Northern Illinois University

Process Layout to Group Layout

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Capstone Approval Page

Capstone Title: (print or type): Process Layout to Group Layout

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Executive Summary:

Currently the job/batch production in Libertyville, IL has a dilemma with cell phones disappearing during production runs. In my fall 2003 case study, *Evaluation of Motorola's Relocation*, I showed that an improved process layout did not improve the manufacturing department's efficiency enough to validate implementing that improvement.

With the goal to recommend an improvement to the current process, while eliminating the disappearing radio dilemma, I am altering the layout of the manufacturing department from a process layout to a group layout. One of the key elements in this procedure was to keep the flexibility of this imposed layout equal to that of the current layout, because the production levels in Libertyville are of batch style. The group layout was incorporated to increase the productivity of the proposed layout and to reduce the risk of disappearing phones, by reducing material handling. The decision making process in this consulting project was decision analysis with emphasis in determining the indifference benefit necessary to implement the process layout alternative. The indifference benefit is an original concept based off of the decision analysis concept of indifferences.

Table of Contents

Introduction:

Motorola has been a leading innovator in technology since 1928. In the past 75 years Motorola has impacted peoples' personal lives from their initial car radio to their latest mobile phone. "Intelligence everywhere" is the slogan they embrace with their newest communication innovations that integrate two way radios, digital cellular phone, wireless internet, messaging and data/fax capabilities into a single solution.

In Libertyville, IL the Motorola New Product Launch Center's (NPLC) manufacturing department is used for the testing and designing new radios for the market. These radios are the future of soon to be released mobile phones by Motorola and are produced there in multiple runs of batch quantities ranging from 50 to 2000 phones per product run. Motorola's production run is a job/batch style of production. For this reason alone, the current layout of the facility is a process layout.

In job shop production the variety of products being produced is large while the quantity of items of each variety is low. A beneficial layout for batch production needs to be flexible enough to cover the huge range in the variety of products being produced. Besides flexibility a process layout needs to be efficient. In manufacturing efficiency is increased by reducing set up time and lead-time. The set up time in a batch manufacturing system is called change over time because of the large variety of products being produced. Changeover time is the time it takes to switch from producing one variety of products to another. The lead-time is defined as the time necessary to complete production of the product. In batch production, since the quantity produced of each product is small and the number of products being produced is large, an efficient layout is more concerned with controlling changeover than lead-time.

In this process layout different operations are grouped together by their job function. The benefit of this grouping is that it results in a very flexible department capable of Motorola's batch demand. Motorola's current demand is a large variety of parts being produced in low volumes. A description of the current process is found on page 6. Currently different parts are produced in different sequences. The grouping of operations by job function increases the flexibility of the manufacturing department. The setback with grouping stations by job function is that material handling is very high. Material handling is defined by the time taken up by moving parts from one station to the next. The reason why the material handling is high is that different stations are not necessarily next to the next operation needed. These distances are long, but are accepted mainly because there is a greater importance on the flexibility of the department and reducing changeover to different jobs than to reduce lead-times of the different jobs.

One side effect of the high material handling is that everyday in a few production runs a few phones are determined missing at the end of the run. When this dilemma takes place time is then taken up by determining where the missing phones are located and completing their manufacturing operations.

In fall 2003, in *Evaluation of Motorola's Relocation,* I evaluated the NPLC's manufacturing department. To evaluate the current layout, it was compared to an improved more organized process layout. To keep the layout job shop I was instructed to keep the different operations grouped by their processes. The technique I used to improve the layout in 2003 was the manual CORELAP algorithm. The manual CORELAP algorithm puts job functions that have higher relationships and places them closer together while taking job functions of lower relationships and places them farther apart. In analyzing the current layout compared to the alternative layout I compared the relative closeness efficiencies of both layouts. The relative closeness efficiency is defined by dividing the closeness rating by the total possible closeness rating. In 2003 the improved process layout increased the relative closeness efficiency by 1.2 percent. The conclusion from this minuscule improvement was although there is always room for improvement, it is not always worth the cost of implementing it. In that case the benefit of that improvement was not significant enough to justify the cost of implementing the improved process layout.

Objective:

The objective of this honors capstone is to utilize decision analysis in improving Motorola's manufacturing department layout while reducing time spent locating missing radios from several production runs. The previous conclusion from last semester stated that an improved process layout did not justify the cost of altering the current layout. In going further from fall semester's facilities design project, I am going to present a group layout that will increase the manufacturing capabilities of this department while keeping the flexibilities capable of the current batch production demand.

Current Process:

The current process can be seen in the appendix on page 15. There are four different families of cellular phones being manufactured in Libertyville. The four different family types are: CDMA, GSM, 3G, and TDMA. Of these four types CDMA, GSM, and 3G are produced in higher volumes than TDMA. That is the reason why TDMA is given the lowest priorities of the four.

The mobile phones are produced by two assembly operations: front-end assembly and back-end assembly. The front-end assembly is the mounting of electronic chips onto a circuit board. The back-end assembly operation is attaching the boards from front-end assembly to the casing and testing for compliance. Currently the front-end assembly is grouped together at one fixed location, for the reason that the solder used for mounting the chips must stay a liquid throughout this assembly operation. The back-end assembly is broken up into different locations based on the different operations. Hence the front-end assembly will be ignored while the back-end is altered to a group layout.

The order of the processes that the different phones are manufactured in is not consistent. Consequently this results in the need of a flexible manufacturing system. The following order of the current process description will be described generally.

From the front-end assembly, circuit boards are usually taken to the back-end's board/radio test station for an initial board test. The board test takes approximately ten minutes. At the board/radio test station, the testing equipment is segregated by the four different family types (CDMA, GSM, 3G, and TDMA). In each family, the testing equipment is lined up with each testing device capable of both board and radio testing abilities. Across from each family's line of testing equipment is a set of analyzers used in conjunction with the testing devices. The amount of analyzers initially across from the test equipment is not needed in full. For this reason they are not all presently utilized.

From the board test the phones are usually transferred to the assembly bench. At the assembly bench three operators manually assemble the boards to the casings at an average rate of about ten minutes per phone. The time it takes manually to assemble one phone is dependent on how new the assembly technology is. Newer first generation phones take longer then the second and third generation radios to assemble. The number of operators also fluctuates between one and three.

Once assembly is complete the radios are usually sent to the board/radio test station. Currently the radio test is conducted at about a three minute interval per phone. When the radio test is completed the phones are generally transported to the customer interface (CIT) operation.

The CIT operation lasts generally three minutes a phone as a headphone volume, speaker volume, and keypad buttons are examined for compliance to standards. Because volume is being tested at this operation, CIT is a noise sensitive station. When CIT is finished phones are more often than not sent to the camera operation.

At the camera station four different operations generally take place. The first is a thirty second inspection of the camera. When completed the camera is tested for focusing, which lasts an additional minute a phone. After that, an examination of shading takes place for another minute. After the shading is complete the final camera operation is a color test lasting another minute approximately.

The thermo test is performed after the camera operation. (With jobs known to have difficulties handling extreme temperatures, the thermo test is performed earlier in the back-end assembly.) The thermo operation tests to see if the radios can handle extreme hot and cold temperatures. Each phone is tested separately at hot and cold temperatures. In ten minutes at either temperature one to ten phones can be tested. The thermo units generate a decent amount of noise while in operation. For this reason it is important to have noise sensitive operations decently spaced away from the thermo test machine.

The last operation performed on the radios prior to completion of the manufacturing process is at a flash station. At the flash station the phones are flashed with the software they need to become operational. The flashing operation takes about ten minutes and may be done to anywhere between one and ten phones at a time.

Methodology:

The missing phone dilemma described earlier in this case study currently takes place in the back-end assembly procedure. After understanding the back-end assembly procedure and looking at the current layout it is easy to determine that some techniques may be applied to solve this predicament. Currently, during production, one or two phones seem to be disappearing from a few production runs. When these phones disappear, a good amount of time is spent locating the missing phones. Because the operations are located by job function, these phones could be located anywhere through out the back-end assembly operation. The large material handling associated with this batch layout seems to be the root cause for these missing phones. Reducing material handling would in turn reduce disappearing phones and can be accomplished by either automation or reducing traveling distances.

Automation can be very expensive, especially with the variety of products with this existing batch production demand. Reducing traveling distance on the other hand may be accomplished by adjusting the process layout to a group layout. In a group layout compromises are made between a product layout and a process layout to utilize both of their strengths and minimize their limitations. A product layout is a layout that uses direct flow from one operation to the next for an individual product. This type of layout has reduced material handling and minute flexibility.

"Group technology refers to the grouping of parts into families" or cells for the benefit of product and process layouts (Tompkins 46). Currently in Libertyville, four families of phones are being produced in the manufacturing department and therefore I have introduced four group technology cells in incorporating the benefits of a process and product layouts (CDMA, GSM, 3G, and TDMA). While making these four group technology cells less priority was given to TDMA because it has respectively the lowest demand.

The benefit of the product layout that was used was direct flow lines to decrease lead-time and material handling. The benefit of the process layout that was used was the continued use of general purpose machines that maintain the current flexibility in Libertyville.

When integrating the group layout a noise conflict arose with two of the operations in every family. The thermo test station is a loud noisy operation and the CIT alternatively requires the operator to listen to the radio's speaker. To settle this disturbance I relocated the noise sensitive operation (CIT) towards the opposite side of the group clustering cell as the noise generator (thermo station).

Application:

The group layout was generated by playing with and altering the current process design in an AutoCAD file. The existing stations were moved around the manufacturing department with 180° rotations applied, when necessary, in accordance with the steps mentioned in the methodology. The current process layout is located in the appendix on page 15 with the alternative group layout on page 16. The restraints in altering the current layout was to keep the space in front of power boxes unoccupied and to leave the aisles set to the OSHA standard regulations. Throughout the AutoCAD manipulation process Chris Oakes and Tom Kusisto helped by identifying possible conflicts and priorities mentioned formerly.

With the group layout improvement approved by Motorola engineers, the next step is to identify the cost of implementation. The cost of moving the equipment around and time lost in production is considered minimal because it can be done during off times of operation. The major cost in implementing this group layout is caused by supplying power. Each test bench, analyzer, CIT, and camera station requires one 120w 20-amp power supply. Every two flash stations and two model assembly station also require one 120w 20-amps of power. The thermo stations require a 208w single-phase 20-amp power supply. The cost to drop a line that does not currently exist is approximately $150 (cost to install an additional power supply). Currently with the adjustments made on page 16 seventeen 120w 20-amp lines and six 208w single-phase 20-amp lines need to be dropped. The cost of adding the twenty-three lines of power is $3,450.

Analysis:

The benefit of the improved group layout is the combination of reduced material handling and reduced time locating missing phones. The material handling is lowered because the traveling distances between the different back-end assembly operations are lowered in this improved group layout. The time spent relocating missing phones is reduced to almost nil because all the operations after the front-end assembly are located in one loop for each of the three major family cells. The fourth family is utilized the least, but is also concentrated to one general area. The overall benefit of this layout is hard to determine. According to the Motorola engineers the benefit of the improved layout would have to be significant to justify the cost of implementation. In an order to show that this improvement is significant, I've decided to calculate a table of indifference benefits to which implementing this layout would be preferred.

The indifference benefit is a concept based off of the decision analysis's indifferences concept. In decision analysis indifferences are used to show how two different outcomes of a decision are equivalent. In this project the indifference benefit is used to determine the value that makes implementing the proposed group layout indifferent to keeping the current process layout. Since the lifetime of the layout is unknown the table will show six month intervals of actual yearly lifetime estimates. The values in the table are broken down into valuable time periods.

From discussions with Tom Kusisto and Chris Oakes it is determined that the benefit of the proposed layout needs to generously exceed the cost of implementation to be considered justified. In an order to show that the improved layout generously improves the current layout, the lifetime of the payback period is one that the actual lifetime will most likely exceed. For this reason, the estimates of time for the lifetime of the proposed layout will be low estimates. As an example if one felt that the average lifetime of the proposed layout were seven years and that most likely the layout would survive for at least three and a half years then they would look up the indifference benefit of three and a half years. The table of indifference benefits below is created so that altering the guess of these low lifetime estimates of the payback period may be altered easily with the indifference benefit broken down into yearly, monthly, and daily periods:

Table of Indifference Benefits

Life Span (yrs)	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7
Yearly Benefit	$3,450	$3,450	$2,300	$1,725	$1,380	$1,150	$986	$863	$767	$690	$627	$575	$531	$493
Monthly Benefit	$575	$288	$192	$144	$115	$96	$82	$72	$64	$58	$52	$48	$44	$41
Daily Benefit	$26.54	$13.27	$8.85	$6.63	$5.31	$4.42	$3.79	$3.32	$2.95	$2.65	$2.41	$2.21	$2.04	$1.90

For the example stated previously with the average lifetime of seven years and the guess at the time that the change would most likely be in affect for at least three and a half years the Table of Indifference Benefits would be used at the three and a half years column. For this lifetime estimate the yearly benefit would have to exceed $986, while the monthly and daily benefit would have to exceed $82 and $4 ($3.79) respectively.

Results:

The objective of increasing the total productivity of the manufacturing department of the NPLC is achieved by transferring the job shop layout to a process flow layout. While accomplishing this objective, by reducing material handling, I also reduced the risk of phones disappearing, which reduced the time spent locating these missing phones. The affect of this also aids in the objective of reducing lead-time and increasing the manufacturing department's productivity because the missing phone dilemma has an effect on the average lead-time. Utilizing all the current stations presently in use and using up the same amount of floor space have maintained the job shop flexibility. I also believe that the benefit of accomplishing my objective exceeds the indifference benefits in the Table of Indifference Benefits shown above (page 12).

Acknowledgements:

John Elsted (Lead Engineer, Motorola) came up with the initial problem statement to solve. Chris Oakes (Analyzer & PTTS Technician Manager, Motorola) and Tom Kusisto (Facilities Planner Engineer, Motorola) supplied information regarding Motorola's operations, priorities, capabilities and needs. Dr. Omar Ghrayeb (Associate Professor of Industrial Engineering, NIU) provided education on different layout alternatives benefits and limitations. Dr. Richard Marcellus (Associate Professor of Industrial Engineering, NIU) bestowed me with the decision analysis tools necessary to solve this predicament.

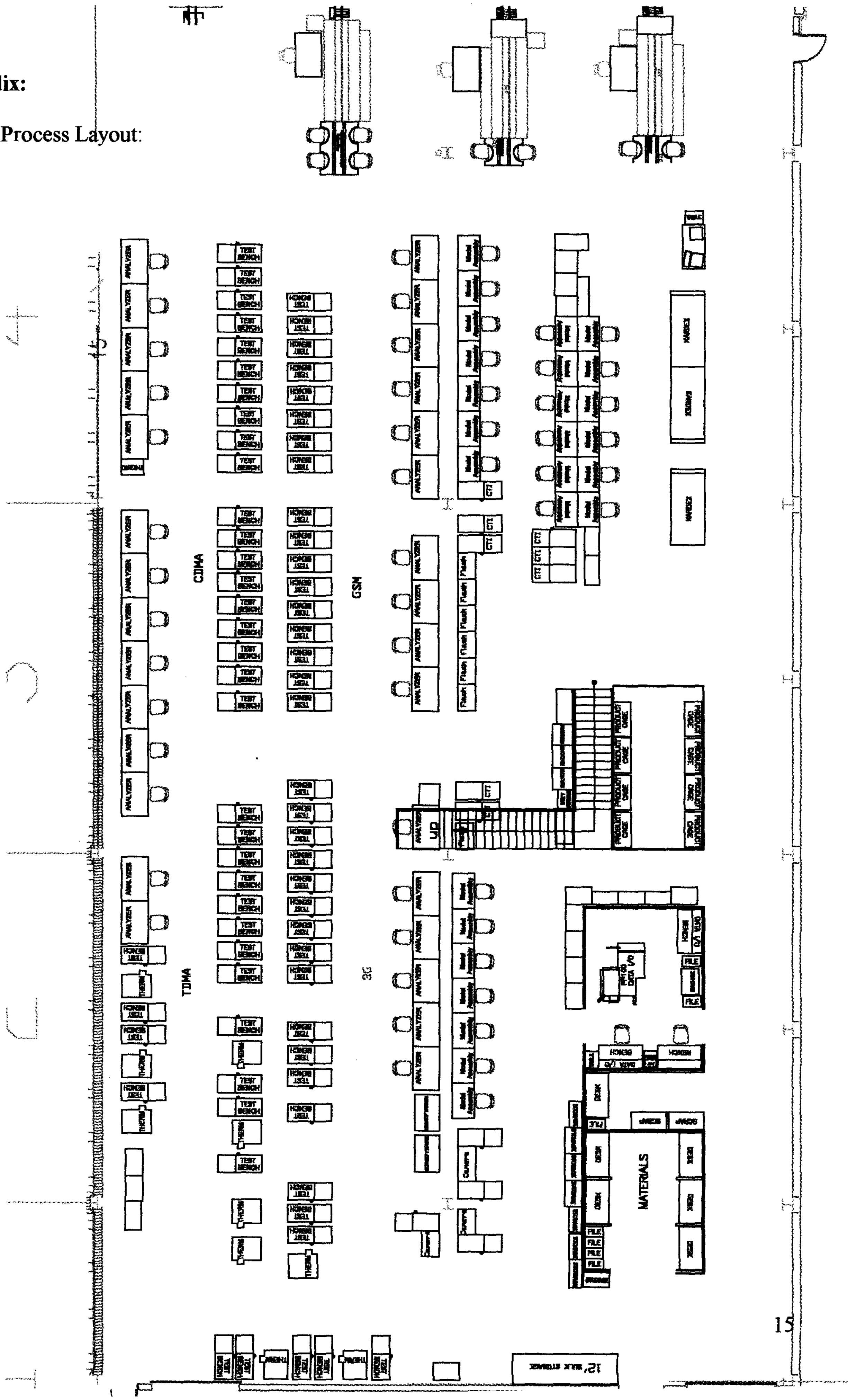
References:

Richier, Pete D. *Evaluation of Motorola's Relocation.* Northern Illinois University, 2003.

Tompkins, White, Bozer, and Tanchoco. *Facilities Planning.* John Wiley and Sons, Inc 2003.

Appendix:

Current Process Layout:



Improved Group Layout: