FACILITY LAYOUT IMPROVEMENT USING SYSTEMATIC LAYOUT PLANNING (SLP) AND ARENA

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ABSTRACT

The objective of this thesis is to improve the production floor layout of the MTA department and to evaluate the proposed alternative layouts using ARENA simulation. This project is conducted at Agilent Technologies, Inc., an Electronics Manufacturing company located in Bayan Lepas, Penang. The major problem faced by the company is high cross-over frequency for E-Cal and Coaxial Waveguide Adapter products between two buildings. There is high flow intensity between departments which have high interrelationship. This leads to high travelling time and high travelling cost. Two alternative layouts are proposed using the 11 steps in Systematic Layout Planning, which is a systematic way of generating layout alternatives. The proposed alternative layout involves transferring the departments which have high interrelationship close to each other. The proposed alternative layouts are evaluated using ARENA simulation student version. The best alternative is chosen based on the performance measures which have the most significant improvement, which are total travel distance, total travel time, total travel cost, number of cross-over, output, average resource utilization, total average WIP level, total average waiting time and total time spent in the system. The best alternative layout is Layout Design 2, which does not need extra space for re-layout. Total travel distance for Coaxial Waveguide Adapter will reduce significantly by 78.1% and for E-Cal the total travel distance will reduce by 62.87%. Total travel time for coaxial waveguide adapter is reduced by 86.42 % while for e-cal is reduced by 75.17%. This will subsequently reduce cost of travel for coaxial waveguide adapter by 86.42% and for E-cal is reduce by 68.09%. The output for coaxial waveguide adapter will increase 55.30 % as well. For e-cal the output will increase by 9.05 %.

ABSTRAK

Objektif projek ini adalah untuk memperbaiki susunatur jabatan produksi MTA dan memilih cadangan layout terbaik menggunakan simulasi ARENA. Kajian kes ini dilaksanakan di Agilent Technologies, Inc.,sebuah kilang elektronik di Bayan Lepas, Pulau Pinang. Masalah utama adalah bilangan ulang alik yang tinggi antara dua bangunan bersebelahan bagi produk Coaxial Waveguide Adapter dan E-Cal. Bahagian yang mempunyai hubungan ulang alik yang banyak terletak berjauhan. Ini mengakibatkan masa pengangkutan yang panjang dan kos yang tinggi. Kaedah "Systematic Layout Planning" digunakan untuk menghasilkan 2 cadangan alternatif susunatur.Dua cadangan ini bertujuan untuk menukar kedudukan stesen yang terletak berjauhan . Simulasi digunakan untuk memilih antara dua alternatif ini. Alternatif terbaik dipilih berdasarkan jumlah jarak pengangkutan,jumlah kos pengangkutan manual, bilangan ulang alik,jumlah masa pengangkutan,output, purata penggunaan sumber, purata WIP, purata masa menunggu dan purata masa dalam sistem. Susunatur cadangan kedua merupakan pilihan yang terbaik kerana tidak memerlukan ruangan yang lebih. Jumlah jarak pengangkutan bagi Coaxial Waveguide Adapter akan kurang 78.1% manakala bagi E-Cal akan kurang 62.87%. Jumlah masa pengangkutan bagi coaxial waveguide adapter akan kurang sebanyak 86.42% dan untuk E-Cal akan kurang 75.17%.Ini akan mengurangkan kos untuk mengangkut coaxial waveguide adapter sebanyak 86.42, untuk E-Cal akan kurang sebanyak 68.09%. Output untuk coaxial waveguide adapter akan bertambah sehingga 55.30% manakala untuk E-Cal akan bertambah 9.05%.

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CHAPTER I

INTRODUCTION

1.1 Background of the problem

In the 21st century business world, companies are exposed to continuous challenges. One of it is to equip organizations with the ability to compete in a global marketplace. (Schonberger, 1986) states "…..world class performance is dedicated to serving the customer." Thus, in order to keep track of performance, organizations must develop measures of performance. The current trend in the electronics industry, which is experiencing very competitive era like many others is striving hard to reduce manufacturing costs, improve quality and customer satisfaction.

Materials handling equipment and the facilities it operates can contribute to as much as 70 percent of the total cost of the manufactured product (Tompkins et al, 1996). Facilities layout design is part of facilities planning (Tompkins et al, 1996). It is the arrangement of work space which, in general terms smoothes the way to access facilities that have strong interactions. The main concern with the plant facility layout planning is to reduce the cost of materials handling as poor materials handling can generate business problems. As Sims (Industrial Engineering May 1990) states "The best material handling is no handling". Subsequently, a good layout will enable the manufacture of the product economically in the required volume and variety.

Other objectives can be stated as effective utilization of manpower, space and infrastructure, as well as providing overall wellbeing and morale of the worker.

Today's manufacturing industry is facing problems that have been growing in size and complexity over the last several years. As a result, there is an immediate need for procedures or techniques in solving various problems encountered in today's manufacturing arena without extended shutdown's or expensive modifications (Clark ,1996). Computer simulation is a powerful tool that allows experimentation with various manufacturing techniques and layout without actual implementation. Simulation can be used as a stochastic model to evaluate the randomness of events which exists. Simulation predicts the behavior of complex manufacturing systems by determining the movement and interactions of system components. It is capable of aiding in the design of the most complex layout and also allows the user to evaluate alternative solutions to examine the flexibility of a design (Eneyo and Pannirselvam,1998).

Based on the above facts, it is obvious that layout optimization and simulation are two tasks that are crucial to any facility planning and layout study (Grajo, 1996). If not tackled in the early phases, it can generate logistics implications for the company involved.

1.2 Statement of the problem

Agilent Technologies, Inc. is an electronics manufacturing company located in Bayan Lepas. It has numerous business units where the problem area which is Microwave Test Accessories (MTA) department will be discussed here. MTA has 2 main buildings, Building 5 and Building 6.Frequency of cross over is high between the two buildings as stations for some products are located in both buildings.

Processes which have high interdependency are not located close to each other. This causes high travelling time for the operator as they have to travel to and fro from building 5 to building 6. The labor cost of each product is also high due high travelling cost.

In response to the above problems, the need for facilities layout optimization and a model capable of simulating workstation production on new layout proposals to evaluate the performance measures related to the manufacturing goals of the company is needed. This thesis proposes to use Systematic Layout Planning (SLP) as the infrastructure for layout optimization. Subsequently simulation using ARENA is then used to systematically to examine the role and impact of product complexity and other key variables on factory performance. The factory performance improvements are in terms of cycle time reduction, productivity increase, reduction in travelling cost and reduction in travelling distance.

1.3 Objective

i. To improve the production floor layout at the MTA department.
ii. To evaluate the proposed alternative layouts using simulation.

1.4 Scope

In this thesis, the case study is limited to the MTA production floor of Agilent Technologies, Inc. The products selected will be only Electronic Calibration Kit and Coaxial Waveguide Adapter. This work focuses on improving the facilities design of the production floor. The layout of the production is process oriented layout. The

Systematic Layout Planning (SLP) methodology will be utilized in this case study as part of the strategy to portrait the relationship between each department to generate improved layout alternatives. The future layout alternative will be evaluated using simulation software – ARENA.

1.5 Methodology

This project is divided into Masters Project I and Masters Project II, which has to be completed in Semester I and Semester II respectively. The methodology for this project is stated in Figure 1.1 on the next page.

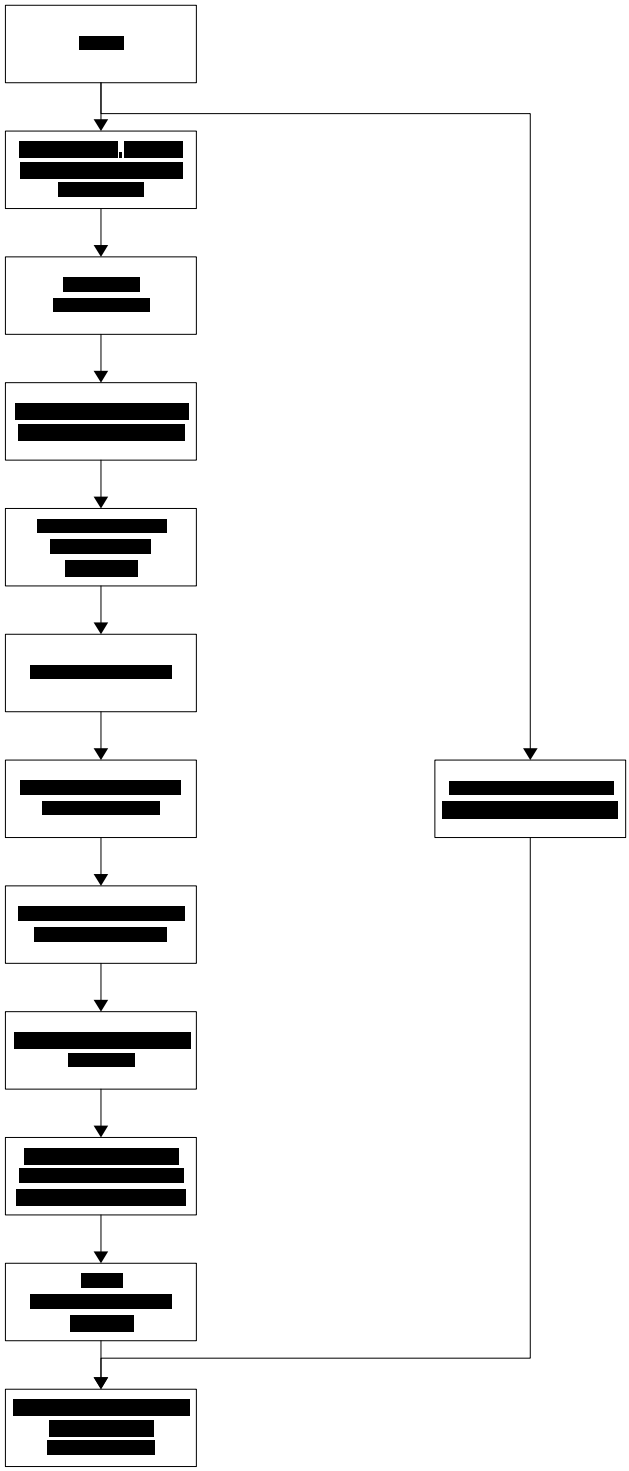

Figure 1.1 Project Methodology

Literature review would be done throughout the 2 semesters to have a more detailed background and theoretical knowledge regarding Facilities Planning, Systematic Layout Planning and simulation –ARENA. This would provide evidence of familiarity with the areas covered in this study and its classifications. Apart from that, current trends, direction and research issues were identified. Previous studies, journal papers, online articles were reviewed critically. Subsequently, evidence of not repeating what others have done will guide in the formulation of problem statement and the justification of proper selection of tools and techniques to be used.

After reviewing previous journals and studies, a company is selected to be studied. The company background is discussed briefly. It covers the company profile, organization structure of the company, understanding the current layout of the company, its manufacturing process and its policies.

Subsequently, the problems faced by the company will be identified. The scope will be limited to the facilities layout of the company and two of the major high revenue products. The process flow for each of the product will be observed and documented. The distance travelled by the operator is calculated. Tools such as crossover chart/spaghetti diagram, From-To-Chart are used. Time studies will be used as the method of cycle time calculation.

Following that, the Systematic Layout Planning (SLP) will be used for the generation of layout alternatives in Chapter 5. Systematic Layout Planning is used in this case study as it is a procedural approach which incorporates both qualitative and quantitative data. It is a proven tool in providing layout design guidelines in practice in the past few decades. At the end of the first semester, new layout proposals will be proposed to improve the facilities layout of the company. Other than that, simulation software, ARENA will be learnt to enhance skills of constructing the model of the layout plan and flow of product for semester two. A draft report will be send to the supervisor.

In Masters Project II, the model of the proposed improvement layouts will be modeled using ARENA. The types of data distribution will be justified. The models will be validated and verified. Experimentation of each layout proposal will be done using the simulation model. The results will be analyzed and compared with the existing layout.

Finally the results of each alternative layout are compared to select the one with the most significant improvement to the company. The full report will be submitted to the supervisor upon completion.

1.6 Relevant Literature

Global competitiveness and advances in technology have given rise to the need for effective space utilization (Muther, 1976). Immer (1950) presented the basic steps in the layout planning as related to material handling and outlined the need for the representation of the flow and its depiction in terms of the output produced by equipment. In the early days of research pertaining to plant layout, the approach was typically one of minimizing the distance traveled between work centers.

Reed (1961) devised a “layout planning chart” as the single most important phase of systematic planning in plant layout. Other approaches are such as Systematic Layout Planning (Muther, 1973), steepest descent search method by pair-wise exchange, graph based construction method, Tabu search, simulated annealing and genetic algorithms.

Other computer aided layout techniques have been developed as well such as CRAFT, ALDEP, COFAD, CORELAP, MULTIPLE, BLOCPLAN. There are also a few commercial packages available for facility layout design namely, PROMODEL, LayOPT, FactoryPLAN and Factory modeler.

From the review of the literature, it can be concluded that layout design problem has been an active research area in the past few decades (Meller and Gau, 1996). However, most of the research does not integrate the layout improvement methodology together with simulation. Therefore the following paragraph summarizes the significance of this case study by using the SLP methodology and simulation using ARENA for optimization.

1.7 Significance of Study

An approach from Muther (1973), Systematic Layout Planning (SLP) is used as the improvement method. It uses a graphical representation and builds up a proximity matrix which represents the closeness of each facility. Flowcharts can also be developed showing quantitative relationships.

From the above proximity matrix a trial and error process can be used to generate the layout but again this approach has not been shown to be a particularly efficient method in practice. Simulation provides a more powerful tool (a 6 sigma capable tool) than those commonly used in a lean – 6 sigma process. Simulation is uniquely able to support achieving a corporate goal of finding a correct or at least a very good solution that meets the system design and operation requirements before implementation at minimal cost. Therefore simulation using ARENA is used as tool in this study to address issues that the Systematic Layout Planning approach failed to identify and could not solve.

This case study which focuses on manufacturing activities in the electronics industry can also be easily applied with minimal modification in other types of facilities such as offices where workflow processes may be present. Thus the model described possesses a general applicability in other domains that can be achieved through mapping of equivalent governing parameters to those that have been identified in the manufacturing sector.

1.8 Arrangement of Thesis

This project report consists of 8 chapters. Chapter 1 begins with an overview of Facilities Layout Planning definitions and its principles. Objectives and Scope of the case study are also well defined. Subsequently, some relevant literature is reviewed to justify the significance of this study.

Chapter 2 will be the literature review on facilities layout planning with the focus area in Systematic Layout Planning methodology, simulation techniques and its importance. Other than that the integration of Layout design and Simulation will also be discussed. Finally, relevant research and previous journals will be summarized with emphasis on the strengths and gaps. Subsequently evidence of the strength of this project compared to the previous studies will be highlighted.

Chapter 3 will discuss about the methodology of the thesis, including types of data to be collected, tools and techniques used to solve the problem and performance measures.

Chapter 4 will review on the background of the company. The company's profile, policies, current layout structure will be described. The problem identification will also be discussed. Cross over diagrams, process flow mapping and travelling cost calculation will be utilized to describe the problem of the production line.

Chapter 5 will adopt the Systematic Layout Planning (SLP) methodology to generate preliminary proposed layout alternatives to the current production line.

Chapter 6 will be the data analysis and modeling. Cycle time data will be collected and the distribution for each product will be determined. The existing and proposed layout will be modeled. Verification and validation of the model will be included as well.

Chapter 7 will discuss on the simulations experiments which also covers the results generated for the existing layout and the proposed layout. The results of the simulation using ARENA are discussed. The comparisons of the existing model and the improved model will be conducted

Chapter 8 will discuss on the best model (layout) to be selected It will summarize the findings from this study and recommendation for future work will be proposed.

1.9 Conclusion

In the beginning of this chapter, an overview of the facilities layout planning and its importance to existing companies is written to further enhance the importance for using it as the main principle for this project. The objectives are also defined to be linked to the deliverables in this case study. The boundary of this project is also defined based on the statement of problem .Some justifications of conducting this case study and its importance is also discussed. At the end of this chapter, the overall structure of the thesis is stated to provide the reader a helicopter's view of the whole thesis.

Subsequently, the literature review of facilities planning, SLP and simulation will be discussed in the following chapter to further enhance the reader's understanding.