ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

Facility Layout Planning: A Review

Rohit Monga [1], Varinder Khurana [2]

Department of Mechanical Engineering, Devraj Group's Technical Campus, Ferozpur, Punjab, India[1]

Department of Mechanical Engineering, SBSSTC (Poly Wing), Ferozepur, Punjab, India[2]

ABSTRACT: Plant layout planning includes decisions regarding the physical allocation of the economic activity centers in a facility. An economic activity center is any entity occupying space. The objective of plant layout planning is a more effective work flow at the facility, allowing workers and equipment being more productive. Facilities layout is a systematic and functional arrangement of different departments, machines, equipments and services in a manufacturing industry. It is essential to have a well developed plant layout for all the available resources in an optimum manner and get the maximum out of the capacity of the facilities. Facility layout techniques apply to the case where several physical means have to be located in a certain area, either industrial processes or services. The objective of the paper is not only Plant layout but re-layout also. To carry out an appropriate plant layout, it's important to take into account the business strategic and tactical objectives.

KEYWORDS: *Facility layout, Plant layout, Production, Plant layout planning.*

I. INTRODUCTION

The plant layout process starts at an aggregate level, taking into account the different departments. As soon as we get into the details, the different issues arise, and the original configuration may be changed through a feedback process. Most (if not all of them) layouts are designed properly for the initial conditions of the business, although as long as the company grows and has to be adapted to internal and external changes, a re-layout is necessary. The reasons for a re-layout are based on 3 types of changes:

- Changes in production volumes.
- Changes in processes and technology.
- Changes in the product.

The frequency of the re-layout will depend on the requirements of the process. Symptoms that allow us to detect the need for a re-layout are Congestion and bad utilization of space, excessive stock in process at the facility, long distances in the work flow process, simultaneous bottle necks and workstations with idle time, qualified workers carrying out too many simple operations, labour anxiety and discomfort, accidents at the facility and difficulty in controlling operations and personnel. A facility layout is an arrangement of everything needed for production of goods or delivery of services. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work centre, a manufacturing cell, a machine shop, a department, a warehouse, etc. The layout design generally depends on the products variety and the production volumes. Four types of organization are referred to, namely fixed product layout, process layout, product layout and cellular layout.

II. OBJECTIVES OF PLANT LAYOUT

The main objective consists of organizing equipment and working areas in the most efficient way, and at the same time satisfactory and safe for the personnel doing the work.

- Sense of Unity: The feeling of being a unit pursuing the same objective.
- Minimum Movement of people, material and resources.
- Safety: In the movement of materials and personnel work flow.
- Flexibility: In designing the plant layout taking into account the changes over short and medium terms in the production process and manufacturing volumes.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

➢ **Factors affecting Plant Layout:** 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 8 categories:

Materials: The layout of the productive equipment will depend on the characteristics of the product to be managed at the facility, as well as the different parts and materials to work on. Main factors to be considered: size, shape, volume, weight, and the physical-chemical characteristics, since they influence the manufacturing methods and storage and material handling processes. The sequence and order of the operations will affect plant layout as well, taking into account the variety and quantity to produce.

Machinery: Having information about the processes, machinery, tools and necessary equipment, as well as their use and requirements is essential to design a correct layout. The methods and time studies to improve the processes are closely linked to the plant layout. Regarding machinery, we have to consider the type, total available for each type, as well as type and quantity of tools and equipment. It's essential as well to know about space required, shape, height, weight, quantity and type of workers required, risks for the personnel, requirements of auxiliary services, etc.

Labour: Labour has to be organized in the production process (direct labour, supervision and auxiliary services). Environment considerations: employees' safety, light conditions, ventilation, temperature, noise, etc. Process considerations: personnel qualifications, flexibility, number of workers required at a given time as well as the type of work to be performed by them.

Material Handling: Material handling does not add value to the product; it's just waste. Objective: Minimize material handling as well as combining with other operations when possible, eliminating unnecessary and costly movements.

Waiting Time: Objective: Continuous Material Flow through the facility, avoiding the cost of waiting time and demurrages that happen when the flow stops. On the other hand, the material waiting to flow through the facility not always represents a cost to avoid. It's necessary then to consider space for the required stock at the facility when designing the layout.

Auxiliary Services: Support the main production activities at the plant: Related to labor: Accessibility paths, fire protection installations, supervision, safety, etc. The auxiliary services represent around 30% of the space at a facility. The space dedicated to auxiliary services is usually considered as waste. It's important to have efficient services to insure that their indirect costs have been minimized.

The building: If it has been already selected, its characteristics will be a constraint at the moment of designing the layout, which is different if the building has to be built.

Future Changes: One of the main objectives of plant layout is flexibility. It's important to forecast the future changes to avoid having an inefficient plant layout in a short term. Flexibility can be reached keeping the original layout as free as possible regarding fixed characteristics, allowing the adjustment to emergencies and variations of the normal process activities. Possible future extensions of the facility must be taken into account, as well as the feasibility of production during re-layout.

The production process normally determines the type of plant layout to be applied to the facility:

- **Fixed position plant layout:** Product stays and resources move to it.
- **Product oriented plant layout:** Machinery and Materials are placed following the product path.
- **Process oriented plant layout (Functional Layout):** Machinery is placed according to what they do and materials go to them.
- **Cell Layout:** Hybrid Layout that tries to take advantage of different layouts types.

In *fixed product layout*, the products generally circulate within the production facilities (machines, workers, etc.); in this particular type of layout, the product does not move, it is the different resources that are moved to perform the operations on the product. This type of layout is commonly found in industries that manufacture large size

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

products, such as ships or aircrafts. *Process layout* groups facilities with similar functions together (resources of the same type). This organization is often reported to be suited when there is a wide variety of product. *Product layout* is used for systems with high production volumes and a low variety of products. Facilities are organized according to the sequence of the successive manufacturing operations. In *Cellular layout*, machines are grouped into cells, to process families of similar parts. These cells also need to be placed on the factory floor. Therefore, one is also generally concerned with so called *intra cells machine layout problems*. The plant layout will be based in allocating a machine as close as possible to the next one in line, in the correct sequence to manufacture the product.

➢ **Plant Layout for a Service:** Most of the concepts and techniques explained here can be applied to any plant layout, including services. Examples: Line Balancing for Restaurant self-services; Process oriented layout for Hospitals. Service Businesses have a more direct customer focus: Sometimes, the customer is required at the facility for the company to be able to perform the service. Frequently, the layout is focused on the customer satisfaction than on the operation itself. Some of the objectives include comfortability during the performance of the service, as well as making attractive those areas in direct contact with the customer.

Plant layout for an office: The material that flows among departments and workstations is basically information. This can be done through:

- Individual conversations face to face.
- Individual conversations through telephone or computer.
- Mail and other physical documents.
- Electronic mail.
- Meetings and discussion groups.
- Interphones.

The layout solution is dictated by workers and physical documentation movements.

III. LITERATURE SURVEY

A literature survey was made on the Facility Layout Planning as follow:

Many industries use activity relationship charts (ARC) and diagrams for layout redesign and layout planning. The use of activity relationship diagram in designing a layout has provided a basic step for layout planning. [1]

Another research focuses on the problems occurred during designing flexible plant layouts for manufacturing facilities where product demands are subject to variability. A flexible layout is one that maintains low material handling costs despite fluctuations in the product demand levels. [2]

Semi- heuristic optimization algorithm (CRAFT) for designing optimal plant layouts in process focused manufacturing/service facilities are also been explained. The proposed algorithm marries the well-known CRAFT (Computerized Relative Allocation of Facilities Technique) with the Hungarian assignment algorithm. Being a semiheuristic search, our algorithm is likely to be more efficient in terms of computer CPU engagement time as it tends to converge on the global optimum faster than the traditional CRAFT. [3]

A case study explains an in detailed redesign of an existing production facility. The design of production facility differs from that of manufacturing layout. The analysis of the capacity of the equipment is done, then by using this analysis a group technology is used to make different type of parts in a layout and identification of a material handling solution for a material flow. [4]

A research conducted in an industry explains about the warehouse redesign of a manufacturing plant Layout and also the problems faced during the redesign of the layout. [5]

A research conducted to identify and improve the plant layout of pulley's factory to eliminate obstructions in material flow and thus obtain maximum productivity. The present plant layout and the operation process of each section (i.e.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

sand mould, core ware house, core making, disassembly surface finishing, furnace, and inspection sections) have been investigated and a new layout has been designed. [6]

Pham and Onder et al[7] have developed a knowledge-based system for optimum workplace design. The system is constructed using a commercially available hybrid development tool. It is interfaced to a database of anthropometrical data and an optimization program. The optimization program employs a genetic algorithm. This combination of knowledge-base technology, genetic optimization methods, and database technology has proved to be an effective for solving complex ergonomic design problems.

Hadi-Vencheh et al [8] .it is crucial to design an efficient FLD problem in a production factory. Ignoring the significant criteria (especially, the qualitative criteria which are not easily stateable in the quantitative measures form) in design time will certainly result in increasing the costs, prices and ultimately decreasing the products‟ sale. In this study, using the SVFJ approach, we transformed the subjectivity subjects of designers (in linguistic variables form) against qualitative criteria which are stated by assessing printed FLPs in program output, to quantitative measures.

Cheng et al [9] introduced the concept of fuzzy inter-flow into facility layout design problem and addressed fuzzy facility layout problem, where uncertainty of material flows among facilities is represented as trapezoidal fuzzy members. They developed a genetic algorithm for solving such hard fuzzy way to build powerful knowledge-based systems combinatorial problem. Polish expression was adopted as the coding scheme of chromosome.

Badiru and Arif [10] developed, FLEXEPRET, a fuzzy-integrated expert system for facility layout. FLEXEPRET considers the multi-criteria nature of the layout problem and the fuzziness of the input data through the integration of an expert system and a fuzzy algorithm with a commercial facility layout program (BLOCPLAN).

REFERENCES

[1] Nehal Elsayar, Elwood S., Armour G. C. and Vollmann, T. E., "*Allocating Facilities with Computerized Relative Allocation Facility Technique*", Harvard Business Review, Vol. 42, No.2, pp.136-158, March-April 1964.
[2]Saifallah benjafaar & Hillier, F. S., "*Quantitative Tools for Plant Layout Analysis, Journal of Industrial Engineering*", IIE Transaction, Vol. 14, No. 1, pp. 33 40, 1963.
[3]. Dr. M. Khoshnevisan Francis, R. L. and J. A. White, *"Facility Layout and Location: An Analytical Approach"*, Prentice Hall, 2/E, Englewood Cliffs, NJ, 1993.
[4]. Thomas lacknsonen, "*Facilities Layout Optimization Method Combining Human Factors and SLP"*, International Conference on Information Management, Innovation Management and Industrial Engineering , Vol 1, pp. 608-611, 2010.
[5]. Anucha Watanapa, *"Analysis Plant Layout Design for Effective Production*", Proceeding of the International Multi Conference of Engineers and Computer Scientists, Vol.2, pp. 543-559, 2011.
[6]. Tobiah r. master, Francis, R. L.; L. F. McGinnis; and J. A. White. "*Facility Layout and Location: An Analytical Approach".* 2nd ed. Englewood Cliffs, NJ: Prentice Hall, vol. 9, pp. 153-155, 1992.4
[7] Onder, H., " A Knowledge-Based System for Optimizing Workplace Layouts Using a Genetic Algorithm", Ergonomics, Vol. 35, No. 12, (1992) pp: 1479-1487.
[8]. Singh S P & Sharma R R K A review of different approaches to the facility layout problems, int j adv manuf technology, 2006 pages 425-433.
[9]. Cheng, R., Gen, M., and Tozawa, T., " Genetic Search For Facility Layout Design Under Inter-lows Uncertainty", Proceedings of IEEE Int. Conf. on Evolutionary Computation, Part 1, (1995), pp: 400-405.
[10]. Badiru, A. B.,Arif, A. " FLEXPERT: Facility Layout Expert System Using Fuzzy Linguistic Linguistic Relationship Codes", IIE Transactions, Vol. 28, No. 4,(1996), pp: 295-308.
[11]. Chung, Y. K., " Application of a Cascade BAM Neural Expert System to Conceptual Design for Facility Layout", Computers and Mathematics with Applications, 37, (1999), pp: 95-110.
[12]. Azadivar F, Wang JJ (2000) Facility layout optimization using simulation and genetic algorithms. Int J Prod Res 38(17):4369– 4383
[13]. Ahuja RK, Orlin JB, Tiwari A (2000) A greedy genetic algorithm for the quadratic assignment problem. Comput Oper Res 27:917–934
[14]. Helm SA, Hadley SW (2000) Tabu search based heuristics for multi floor facility layout. Int J Prod Res 38(2):365–383
[15]. Aiello, G., Enea, M., & Galante, G. (2006). Multi-objective approach to facility layout problem by genetic search algorithm and Electre method. Robotics and Computer-Integrated Manufacturing, 22, 447–455.
[16]. McKendall, A. R., & Shang, J. (2006). Hybrid ant systems for the dynamic facility layout problem. Computers & Operations Research, 33(3), 790–803
[17]. McKendall, A. R., Shang, J., & Kuppusamy, S. (2006). Simulated annealing heuristics for the dynamic facility layout problem. Computers& Operations Research, 33(8), 2431–2444.
[18]. Nearchou, A. C. (2006). Meta-heuristics from nature for the loop layout design problem. International Journal of Production Economics, 101(2), 312–328.

ISSN(Online) : 2319 - 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

[19]. Xiaodan. W, Chao. C, Yunfeng. W and Dianmin, Y. 2007. Genetic algorithms for integrating cell formation with machine layout and scheduling. Springerlink International journal of Computers & Industrial Engineering 53 (2007) 277–289.
[20]. Hong Zhang, and Jia Yuan Wang--Particle Swarm Optimization for Construction Site Unequal-Area Layout Journal of Construction Engineering and Management, Vol. 134, No. 9, September 2008, pp. 739-748
[21]. Guoxin Wang. "A simulation optimization approach for facility layout problem"IEEE. Industrial engineering and engineering manegment, 2008,IEEM, International conference 8-11 Dec, 2008, PP. 734-738.
[22]. Ashwani Dhingra; Pankaj Chandra Hybrid Genetic algorithm for Multicriteria Scheduling with sequence dependent set up time International Journal of Engineering Vol.3(5) Nov 2009 p- 520-530
[23]. Scholz, Daniel Petrick, Anita Domschke, Wolfgang , A Slicing Tree and Tabu Search based heuristic for the unequal area facility layout problem European Journal of Operational Research. , 197 (August 2009,1) p-166-178
[24]. Nurul Nadia Nordin, Zaitul Marlizawati Zainuddin, Sutinah Salim and Raja Rajeswari d/o Ponnusamy, Mathematical Modeling and Hybrid Heuristic for Unequal Size Facility Layout Problem Journal of Fundamental Sciences 5 (2009) 79-87
[25]. Komarudin, Kuan Yew Wong, Applying Ant System for solving Unequal Area Facility Layout Problems European Journal of Operational Research, Volume 202, Issue 3, 1 May 2010, Pages 730-746
[26]. Goetschalckx M (1992) An interactive layout heuristic based on hexagonal adjacency graphs. Eur J Oper Res 63:304–321
[27]. Hassan MMD, Hogg GL, Smith DR (1986) SHAPE: a construction algorithm for area placement evaluation. Int JProd Res 24(5):1283–1295
[28]. Tam KY (1992) A simulated annealing algorithm for allocating space to manufacturing cells. Int J Prod Res 30:63–87
[29]. Bozer YA, Meller RD, Erlebacher S J (1994) An improvement type layout algorithm for single and multiple-floor facilities. Manage Sci 40(7):918–932
[30]. Tate DM, Smith AE (1995) A genetic approach to the quadratic assignment problem. Comput Oper Res 22:73–83
[31]. Burkard RE, Rend F (1984) A thermodynamically motivated simulation procedure for combinatorial optimization problems. Eur J Oper Res 17:169–174
[32]. Tavakkoli-Moghaddain R, Shanyan E (1998) Facilities layout design by genetic algorithms. Comput Ind Eng 35(3/4):527–530
[33]. Helm SA, Hadley SW (2000) Tabu search based heuristics for multi floor facility layout. Int J Prod Res 38(2):365–383
[34]. Talbi EG, Roux O, Fonlupt C, Robillard D (2001) Parallel ant colonies for quadratic assignment pronlem. Future Generation Comput Syst 17:441–449.