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Un-Simulated Facilities Layout Designs, Un-Determined Risks of Manufacturing Firms: Desk Review

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ABSTRACT
This desk review paper aims at showing that simulation saves the manufacturing companies from undetermined costs if they first employ it to their facility design layout before installation. More than 70% of the cost of production is contributed by the cost to handle the materials from end to end. An optimized material handling cost can only be achieved through an optimized facilities layout design. But, companies certainly cannot become sure that the layout at hand is optimized unless several alternatives are developed and simulated. So, with the application of simulation, companies can save the un-determined cost of the un-simulated facilities layout design. This article tries to review various scientific literatures and different research applications of scholars and come up with the recommendation that manufacturing firms should stimulate their facilities layout before its implementation so as to save time and industrial resources.

Kew words
Facilities, layout design, simulation, manufacturing

1. INTRODUCTION
It is remarked that the materials handling facilities can contribute to as much as 70% of the total cost of the manufactured product (Tompkinset al, 1996). This higher cost has to be solved and optimized using a good and reasonable facilities layout design.

Facilities layout design is part of facilities planning (Tompkinset al, 1996). It is the arrangement of work space which, in general terms smooths 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 (IndustrialEngineering 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 (Ailing, 2009).

Computer simulation (CS) 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. According to Eneyoet al (1998), CS 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 (Ailing, 2009).

This paper will present the problems with un-simulate facilities layout design and highly suggests the manufacturing firms to simulate their facilities layout design before they install their facilities that help them to enhance productivity, better market share as a result of supplying quality products with reasonable selling price.

2. STATEMENT OF THE PROBLEM
In the real market, the selling price of products is high. But, researches showed that this high selling price happenedpartly due to the higher cost of production. Why the cost of production is as such high? Many may feel that the reasons for the higher production cost are the labor and material costs. However, the fact is far from what people believe. The exaggerated costs and the resulting magnified selling prices of products of the majority of manufacturing firms is the material handling costs, from the raw material stage to the end product phase.

If one can trace more, the higher cost of handling materials is also caused by the poor facilities layout. Bobby et al in their publication (2013) have recommended the manufacturing companies to improvethe layout design of their facilities so as to reduce the production costs of their products for a better competitive advantage in the market.

It is depicted in the research work of Kulkarni et al (2013) thatBalakrishnan etal (2007) have estimated that over $250 billion is spent annually in the United States on facilities planning and re-planning. Further, between 20%- 50% of the total costs within manufacturing are related to material handling. Globally, the cost of material handling is estimated to go up to 70% of the total production cost, and effective facility planning can reduce these costs 10-30% (Tompkins et al, 1996). Imagine the re-planning costs associated with the facilities design and how much good facilities planning save the world! This set the reviewer of this paper to focus on the untouched matters associated with un-simulated facilities layout designs.

How companies can be surer that they have minimized their production costs through the improvement of facilities layout designusing varieties of facilities layout design improvement methods is left as the work of CS. This paper will try to present

the dual guarantee CS as a producer of alternative layout and as a pre-mimicker of the real facilities layout design.

3. OBJECTIVE OF THE REVIEW

The major objective of this review is to show that the un-simulated facilities designs are un-determined risks of manufacturing companies.

4. METHODOLOGY

This paper is based on an extensive literature survey on the use of simulation modeling on facilities layout design. It critically examines research findings, case study reports, scientific journals related to facility layout optimization methods, tools, techniques, with special focus on the application of simulation modeling. Local and international scientific research experiences, official research reports, and the author's own experience were reviewed to assess theoretical gaps and to identify future research directions. Many researchers have examined the link between facility layout and productivity. As a result this paper tries to show the role of simulation modeling and the risk of un-simulated facility layout design in manufacturing firms for effective and productive arrangement of facilities and crews.

5. LITERATURE REVIEW

Facilities are the overall possessions of a certain company that are useful to process raw material into raw or end products. These are the company properties located on certain space for production and on which the efficiency of production depend.

5.1 Definition

A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work center, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu,1997). Hence, a facility layout, for Ailing (2009), is an arrangement of everything needed for production of goods or delivery of services. It means planning for the locations of all machines, utilities, employee workstations, customer service areas, material storage area, aisles, restrooms, lunchrooms, internal walls, offices and computer rooms. This is for the flow patterns of materials and people around, into and within the manufacturing buildings.

5.2 The Principle of Facilities Layout Design (FLD)

According to Heragu, the term "facility" represents any machine, work station, inspection-station, washing station, locker-room, rest area or any manufacturing or support facility (Ficko et al, 2013).

Why firms need to have good facility layout? Ailing (2009) stated that the main objective of FLD consists of organizing the equipments and working areas in the most efficient way, and at the same time satisfactory and safe for the personnel doing the work. An analyst or a designer can meet this FLD objective whenever s/he meets at least the following five strategies:

- Product Strategy (Product Design and Volume),
- Process Strategy (Process equipment and capacity),
- Human Resource strategy (Quality of work life),
- Location Strategy (Building and site constraints),and
- Material Handling Strategy (Raw materials and WIP) (added by the reviewer)

The final solution for a Plant Layout has to take into account a balance among the characteristics and considerations of all factors affecting plant layout, in order to get the maximum advantages. The factors affecting plant layout can be grouped into 5 main categories: Materials, Machinery, Labor, Material Handling, and Waiting Time.

5.3 Types of Facilities Layout Designs

5.3.1 Traditional Types of Layout

Traditionally 4 types of layout are considered appropriate for a manufacturing facility:

5.3.1.1 Process (Job Shop) Layout

This type of layout is characterized by the following:

- Machines are grouped according to function to machine centers;
- Useful when production process is organized in batches;
- Different items have to move from one area to another one, according to the sequence of operations previously established;
- Variety of products will lead to diversity of flows through the facility;

5.3.1.2 Product (Flow Shop) Layout

The features of job shop layout are:

- Product (or products) follows a fixed path through the production resources;
- Useful when the production process is organized in a continuous or repetitive way.
- The plant layout will be based in allocating a machine as close as possible to the next one in line;

5.3.1.3 Fixed Position Layout

In the fixed position layout type:

- Item being worked on remains stationary and workers, materials and equipment are moved as needed;
- Useful for tasks on large objects such as the manufacture of an electrical generator, the construction of a building, or the repair of a large airplane

5.3.1.4 Group technology (cellular) Layout

Here, in the cellular layout, the following listed conditions are required to be performed:

- Technique of identifying and bringing together related or similar parts in a production process in order to utilize the inherent economy of flow production methods;
- Each cell is designed to produce a part family;
- A part family is a set of parts that require similar machinery, tooling, machine operations and jig or fixtures;
- The parts within the family normally go from raw material to finished parts within a single cell;

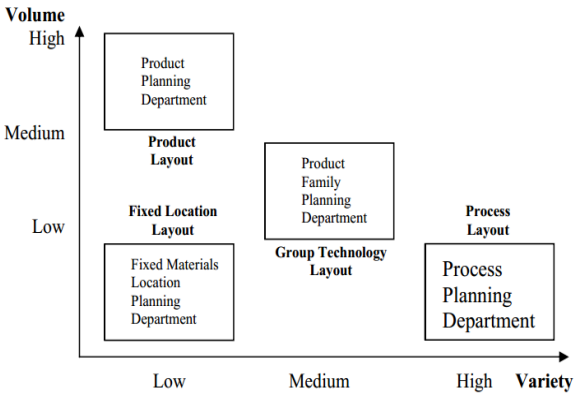

Figure 1. Traditional types of layouts in relation to production volume and product variety

5.3.2 Non-Traditional types of Layout

In an extension to the traditional layouts, many nontraditional layouts have been introduced. Some of them are listed in the figure below:

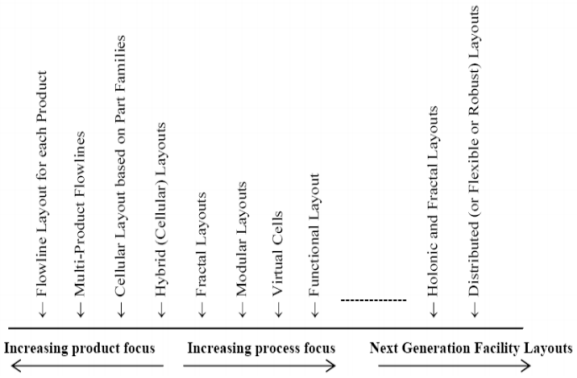

Figure 2.Non-traditional and future generation layouts

6. COMPUTER SIMULATION (CS)

6.1 Definition of CS

Simulation is the process of designing a model of a real system and conducting experiments with this model for the purposes either of understanding the behavior of the system or of evaluating various strategies (withinthe limits imposed by a criterion or set of criteria) for the operation of the system (Shannon,1975).

A model is a representation of a system or process. Asimulation model is a representation that incorporates time and the changes that occur over time. A discrete model is one whose state changes only at discrete points in time, not continuously.

6.2 Principles of CS

Ailing (2009) in his Master's thesis concluded that though the layout design problem has been an active research area for many decades, but the problem is not yet solved because the researches did not integrate the layout improvement methodology together with simulation.

The process of layout design is necessary in order to improve the performance of the existing layout or for solving certain problem related with the layout. To evaluate whether the objectives set would be achieved by the new layout, it is essential to measure the performance of the existing layout and the proposed layout. Static performance measures are easy to calculate by simple formulations. There are some measures which are time dependent that is the number of accidents, annual production level, number of batches waiting for processing and many more. These time dependent measures are not deterministic due to dynamic behavior of the plant. The actual model building can take months and cost a company plenty of money. After modeling it may be found that the new layout doesn't meet the desired expectations. The process of layout design is required to be repeated until a satisfactory layout is obtained. Using simulation software is the way out to quickly model and test the layout economically.

One of the best tools available to provide correct evaluations of system interdependencies is discrete event simulation. With the use of this simulation technique, manufacturers are able to quickly and accurately model future proposed modifications to their facilities without making costly guesses. It saves time and money in modeling the layout, and enables testing the performance. The models being created not only serve the initial purpose of determining buffer space and resource levels, but also permit evaluation of new cuttings on a regular basis. This multi-functionality feature has turned the simulation models into an operational planning tool and has brought facilities planning directly to the plant floor where the everyday engineer can evaluate changes quickly and accurately. The multi-purpose plant model is now becoming the norm rather than a farfetched dream when evaluating new product flows on the plant floor.

The objective of the simulation exercise must also be clear. The focus primarily is on minimizing travel distance and material handling cost. Simulating the layout after design phase is better when applied to deterministic problems with predefined operational policies and production strategies. However, simulation, followed by design, is best applied for problems exhibiting uncertainties and those where the objective is to justify production strategies and improve layout operational parameters. By observing the above, it can be readily seen that using simulation prior to and after the layout generation is the best approach. This provides for straight forward evaluation of the alternative layouts made available by the program. One can chose the best layout based on the pre-defined objective or performance criterion.

In simulation modeling, an existing or proposed system is statistically imitated using probability distributions or a computer program code such as in intelligent agents-based simulation in order to observe the performance of the system as though the real world system were being observed(Asio, 2011).

6.3 Steps/Procedures of CS

For different types and purposes of CS, there could be developed several models of procedures. However, the procedure that is depicted in the following figureis an example of the development of simulation models.

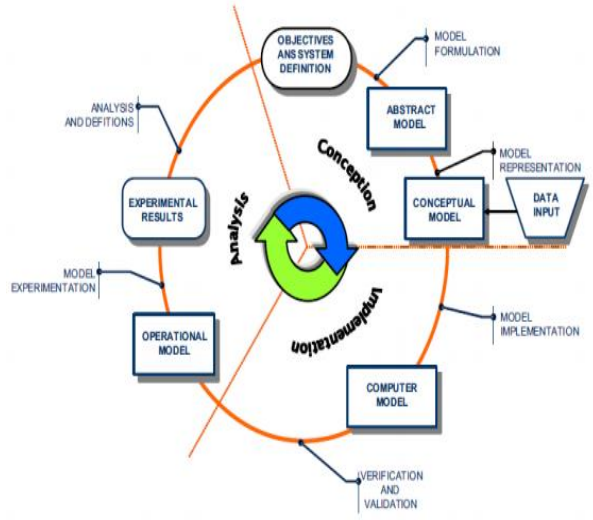

Figure 3. Development of a simulation model (Chwifet al, 2006)

7. RESULTS AND DISCUSSION

It is commonly known that facility layout design determines arrangement, location and distribution of machines in a manufacturing facility to achieve minimization of make-span time, maximization of productivity. Furthermore, a poor facilities layout results in a high work in process, longer waiting times, low efficient scheduling and increased material handling costs (Shanti Sagar B.T. et al, 2015).

Simulation allows experimentation with a model of a system instead of experimenting with the real thing, which might cause production loss and disruption (Carson et al, 2003). Manufacturing simulation has become one of the primary application areas of simulation technology. It has been widely used to improve and validate the designs of a broad range of manufacturing systems. Typically, manufacturing simulation models are used to predictsystem performance or to compare two or more system designs or scenarios (Arisha et al, 2005).

In addition to this, as Arisha concluded in his research on the proper application of simulation in semiconductor manufacturing companies, simulation may also be used to evaluate and analyze solutions for equipment layout, material flow, and automated material handling systems to minimize tool count, WIP, and cycle time.

Other researchers, Angeliki et al (2006) [2], have stated that simulation models can be an extremely valuable, timely and cost-effective means to study the performance characteristics of a proposed layout before firms redesign the facility. He also concluded that simulation modeling approach is a powerful facility evaluation tool as it can be employed within a facility layout problem and thus, assist in evaluating alternatives.

8. CONCLUSION

The review shows that it is risky, cost wise, to implement any proposed facility layout optimization before knowing its performance by using appropriate computer simulation modeling. A firm that tries to install its facilities before simulation modeling, unless the proposed layout is optimized by chance or the layout is easy to uninstall and relocate, should know that it is in a risk of non-optimized facility layout that leads to un-determined cost. The un-determined cost of un-simulated facility layout could be: high material handling cost, high production lead time, low throughput, unnecessary cost of redesign of the facilities, and unplanned cost of uninstalling and reinstalling the facilities. CS saves time and money and gives variety of facility layout alternatives.

From the desk review, it is found that there is a risk of un-determined cost resulting from un-simulated facilities layout design. Hence, it is highly recommended that manufacturing firms have to arrive at an optimal facilities layout design that is modeled through the computer simulation so as to minimize or reduce the un-determined cost of un-simulated layout.

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