Optimization Design of Facilities Layout in a Certain Machining Shop
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Abstract. The workshop facility layout design is an important link in the development process of enterprise management, production, reasonable layout of workshop facilities can not only improve the production efficiency, reduce cost and reduce the amount of logistics handling, but also conducive to employee safety and health, improve enterprise's comprehensive competitiveness, and less effective. In this paper, based on the theory of facility layout, this paper designs and improves the current situation of the facility layout of a machining workshop.

Introduction
The purpose of the workshop facilities layout is to keep the logistics in the workshop open, efficient, coordinated, safe and orderly operation. According to statistics, in a production cycle, transmission and waiting time in the proportion reached 90%-95%, for real time processing products accounted for a small proportion, but in the last 20%-50% manufacturing process will cost in material transport costs. Reasonable arrangement of facilities can reduce the cost of transmission and waiting for at least 10%-30%. In addition, the facility layout can accelerate the reasonable material treatment efficiency, reduce the residence time during the production process, and improve the production efficiency. It can also reduce the buffer capacity of the work piece and reduce the manufacturing system of the space scale, reduce the cost of investment in construction enterprises. In short, the production workshop equipment layout will have a direct impact on the overall performance of the whole system, such as logistics, information flow, production capacity, production efficiency, production cost, safe production, workshop layout reasonable design can give full play to the capacity of production system, to improve the quality of the products and production equipment utilization rate production flexibility, reduce logistics volume, improve the production environment, ensure employee health has positive significance.

Facility Layout Theories
Arrangement of facilities is the arrangement of the location of the different objects and the space of the working space. For factory production, any attention to the output of the layout of the problem has a qualitative consideration, that is, the requirements of these arrangements can be as far as possible to improve production efficiency. But because the mass production stage, the production of low complexity, the facility layout did not cause enough attention, only to the production of products, complex process needs the cooperation between the factories, including the design of the workshop layout issues gradually aroused people's attention.

Target of Facility Layout
The most basic requirement is to ensure the feasibility of production, so that the material can be processed space, workers can facilitate the production. From this point, as long as the space is large enough, the facility layout can ensure the feasibility of production. But because the factory is mostly a part of economic organization, the need to be able to achieve the production of goods more competitive in the market, therefore, infrastructure layout in the basic requirements, but also should be as much as possible to meet the various needs. Design personnel in the process of the layout of
the facilities, to consider the following objectives to facilitate. The first is to meet the needs of the production process, that is, to meet the basic requirements, of course, this is to meet the process, for different products according to different principles of the location of the functional area.

**Content of Facility Layout**

Facility layout design is to plan and adjust the location of different functional areas, so as to achieve the planning objectives. In the simple process of product production, the significance of plant facilities layout is not important, such as hand weaving, manual production of packaging boxes, etc., this simple process only need to plan production areas and warehouses. But for the complexity of the production process, the working procedure is as high as dozens or even hundreds of products, because the job position and personnel of the machinery and equipment layout will affect the manufacturing efficiency, therefore, must through the planning and design to improve the efficiency of production. We can see from the above analysis, the space, the cost of investment, technological process, scalability and security and other auxiliary factors will affect the facility layout planning, therefore, the contents of the facility layout design is that these and other factors may consider the existence of the factors, comprehensively considering the influence of various factors of production, and optimize the layout, so that these factors either do not interfere with the production process, or can promote the improvement of production efficiency.

**Principles of Facility Layout Design in Production Workshop**

According to the management objectives of the enterprise, the principles that should be followed in the facility layout of the production workshop should include: the overall comprehensive principle, the minimum principle of the total logistics, the minimum cost principle, convenience and safety and so on. From the point of view of the production process, the layout of the workshop should be adjusted according to the different products and processes. Such as large and bulky products, such as aircraft, and its facilities, the aircraft should be fixed, and the personnel and equipment around the aircraft layout. Therefore, from this point of view, there are several principles that can be followed by the production workshop (see Table 1.).

<table>
<thead>
<tr>
<th>Layout Modes</th>
<th>Lead Time</th>
<th>WIP Level</th>
<th>Technique Level</th>
<th>Flexibility</th>
<th>Machine Utilization</th>
<th>Manpower Utilization</th>
<th>Unit Cost</th>
<th>Maintenance</th>
<th>Investment Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Product-oriented Layout</td>
<td>Short</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Complex</td>
<td>Large</td>
</tr>
<tr>
<td>2. Process-oriented Layout</td>
<td>Long</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Simple</td>
<td>Small</td>
</tr>
<tr>
<td>3. Layout based on group technology</td>
<td>Short</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>4. Fixed position layout</td>
<td>Medium</td>
<td>Medium</td>
<td>Hybrid</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>-</td>
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</tr>
</tbody>
</table>

(1) Product-oriented Layout. Workshop facilities layout to the product as the core, to the good transfer between the various processes is for the main purpose of the facility layout. This principle is mainly applicable to the product of the process more, can be used in production line, because the process needs a better convergence and mutual non-interference, therefore, equipment and equipment should be placed in a certain order. The principle of product is more common in modern production, because the production process of modern products is more complex, need more equipment and more types of work. The process principle is most common layout of manufacturing shop, in line setting, a straight, rectangular, circular, horseshoe shaped and snake, generally takes the shape of the better and more simple, because simple layout is conducive to improve the production efficiency, the machining workshop common lathe as an example, to the principle of setting up the product workshop to raw materials semi-finished products to finished processing the order; in the assembly stage, hierarchical order of a plurality of semi-finished parts according to the group after the first period are matched, finally assembled.

(2) Process-oriented Layout. Process principle refers to the layout of facilities around the product process, this layout is in accordance with the role of the production in the role of similarity to the
organization and arrangement of the Department of equipment and facilities. In manufacturing enterprises, the workshop layout is grouped according to the function of the equipment, the same process or similar performance to the equipment are arranged in the same fixed locations, in the large injection molding equipment and casting products such as the production workshop, due to the large equipment is usually fixed, and the use of the mold, processing of different products in the same equipment so, the same technology can process multi class similar products. In the process of principle, not every processing equipment to the processing of many types of products, but the main processing equipment for processing various products, to lathe workshop as an example, the center link in the large NC machine tools is the process principle of the facility layout, and other aspects still can be arranged according to the assembly line.

(3) Layout based on group technology. Group refers to the process of production, part of the process need to be combined together to complete. Such as processing and assembly, pretreatment and processing sectors, when such a combination is more suitable for the workshop production, should be set up facilities layout groups related to the workshop, more efficient, to avoid the phenomenon with many twists and turns and cross. When using the group layout, the workshop generally presents a small regional pattern, the contact between each area is less, and the production activities within the region are more frequent. Group principle is the organic combination of process principle and principle of the product, because the actual production because of the characteristics of products, using a separate principle is very dogmatic, some of the factory manufacturing process layout is part of the improvement measures to enable the system to have the advantages of product layout, this makes the system not only has certain flexibility it has the characteristics of high efficiency and low cost. The group principle can be regarded as a family of parts with similar processing technology, and then the corresponding processing equipment can be grouped according to the processing unit. The lathe as an example, the characteristics of some products makes this kind of product in milling, boring and other such cars or just without further treatment by processing, characteristics so that it can be around this kind of product, process chain processing group, dedicated to the processing of such products or semi-finished products. Similarly, if in other links, these semi-finished products can also be used in combination process is very easy to process, it should be the equipment of these processes to the principles of process layout, in order to fix the processing of such products. This layout fully considers the characteristics of the product processing, can be processed in batches of semi-finished products, reduce product logistics time, improve production efficiency.

(4) Fixed position layout. Fixed principle means that the product manufactured by the workshop itself is fixed, not the product around the facilities and equipment, but the equipment moves around the product. This situation occurs in the special bulky goods, such as aircraft, large sculptures, etc.

Flow Pattern of Production Workshop

The workshop flow pattern generally refers to mobile mode, infrastructure layout in product principles, raw materials or semi-finished products in equipment flow between the different processes of processing and testing, and ultimately to the way to the mobile terminal products. Because there are also mobile logistics workshop, the workshop entrance position of logistics channel and key nodes can use different shapes to match, the use of letters to the analogy, it mainly has the following several modes:

I shape: also known as a straight line, is the most simple of a flow mode, the entrance and exit location relative, the building is only one span, the shape of a rectangle, the equipment layout along the channel on both sides.

L form: also known as the right angle, suitable for existing facilities or buildings do not allow a straight line flow situation, equipment layout and straight line shape, inlet and outlet were at the two adjacent sides of the building.

U shape: applicable to the entrance and exit in the same side of the building, the length of the production line is basically equivalent to two times the length of the building, the general building is two, and the shape is similar to the square.
O form: applicable to the requirements of materials to return to the starting point of the case.
S shape: in a fixed area, you can arrange a longer production line.

Optimal Design of Facility Layout in a Machining Workshop

Analysis on the Present Situation of Facility Layout in a Machining Workshop

The machine shop is a large pressure vessel manufacturing group supporting the workshop, the main processing object for the heat exchanger tubes, flanges, etc. The main processing steps are: turning, positioning management, drilling, milling, cleaning, etc., the main processing equipment: lathe, high speed drilling, radial drilling machine, milling machine, ultrasonic cleaning machines, etc. Figure 1. for the improvement of the facilities layout. Raw materials from the warehouse began to bypass the "tool warehouse" into the "turning area", after "positioning management area", "drilling area", "milling area" after bypass into the "cleaning area", and finally to the "finished". Here the obvious problems are: 1) The circuitous logistics, increasing the total length of the logistics, the corresponding logistics costs. 2) Adjacent operations not smooth by other functional areas of the barrier. 3) "Finished" from the "waste" too close, surface cleaning products are vulnerable to the impact of waste. 4) "Tool Warehouse" from the "Lathe", "high speed drilling machine, milling machine" is not reasonable, remote distance, affecting the efficiency of workers receiving and replacement of cutting tools and fixtures. 5) Operating area is not set Rest Area temporary employees, potentially affect employees' physical and mental health and work efficiency.

Optimization of Facility Layout in a Machining Workshop

Based on the above analysis, the existing facilities are arranged as follows: adjustment and optimization. Figure 2. layout for improved facilities.

From this chart, we can see that the logistics is a clear "U" - type flow, the logistics of the basic no detour, reentry, logistics efficiency is higher. The position of the "tools warehouse" is more reasonable than that of the previous. In addition to the "office" across the set "staff Rest Area", to ensure that employees can after high intensity work to relax and restore the body and mind reasonable area, helps to reduce employee dissatisfaction, and promote the improvement of production efficiency.
Conclusion
In this paper, the machining workshop is relatively simple, the product is relatively simple, so only the use of the layout of the production facilities, logistics and other theories to optimize the existing facilities layout of the organic processing plant. In the company of other more complex production process, will use the SLP method to optimize the overall layout of workshop facilities for more systematic improvement, in order to achieve the company's production logistics system level short distance, low cost, high production efficiency, safe operation environment and other comprehensive goals.

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References