Layout Intelligent Optimization of Chip Manufacturing Workshop by Simio Simulation Software

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Abstract: Workshop facility layout planning is a key part of manufacturing system. Nowadays customized products demand is increasing, thus developing a virtual layout can quickly respond to market in a flexible way. In this paper, the layout SLP method of workshop facilities is used to make reasonable layout plans of the original chip workshop facilities. Then, Simio simulation software is used to establish simulation models of workshop facility layout to analyze the advantages and disadvantages of each layout plan. Finally, the best layout plan is selected, so the total chip processing time can be shorter.

1. Introduction

Chip manufacturing workshop is a multi-stage production system. When using the multistep process, if the actual operating distance is too long, it will reduce the utilization rate of machine tool equipment and the overall output of the workshop. If companies want to stand out in the fierce competition, they must respond to market demands more quickly while producing chips that meet production requirements.

In recent years, semiconductor chips have been widely used in high-tech fields such as computers and communications, which has led to the rapid development of semiconductor manufacturing in the world. However, semiconductor manufacturing equipment is expensive and the manufacturing process is complicated, so it is not easy to change the layout of the factory. If the initial layout is poor, this will result in huge material handling costs and inefficient production, while re-layout will also cost a lot of manpower and resources.

Conversely, if the layout of the workshop is reasonable, this can minimize the floor space of the processing equipment, greatly improve the production and transportation efficiency and greatly shorten the material transportation time. These factors will greatly reduce production costs. According to research statistics, in the total cost of manufacturing, the proportion of material handling costs is as high as 20% to 50%. By optimizing the layout of the facilities, the cost can be reduced by at least 10%-30% [1].

2. Problem Description and Solution Strategy

2.1 Analysis of the Current Situation of B Company's Chip Manufacturing Workshop

Due to the complexity and small size of the chip, the actual production process steps are complicated. This study will simplify the production process of the chip. The specific steps are as follows (letter indicates the type of processing area):

Entrance → A→B→E→A→C→E→ B →D →A →Exit

It is known that the entire chip manufacturing workshop is rectangular in shape, 300 meters long and 220 meters wide. Each area has a width of 100 meters and the lengths are: area A (150 meters), area B (75 meters), area C (75 meters), area D (75 meters), area E (75 meters), Support Area (150

meters).Support Area does not participate in the actual processing, but it needs to be reserved as an auxiliary area. The detailed workshop layout requirements are shown in Fig. 1.

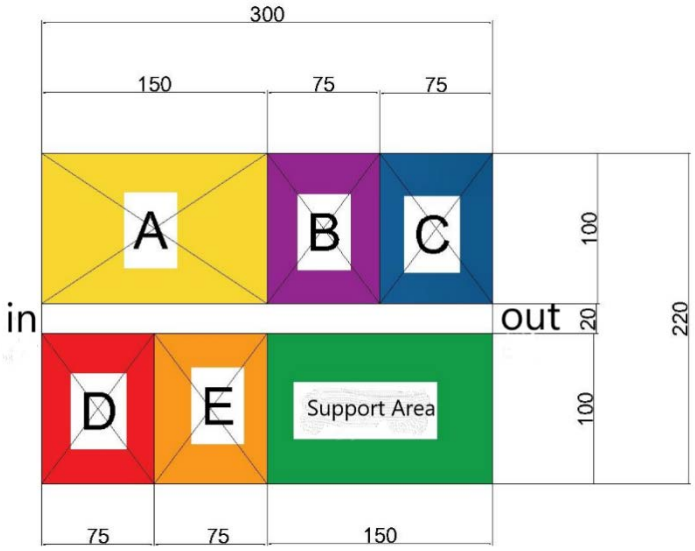

Fig. 1 Workshop Floor Plan Size Requirements

2.2 Workshop Layout Optimization Overall Thinking

First, a preliminary plan needs to be determined. Since each operating area is related to each other due to the order of chip processing, and each area has the required maximum area, the SLP system layout design method is used to determine three layout plans to make a reasonable initial decision.

Then, Simio simulation software is used to visualize and quantitatively analyze the three plans to establish a vivid model to simulate the actual production workshop. By running the model, relevant experimental data can be obtained. By comparing these data, the pros and cons of each plan can be evaluated.

Finally, the best one of the three plans can be selected. In this way, the better layout planning of the actual chip manufacturing workshop is designed.

3. SLP-based Workshop Layout Design

Workshop layout refers to the process of placing various production resources such as processing equipment, fixtures and shelves into a limited plant space. Reasonable factory layout can improve space utilization, save cost, shorten logistics path and improve equipment efficiency [2]. The SLP method was first proposed by Richard Muther. The method first collects and analyzes the basic data of the research target, and then integrates and compares the relationship between the relevant work units in the layout. The layout of the workshop is based on the close relationship between the work units [3].

Table 1. Total Material and Handling From-to Table

	Area A	Area B	Area C	Area D	Area E	Total
Area A	—	416	264	—	—	680
Area B	—	—	—	144	128	272
Area C	—	—	—	—	108	108
Area D	288	—	—	—	—	288
Area E	192	128	—	—	—	320
Total	480	544	264	144	236	1668

Since logistics factors are the key to determining production efficiency, various non-logistics factors are not considered for the time being. From the mutual distance between the various

processing areas, the total amount of logistics and handling is obtained from the from-to table as shown in Table 1.

Combined with the specific operation steps of SLP, the original logistics related table of the relationship between the reactants and the logistics can be established to show the degree of logistics association among all processing areas in a concise manner as shown in Table 2.

Table 2. Original Logistics Related Table

—	to	1	2	3	4	5
from	—	Machine A	Machine B	Machine C	Machine D	MachineE
1	Machine A	—	A	E	E	I
2	Machine B	A	—	U	I	E
3	Machine C	E	U	—	U	O
4	Machine D	E	I	U	—	U
5	Machine E	I	E	O	U	—

According to the actual area requirement of the processing area of the chip manufacturing workshop and the total area limitation, three feasible layout plans are obtained from the processing flow of the chip, as shown in the following Fig. 2.

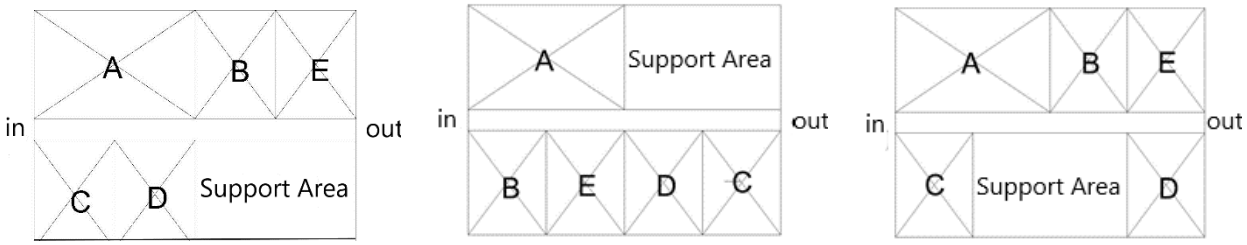

Fig. 2 Layout of Plan 1, 2 and 3

4. Simulation Test and Result Analysis based on Simio

Simio software is a simulation software that can realize a full 3D system, realistically simulate the shop layout scheme, and is widely used in manufacturing systems and logistics systems. Due to the Simio software version, the number of entities for simulation modeling is limited, and the number of employees and equipment in the original workshop needs to be compressed without affecting the operation of the system. In the simulation process, the distance parameters are set according to the actual measured values, and all raw materials, parts and tools are supplied in enough quantities, and there is no shortage. Employees have the same level of proficiency and remain efficient during continuous operations [4].

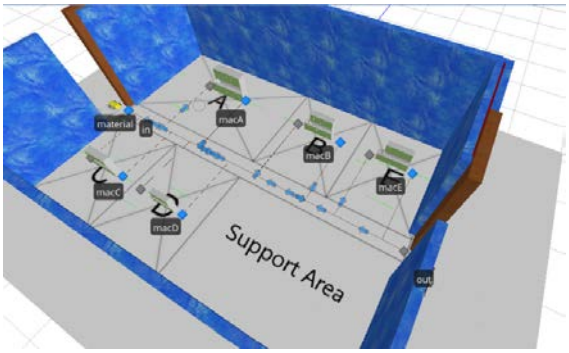

Fig. 3 Workshop Production Line 3D Simulation Model Diagram

In the simulation modeling process, it is assumed that the same type of chip is replaced by the same temporary entity. And because the chip product is light in weight and small in size, in order to simplify the model, no handling tools and operators are added to the production line. 3D simulation modeling is shown below in Fig. 3.

After the simulation model is finished running, the simulation results can be viewed in the Results module. The results are then imported into an Excel spreadsheet for statistical analysis. Flow Time can reflect the influence of the shop layout on the efficiency of the production line. Therefore, this study evaluates the layout of the chip manufacturing workshop from this aspect. The comparison results are shown in Fig. 4.

				Layout 1	Layout 2	Layout 3
Entity Name	Sort	Data Item	Type of Data	Value	Value	Value
material	Content	NumberInSystem	Average	1.671975	1.59253	1.643507
material	FlowTime	TimeInSystem	Average	0.007015	0.006682	0.006896
Path1	Content	NumberOnLink	Average	0.082755	0.087058	0.08441
Path1	FlowTime	TimeOnLink	Average	0.000347	0.000365	0.000354
Path10	Content	NumberOnLink	Average	0.191329	0.190005	0.191991
Path10	FlowTime	TimeOnLink	Minimum	0.000803	0.000797	0.000806
Path2	Content	NumberOnLink	Average	0.145317	0.128435	0.152269
Path2	FlowTime	TimeOnLink	Average	0.00061	0.000539	0.000639
Path3	Content	NumberOnLink	Average	0.118174	0.123139	0.120822
Path3	FlowTime	TimeOnLink	Average	0.000496	0.000517	0.000507
Path4	Content	NumberOnLink	Average	0.260843	0.132076	0.233368
Path4	Content	NumberOnLink	Maximum	4	3	4
Path4	FlowTime	TimeOnLink	Average	0.001094	0.000554	0.000979
Path5	Content	NumberOnLink	Average	0.145648	0.197287	0.129097
Path5	FlowTime	TimeOnLink	Average	0.000611	0.000828	0.000542
Path6	Content	NumberOnLink	Average	0.215162	0.210197	0.231713
Path6	Content	NumberOnLink	Maximum	3	3	4
Path6	FlowTime	TimeOnLink	Average	0.000903	0.000882	0.000972
Path7	Content	NumberOnLink	Average	0.18206	0.156241	0.148958
Path7	FlowTime	TimeOnLink	Average	0.000764	0.000656	0.000625
Path8	Content	NumberOnLink	Average	0.180736	0.18206	0.120822
Path8	FlowTime	TimeOnLink	Average	0.000758	0.000764	0.000507
Path9	Content	NumberOnLink	Average	0.149951	0.186032	0.230058
Path9	Content	NumberOnLink	Maximum	3	3	4
Path9	FlowTime	TimeOnLink	Average	0.000629	0.000781	0.000965

Fig. 4 Flow Time Situation Comparison

From the above, the average total flow time of the layout 1 is 0.007015, the average total flow time of the layout 2 is 0.006683, and the average total flow time of the layout 3 is 0.006896. The average total flow time of layout 2 is the shortest, so layout 2 has the highest production efficiency.

5. Summary

This paper uses the Simio simulation model to simulate the layout of the shop floor, which has the advantages of strong visualization and object orientation. And the experimental research data is generated based on the simulation, which can reduce the cost of data acquisition. Then by analyzing the data statistically, the operation accuracy of the model is greatly improved.

On the other hand, when simulating modeling with Simio software, the usage rate of each processing area is considered shallow. If these conditions are taken into account, it will have practical value for the simulation results of the model. And the layout of the workshop belongs to a more complex discrete system. When using Simio software simulation, only the narrow processing area layout is considered. So, if factors like material handling equipment and staff location are taken into consideration, this paper will have more extensive research significance.

References

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