production system (IMPS). The balancing is a best idea to control the production of the part in each cells. That is helpful to make faster production with run the long cycle before run the shorter cycle. Or we can run two or more short cycle of operation with one machine (depend on the

machine such as plat change or have large plat to put the fixtures on). By this type of control can minimize the wait time between two operations and can run the production in the cells.The SOR (standard operations routine are design to use the minimum number of operator in the production line. This is make the one operator can run the two or more machine same time. for example in figure 6 show the one robot can be programing to run the three machine such as two lath and one milling machine same time. By using this kind of technology can be minimize in cast of the part and save lots of many in production.When balancing and leveling are apply to the integration manufacturing production system (IMPS) cell, they regular and can be minimize the labor amount. Those are important point in cast of a part in manufacturing systems. Cycle time is the important point of the manufacturing systems because by reduce the cycle time we can minimize the cost of part and finally reduce the labor content, but other ways by increase the cycle time can be maximize the cost of part and also increase the labor amount and the finally lose the production of the parts. Because one of the customer point is the less pay of the part, know important to manufacturing the parts are working to minimize the cost of material and tools and time of the production and also worker. They need to reduce of those thing and at the finally minimize the cost of productions to keep the customer happy. But for internal customer is cycle time very important because they don't like to longer wait for a part.

KANBAN

In production control (PC) one of the important point is the worker in the manufacturing system to know where part or material is to moving, how many items are needed, and where it is needed and when material is to be ready. To control the manufacturing system, can use the PC (production control). This department use special document that called a traveler or rout sheet, that is showing where the parts go in to manufacturing system and what process are to be done on the parts when those parts there. The material requirement planning (MRP) methodology is the amount of material moving to the manufacturing system. By this system (MRP) can be use the economic order quantity calculation to build quantities of parts in the manufacturing system. The integrated manufacturing production system (IMPS) use a pull system for inventory and production control, they call Kanban system.The Kanban systemis a manual methods of harmony control to inventory and production quantities during the plant. [2]That is working best with the L-CMS, because the

CMS before using Kanban system was carry out to make the manufacturing system hungry and lean. The health and clean of the manufacturing system can be proved by minimizing waste. Kanban is a method of inventory control and production information management, designed to carry out JIT (just-in-time) target. That is best idea to use Kanban in to manufacturing system. That is generally Kanban means "card." Many American company are using dual-card and also single-card Kanban in our systems. In dual-card Kanban system, the matchless characteristic is that control information moves in the inverse direction of parts movement. That means, upstream production rates directly controlled by downstream elements. A Kanban always is a rectangular card with a plastic bag attached to the container of materials. Any containers are design for one group of parts and hole small size of that parts number. There is two kind of Kanban cards are using one is the POK (production ordering Kanban) that is upstream cell, and second is a WLK (withdrawal Kanban) that serves to processes. [3] [2]Thetype and the number of a part amount that a downstream process can be withdraw from upstream process is specifies of a WLK. For example the figure 7 show the WLK card. The type and a number of the parts in the process or next cell must manufacture is specifies of a POK. For example the figure 8 is show the POK card.

Figure 7: An example of WLK (withdrawal Kanban).

Figure 8: An example of POK (production ordering Kanban

The best thing about this system is visual and very simple and also very easy to use by an operator. The worker trustto use this system. For example if parts withdrawn from lots of 200 in container of 10. This process start from outside production to make the forging, then move to machining cell, next check the finishing part and then assembly at the final check the final assembly and send the part assembly to the customer. To run this production Kanban system is very use full. The figure 9 show the how we can work on this system. To run this process first we make the lots size to move the parts easy and more control on it, at this time make sure have a Kanban system size for example container or lot size is 10 parts. And then Kanban size is 20 lots. The more control of this parts we give the any single part one Kanban to make sure they can control part by part, with this control can be find the how many and when be complete finish the customer order with minimize the waste of parts and materials.
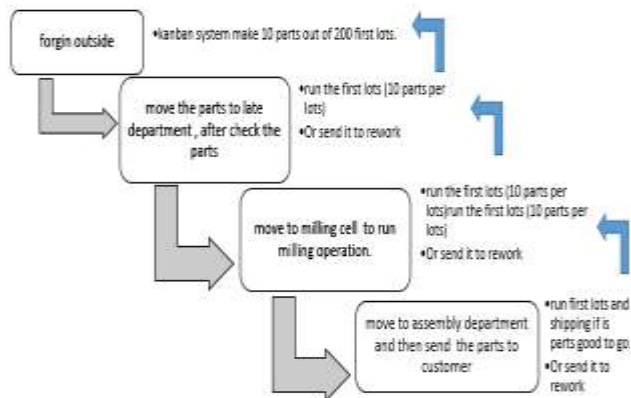

Figure 9: Show how Kanban works in the machining system.

The Kanban system is one of the help full system to easy control of the movement of a part in to the integrated manufacturing production system (IMPS). The figure 10 show the how inventory work with WLK and POK in Kanban systems.

With this system can find the any problem in the manufacturing system very faster than other systems and should be start to fix that problem soon as possible.   That is very easy to use and training the operator to use Kanban system. Today many of American company use this Kanban system in our work place. And also they have power full system to control the JIT (just in time) with the using Kanban system.
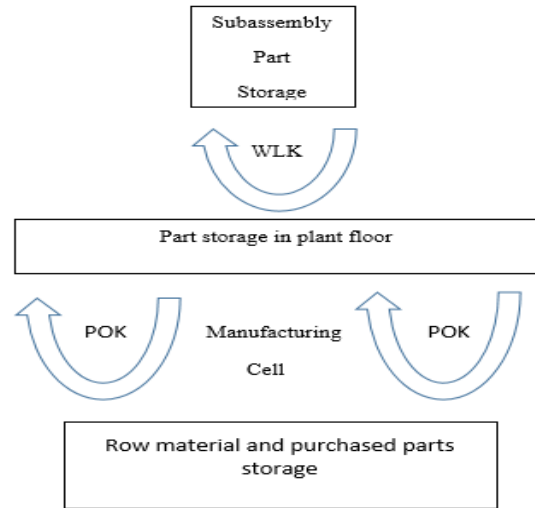

Figure 10: The final assembly area with Kanban inventory system.

Integration of Inventory Control

This is one of the powerful deduction offered by Shingo (1981), which is famous named "rocks in the river". The rocks in this analogy are equated to problems, and the river are equated to material (inventory) moving through the plant. The important point is the level of a river is equal to the WIP (work in process), that inventory flows through the plan (factory). [1] [7] Figure 11 and 12 show the level of inventory using the rocks in the river.Figure 11show the high level of WIPinventory covers of all problems such as poor quality, long setup time, machine tool breakdowns, shortages of parts, and many other defect in production system or manufacturing system. This inventory are waste full and carry is too expensive. The high level of WIP will not low cost and high quality of manufacturing controlled and that is not good idea to use in manufacturing system. Figure 12 show the low level of WIP (work in process), this is Exposes problems in the cells and make all cells even. With this ideas, they have better control on the process of the parts.
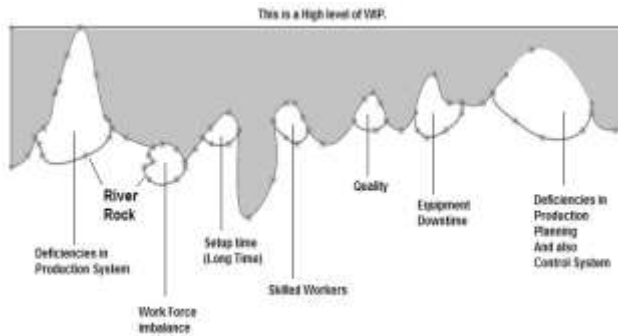
Figure 11: High level of inventory uncovers the problems.

Figure 12: Lowering the level of inventory uncovers the problems.

Problem and traditional solution in the workplace can be listed below.
Problem in the workplace (rocks in the river) [1]
➢ Machine failures (wait for repair)
➢ Bad raw material (poor incoming quality)
➢ Tool failure (fractured, worn, missing)
➢ Working absent or late
➢ Changeover from one part to another
➢ waiting for parts
➢ Waiting for materials
➢ Waiting for inspector/setup/or maintenance person

Typical Western (USA) solution
➢ Lots of inventory and buffer stock
➢ Backup machines or material-handling equipment.
➢ Super machines (large and expensive automation)
➢ Extra tools and materials
➢ Extra repair parts
➢ Extra worker (expediters and dispatchers)
➢ Elaborate information systems (computerized)
➢ Robotize and automate (expensive) [1]

Those are example of some problem and solution in the workplace that can be find during of inventory control. This is so important to solve all problem to minimize cost of the part.

Check IMPS
In IMPS they have some important point such as lot sizes, inventory level, lead time, and long term improvement. This point of manufacturing system are control by the lowest possible cost, delivery on time, and run the production in flexibility In flexibility means the system can be change in demand without any problem and fast as possible. [5]They have some deferent system to use such as the first case in the production, mix of the some operation as possible or minimize the operation. For example use the four axis CNC milling instead of three axis CNC milling. If we have one cube and that have some hole or shape in side and top of the cube. Figure 12 show the finish cube machining. If we run this part by three axis CNC milling, of course need some more operation to finish a machining of any side of the cube. Because any operation can finished the one side of a cube and also for any operation need one setup times. That is more cost to finish all side of the cube. But if use the four axis machine we can finish a cube by one or two operation. That means minimize the setup time and also fast operation to complete cube machining. Also we can use the five axis CNC milling to more minimize the machine operation.

Figure 13: Show the finished machining of a cube can be run by 3, 4 and 5 axis CNC machine.

The second case is use the small and short term conversion in the daily production loads, however the monthly complete load remains the same amount. Just the frequency of Kanban movement will decrease or increase. The actual number of Kanban tends can be fix despite the conversion in demand. For example if one part need two or more different

operation with three, four, or five axis CNC machine. That is important to minimize to change the daily production load. By use the small lots of the parts and run one or two different operation of that part in daily production load, we can minimize the waste the time to complete that part in monthly total loads. Figure 13 show how to minimize the production loading. That part have four operation to run this production is good to use the 10 part per lots and can be finished the two operation per day.
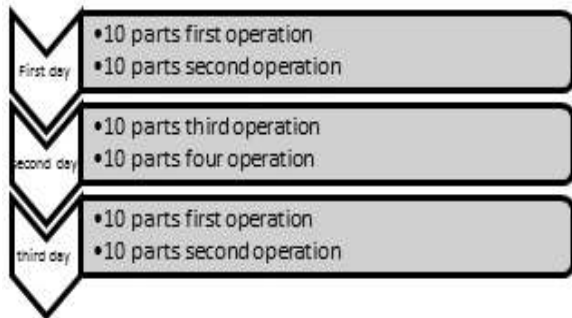

Figure 14: Show how to minimize the production load.

By using this rules they can minimize the waste time on load the different operation on same part. That is important to less cost in the production.The next case is change in demand or decreases and increases in actual monthly demand. The actual number of Kanban in system can be decreased or increased, and can be rearranged the production lines. [4] They can rearranged by change the cycle time and also minimize the operator (worker) in the system. For example if they run the part by couple different operation with different machining such as four milling, four lathe and one press machine. To run those machine they need to used one operator per machine, and waste the time to use the many of machine to load and unload and run time per machine. To minimize the worker can be put the machine closes to each other and run two or more machine with one worker. And to minimize the machine time, they can use the flexible machine such as mill-lath machine. That can be help to use one machine run andtaken out of the two different machines (one lathe machine and one milling machine) from the cell.By using this idea they can minimize the worker too. And also use those two machine to other stuff. The figure 14 show the first idea to use machine in the cell. They use the one saw, four lathe, four milling and one press machine in the cell. In this cell can be minimize the worker by run the two or more machine. But in figure 15 limited the

lath and milling by used the mill-lathe machine. With this idea can minimize the worker and setup time and load and unload time too.
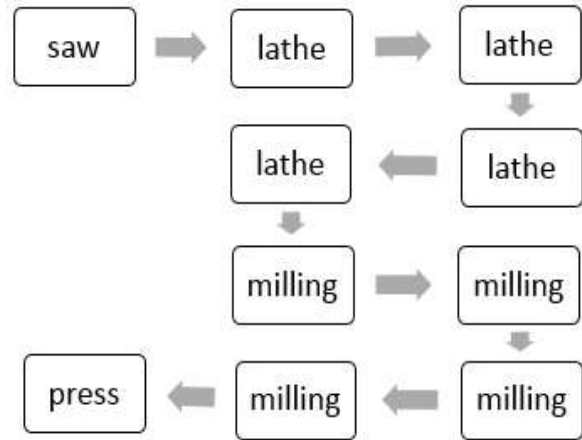

Figure 15: Show first idea using in cell.

There is important to know how to minimize the time and worker in the manufacturing process. If they use the less worker make sure one operator can be run two or more machine with the same time or close as runwith the more workers, other ways they lose a time. By add a machine and minimize two machine or more, they can lose waste of time and run the production faster and easier than before. Save more time, less worker, fast production also other side is less cost, JIT produce.
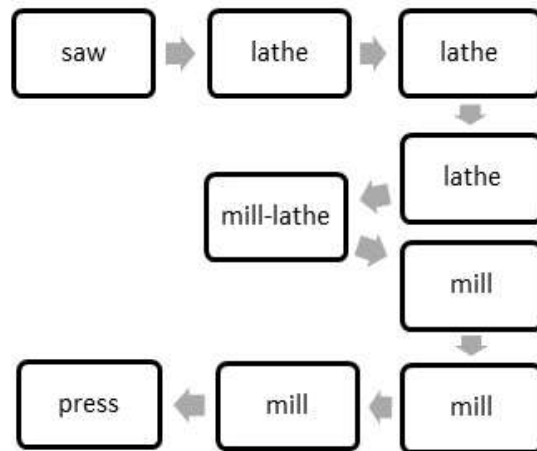

Figure 16: Show how to minimize the machine in the cell.

By using those strategy can minimize the cost of the production. And fast moving through the manufacturing system. Make the part JIT (just in time) and sanded to customer soon as possible. Those

are important to save a job and expend the less money and more save it.

The Automation and Robotize

The world automation is started around 1950, which mean to material handling use the automatic system. From the 1950 until today, they change many of automatic system such as CNC machine using the cart reader until now using G codes and M codes to control the machine, and also use the robotic control too. By use the automation system the work place coming more controlled and can be made better of the parts, because automatic control of a machine can be work repeatability that means makes all parts same thing. This is help us to minimize the human mistake and make more good part at all. The automation also make the high quality, fast produce of a part, smooth to move the material in the manufacturing system, minimize the error.

Conclusion

The strategy for the factory with a future is the use of integrated manufacturing production systems (IMPSs). This strategy is based on L-CMS. In modern manufacturing environment, L-CMS is greater importance in batch-Type production and job shop to make economy advantage to mass production. By use this system can provides for the continuous flow or smooth movement of parts through the plant. This ideas open the picture into the method of link-cell manufacturing system, which has received more attention of researchers to providing a cell formation technique.We can control the cell by using the L-CMS by researching nine strategy into the cell. This are started by a creating cell, and then use the rapid exchange or minimize the setup time and load and unload the parts. Also use the identify maintenance and machine dependability in the production process.The next strategy usability was level and balance in manufacturing process control. The Kanban is the other strategy can be used to control of the production process, by this strategy can be made the layout of the manufacturing system, and show the part how they run in the plant. The next two strategies was using the integration of inventory control into the manufacturing system by minimize lot size and WPI. And the last one was the Automate and Robotize the manufacturing system to solve many of problems into the producing a parts. By using dose strategy can be minimize the error in the produce the part in manufacturing system.

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Author Biblography

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Place here a photograph of the author	**Athor Ravindra Thamma Dr. RAVINDRA THAMMA** is currently an associate professor of Mechatronics and Robotics at Central Connecticut State University. Dr. Thamma received his PhD from Iowa State University. His teaching and research interests are robotics, linear control systems, and intelligent systems. Dr. Thamma can be reached at thammarav@ccsu.edu.