CHAPTER 3

METHODOLOGY AND CURRENT PLANT LAYOUT

3.1 Overview of methodology

This chapter will discus in the methodology of designing new plant layout and the current plant layout that is being used. The current plant layout will be studied and analyzed the flow of work and the characteristic of work, in order to use as an example and to develop the new plant layout. For the methodology, the detail of how to research and collect the data will be described and discussed in this chapter.

According to the research procedure in chapter 1, the methodology can be divided into 3 steps. It will start at the study of the current plant layout; the material flow, location of the department, and the requirement of equipment will be studied and used as a guideline for the designing new plant layout. All the data of current plant layout will be collected, analyzed, and used for designing new plant layout under on the criteria of designing. After all data is studied, the improvement of plant layout will be designed in the new available space with the number of alternatives. Finally, the improvement of each new plant layout will be evaluated whether it meets the expectation or not and the best layout will be chosen.

In analyzing the existing plant layout, all the detail of the existing plant, which are the area and dimension of the existing plant, the location of the department, the flow of material, and capacity of the plant will be analyzed and identified the problems.

3.2 Existing Plant

The existing plant of the company is located in the middle area of the Bangkok. The area of the factory is 1369 square meter. Machines, departments, material handling devices and the dimension in the factory area will be shown in the following figure. According to the type of layout, the existing plant layout can be classified into process layout (Fig 3.1).

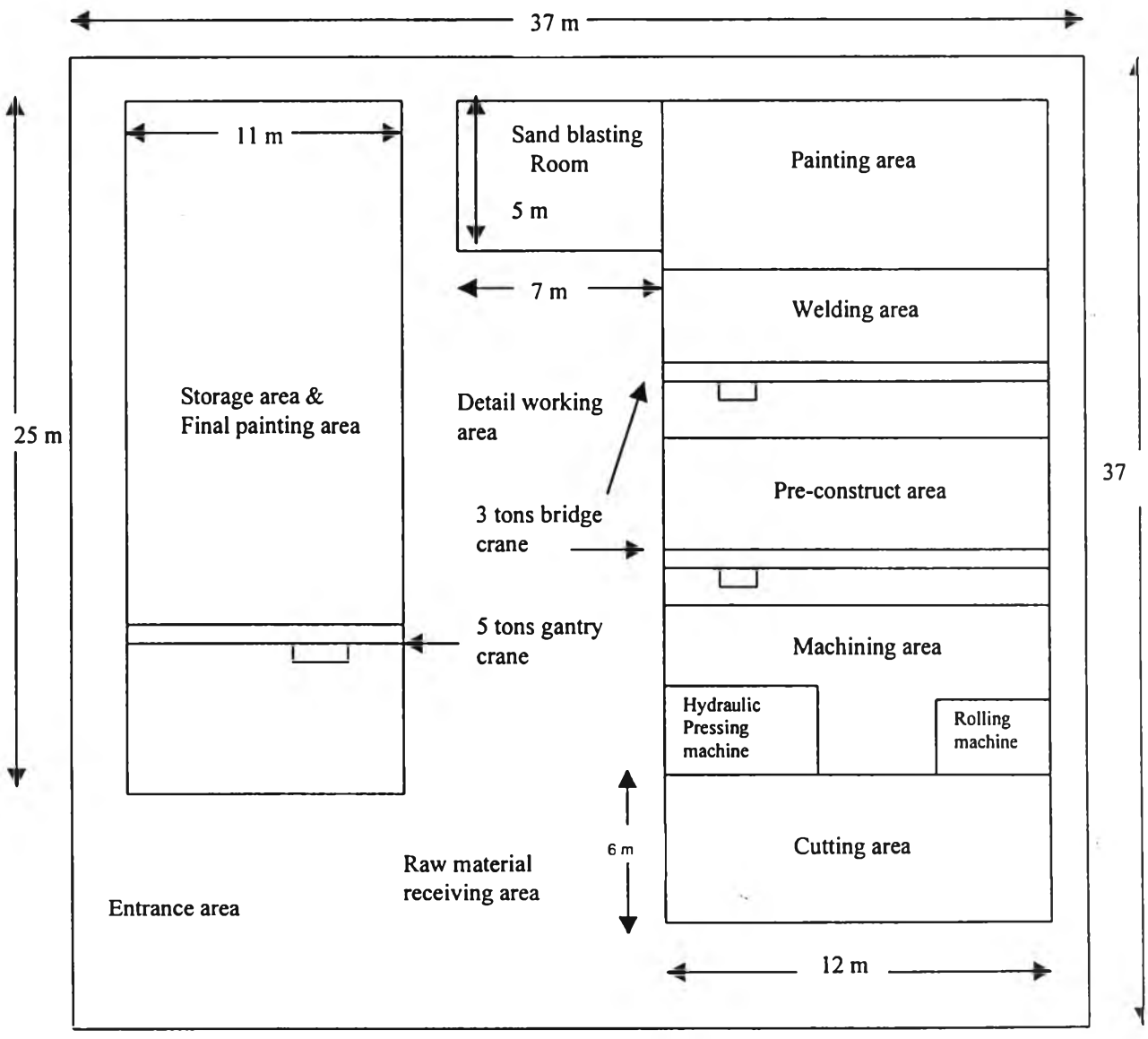


Figure 3.1: Existing plant layout

3.3 Type and quantity of the production

The quantity of the product is the important aspect to concern in designing the new plant. The different quantity of the product will result in the different size and capacity of the factory. This concerns to the layout of the factory.

From the historical data, the company usually had been making the various types of products; the following are the product range of the company.

1. Pontoon
2. Oil tank
3. Cylinder tank

The quantity of the product usually depends on the customer demand. Each project has a different quantity of the product and different specification. For the past 4 years the company had made mostly 4 types of pontoon, which has a minor different in specification.

Types of pontoon

1. SD 03/41 (Fig 3.2)
2. EPP 203
3. EPPS 01/44
4. EPPS 02/4

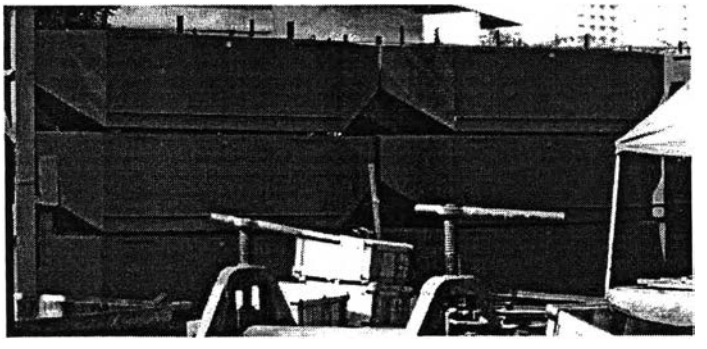


Figure 3.2: Pontoon SD 03/41

The following table shows the detail of the quantity and type of product made each year during year 2000-2004

Note: (1 set of pontoon composes of 2 pieces of pontoon, left side and right side)

Table 3.1: Quantity of pontoon (set, 2 pieces) acquired from bidding in year 2000-2003

Year	Pontoon (SD 03/41)	Pontoon (EPP 203)	Pontoon (EPPS 01/44)	Pontoon (EPPS 02/44)	Total
2000	82	10	-	-	92
2001	97	32	-	-	129
2002	80	-	43	27	150
2003	40	-	-	-	40

Also the company had some projects of making steel tube. In year 2001 the company made the steel tube in the amount of 650 pieces.

From the historical data, the capacity of the company can be estimated. However, as the company acquired the job from bidding process, it also depends on the price that company offered. Some of the year the company did not use full capacity of work. The company will increase the overtime work when higher of quantity is needed. From having the limited period of time for making product, usually the time allow of 40 sets of pontoon is 75 days started from the date of signing contract.

In this project, the base size of the production will be set as 40 sets of pontoon (80 pieces) per 75 days, as equal to the time allow for 2003 project.

3.4 Flow of material

The following chart shows the flow of material in making the pontoon.

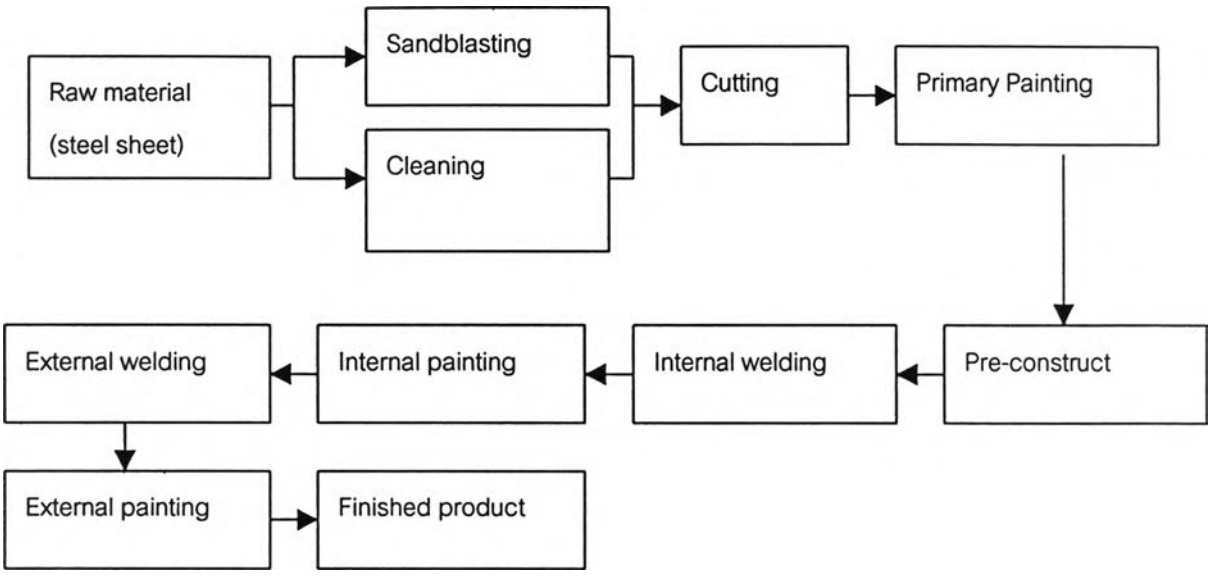


Figure 3.3: Flow of material

3.4.1 Flow process chart

The flow process chart will shows all the activities in the process of manufacturing the pontoon. The data of this chart will contain the measurement of time consuming in each activity and also the distance of the product movement.

From the studying of the flow process chart, we can clearly see more on the performance of each activity, also the non-value-added can be identified and improved.

Table 3.2: Flow process chart of existing plant layout

	Description	Time/1set of pontoon	Department	Total time	Distance	Total distance
1	Cut 6 pieces of the steel sheet (excluding top part)	4 hours	Cutting department	4 hours		
2	Deliver to the sand blasting area	20 minutes	Cutting department	4 hours 20 minutes	30 meters	30 meters
3	Sand blasting process	4 hours	Sand blasting room	8 hours 20 minutes		
4	Deliver back to cutting area	20 minutes	Cutting department	8 hours 40 minutes	30 meters	60 meters
5	Apply the first layer painting to the steel sheets	1 hour 30 minutes	Painting department	10 hours 10 minutes		
6	Wait for the paint to dry	1 hour	Cutting department	11 hours 10 minutes		
7	Deliver the steel sheets to machining area (2nd area)	30 minutes	Machining department	11 hours 40 minutes	6 meters	66 meters
8	Apply pressing process for a required shape	1 hour	Machining department	12 hours 40 minutes		
9	Deliver to the pre-construct department (3rd area)	10 minutes	Pre-construct department	12 hours 50 minutes	6 meters	72 meters
10	Pre-construct each steel sheet into a pontoon shape	1 hours	Pre-construct department	13 hours 50 minutes		
11	Inside welding	2 hours	Welding department	15 hours 50 minutes		
12	Construct internal structure	8 hours	Pre-construct department	23 hours 50 minutes		
13	Deliver to welding area (4th area)	10 minutes	Welding department	24 hours	6 meters	78 meters
14	Inside structure welding	4 hours	Welding department	28 hours		
15	Outside welding	2 hours	Welding department	30 hours		
16	Internal cleaning and inspecting	2 hours	Welding department	32 hours		
17	Deliver to painting area (5th area)	10 minutes	Painting department	32 hours 10 minutes	6 meters	84 meters
18	Internal painting	2 hours	Painting department	34 hours 10 minutes		
19	Wait for the paint to dry	18 hours	Painting department	52 hours 10 minutes		
20	Deliver back to welding area (4^{th} area)	10 minutes	Welding department	52 hours 20 minutes	6 meters	90 meters
21	Welding top side of the pontoon	2 hours 30 minutes	Welding department	54 hours 50 minutes		
22	Deliver to painting area (5th area)	10 minutes	Painting department	55 hours	6 meters	96 meters
23	Finish detail work (closing man hole, drill hole, cleaning)	3 hours	Painting department	58 hours		
24	Deliver to storage area	30 minutes	Storage area	58 hours 30 minutes	19 meters	115 meters
25	Paint the 2^{nd} layer	1 hour	Storage area	59 hours 30 minutes		
26	Wait for the paint to dry	8 hours	Storage area	67 hours 30 minutes		
27	Paint the 3rd layer	1 hour	Storage area	68 hours 30 minutes		
28	Wait for the paint to dry	24 hours	Storage area	92 hours 30 minutes		
29	Transfer the product to the truck	1 hour		93 hours 30 minutes	20 meters	135 meters

3.4.2 Simulation output

Having the complicate flow of material alongside with the large number of queue, running the simulation program will ease the difficulty in finding the production time. In this project, the Arena Siman will be used as a simulation program to find the relevant data. The constraint of running the simulation program will follow the information in the flow process chart.

The following table will show the output of the relevant data from running the simulation of the existing plant.

Table 3.3 Simulation output of the existing plant layout

ARENA Simulation Results
Summary for Replication 1 of 1

Project:Existing Plant — Run execution date : 8/15/2004
Analyst:Jobshop — Model revision date: 8/15/2004

Replication ended at time: 75,850

TALLY VARIABLES

Identifier	Average	Half Width	Minimum	Maximum	Observations
avgflowtime	12998.	(Insuf)	6510.0	14500.	80
cycletime	877.72	(Insuf)	245.33	1325.3	79
overallidletime	186.25	13.058	.00000	6998.6	2800
craneutilization	.1285	.012985	.00000	1.0000	.00000

COUNTERS

Identifier	Count	Limit
jobdone	80	Infinite

Simulation run time: 0.00 minutes.
Simulation run complete.

From the data in output, it shows the relevant data of the existing plant layout. Each of data will be explained in the follow paragraph.

From looking at the flow process chart of the existing plant layout, time of producing a pontoon consumes approximately 93 hours 30 minutes. However, these data is calculated from only the first piece of pontoon that passed through all the process. When running all the 80 pieces of the pontoon, the delay time caused from the bottleneck will be occurred. Then it is not sufficient to this data to analyse.

The replication end time is the data that shows length of time to finish the production of the 80 pontoons. All the number output data has a time scale in minute, which the replication end time or make span is 75,850 minutes. By constraint of running the program in 24 working hours per day, this shows that the overall production time for producing 80 pontoons is approximately 53 days.

The average flow time in the existing plant layout, the time that each pontoon takes in the production line, is 12998 minutes or 9.03 days.

The cycle time of production is the gap between each finished product, which goes out of the production line. It shows that the cycle time of the product in existing plant is 877.72 minutes or 14.63 hours

Overall idle time shows how long and how many times that idle has happened. The observation will show that how many times the idle time has happened in the system. For the existing plant layout the average idle time for each idle is 186.25 minutes or 3.1 hours and it happened for 2800 times.

In the simulation program the over all idle time is classified into 3 types according to the appendix which are the idle time waiting for the operation (idletimeq),

idle time waiting for the crane to transfer (idletimecrane), and idle time waiting for the space in the next operation (idletimescanq).

Crane utilization shows how many percent the cranes are used in the production of 80 pontoons. The percentage of using crane is compared to the replication time of producing 80 pontoons. In the existing plant the percentage of using cranes is 12.85 of time in producing 80 pontoons.

3.4.2.1 Validation of the simulation model

Before using the result from the simulation program in analysing the performance of the existing plant, the data acquired from the program will be compared to the historical data in order to validate the result whether the result is from running simulation is practical to used or not.

Taking from the historical data of the company, in year 2002 when there were 2 projects of 80 pontoons. The production time of both projects was 54 days and 55 days consecutively. By looking at the time acquired from the simulation program of running 80 pontoons, which the production time is 53 days, this can be said that the validation of the model is quite accurate. So the simulation program will be further used in running the for the other design layout.

3.4.3 Flow diagram

Flow diagram shows the route and the direction of the material in the plant layout, it is easy to see where the process is going. This also shows the location of the department, which helps to identify the position of each department whether it is located in the suitable place or not.

By looking at the flow diagram (Fig 3.4), it can be seen that the current plant layout has quite a complex of material flow especially between painting area and welding area.

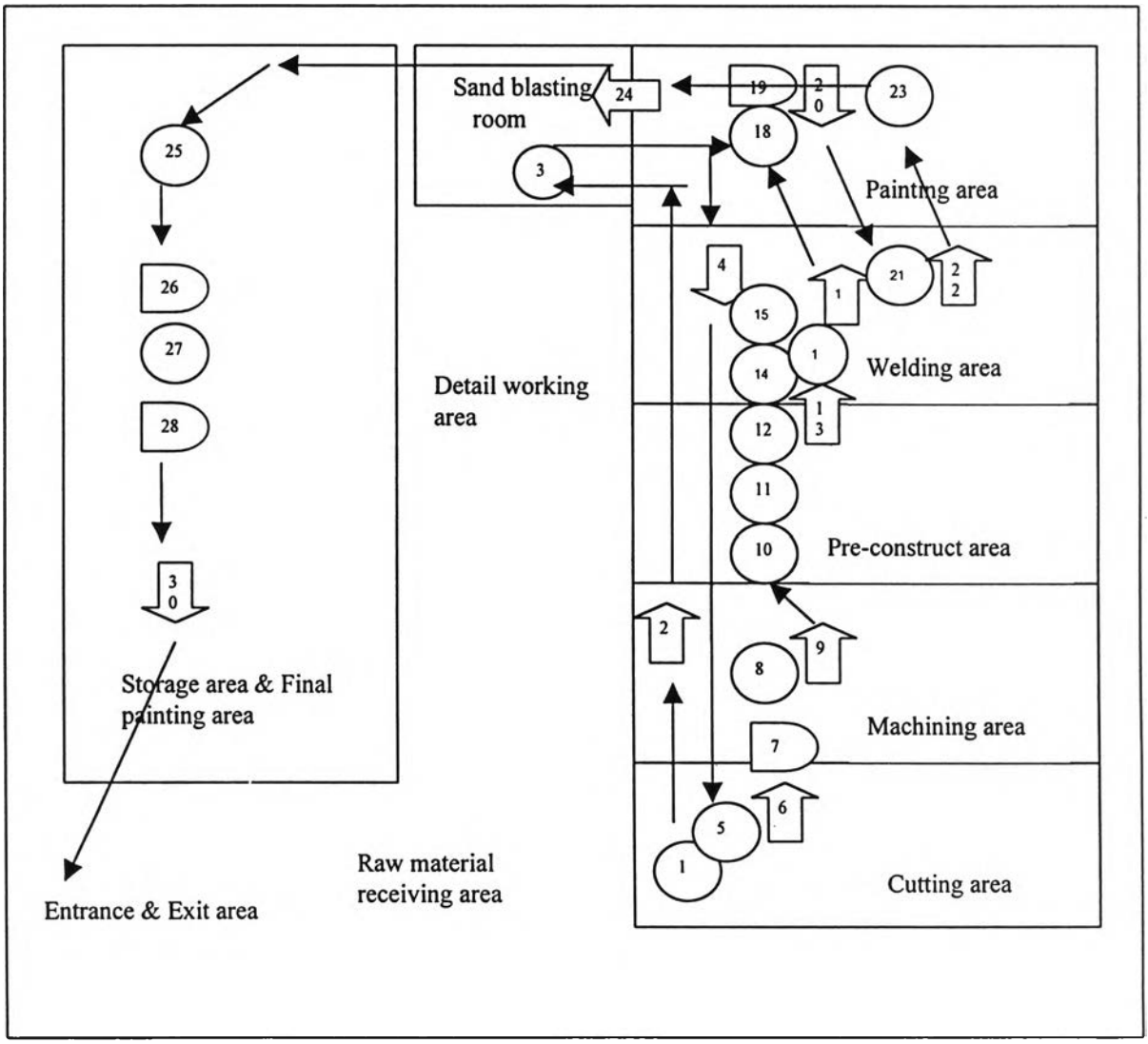


Figure 3.4: Flow diagram of existing plant

3.4.4 Cycle time of the product

Usually company will be given the period of time to make the product. Mostly for the pontoon type, the time given will be 75 days for 80 pontoons. Excluding the document work at the early period of 75 days the company can finish the product of 80 pontoons in 60 days. By having the measurement the cycle time from the simulation program, the cycle has found to be an approximately 14.63 hours pontoon per day.

However, from time to time the company has found some difficulty in finishing the project within a given period. This problem is overcome by adding the overtime work, which adding more expense to the company.

3.4.5 Distance of moving the material handling (crane)

The distance of using the material handling, not include when the material handling is not occupied, is 135 meters from the beginning of the production until the end of the production.

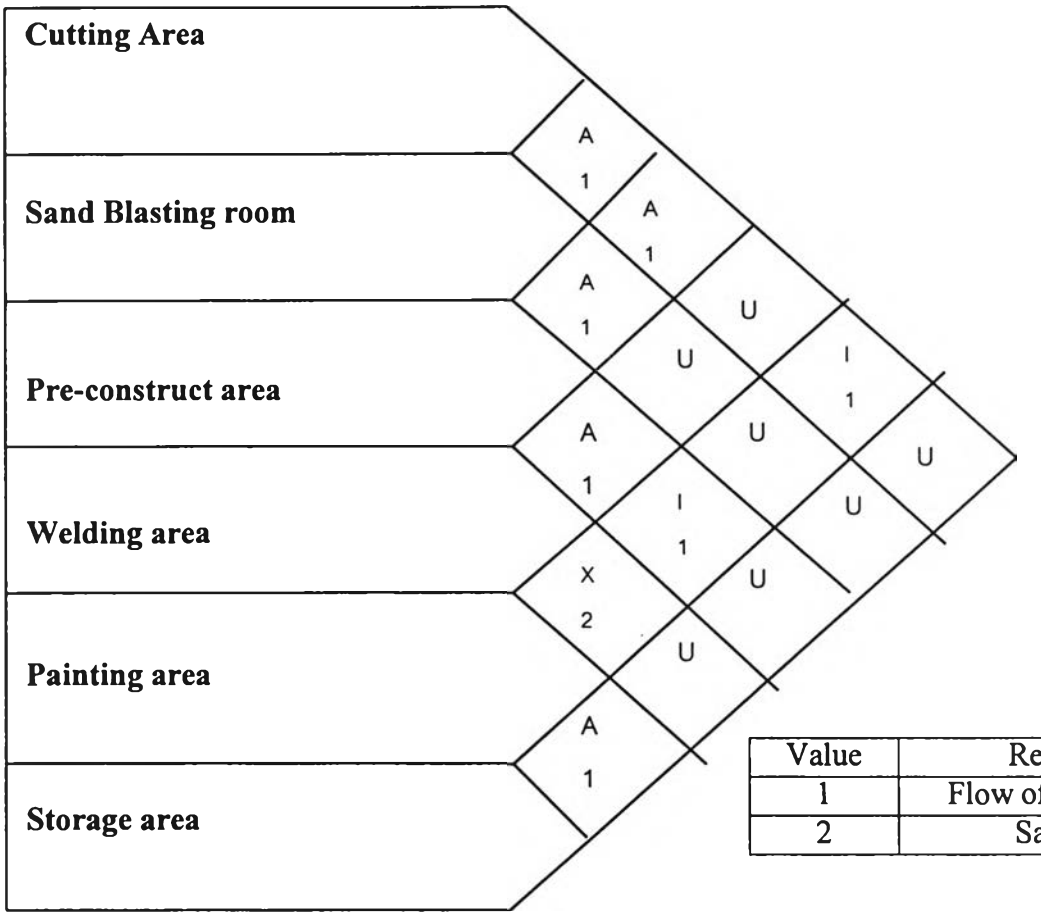
Note that the distance will be measured at the centre of the working area and in only 2 dimensions which is back and forth, the distance of going up, down, left, and right will be neglected in order to make the measurement easier.

3.5 Closeness Relationship chart

The closeness relationship chart (Fig 3.5) shows the relationship between each department in the aspect of department's location. The rating indicates the importance of locating department pairs next to each other.

The most closeness of each department will be categorized in to 6 alphabets, which indicates the proper relationship between each department.

From observation of the working characteristic, the relationship between each department is shown in the following figure.



Value	Reason
1	Flow of Material
2	Safety

Symbol	Closeness
A	Absolutely necessary
E	Especially important
I	Important
O	Ordinary
U	Unimportant
X	Undesirable

Figure 3.5: Closeness Relationship chart

By looking the closeness relationship chart, the most important factor to be concerned is the location between welding area and painting area. These two departments can cause the accident, which the company used to have before. The reaction between the spark from welding and the wet paint can be very explosive.

Another concerned in the closeness relationship will be the flow of the process, because the better position of the department located along with the flow will mean the more effective work.

3.6 Worker capacity

The worker capacity is the quite the most important factor of production system. Having most of activities depend on the capacity of worker along with the worker's equipment, this aspect will be concerned in the part of production performance. In each department there are numbers of worker running each operation. Each operation requires different number of worker. The following table will show the amount of worker in each department in the producing the pontoons.

Table 3.4: Number of workers in Existing plant

Operation	Number of workers
Cleaning	4
Sand Blasting	1
Painting	16
Welding	10
Pre-constructing	10
Cutting	4
Total	45

The capacity of the welding equipment (Fig 3.6) will be equal to the number of worker in welding area, pre-constructing area, and cutting area which are 24 units of welding equipment. The welding equipment consists of one electric generating box and one welding device. At each one welding activity will need welding equipment at each point. Painting equipment will have the same concern as the welding equipment.

Figure 3.6: Welding equipment

The standard payment to the worker is 150 Baht per day for 8 working hours. From the amount 45 workers, the company needs to pay 6,750 Baht per day. By using 53 days to finish the 80 pontoons, the labour cost will be 357,750 Baht.

3.7 Problem in the existing plant

By looking at the process of the existing plant, main problem of the company is lacking of space to work. Especially in the welding and painting department since the product need to go back and forth twice between these two departments. And the space in these two departments can keep only 4 pieces of product in one at time (Fig 3.7). Also the space between each pontoon is quite too small. From the measurement, the space for a worker, including the equipment both welding and painting, to work at the left side and right side of the pontoon is approximately 0.75 meter. Then the space of 1.2 meters will be the problem when the workers are working at the same position for different pontoon.

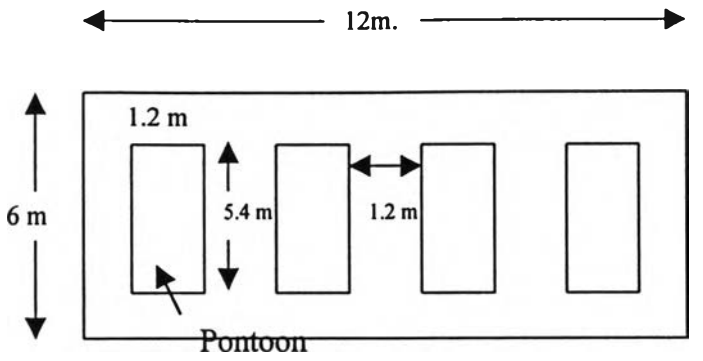


Figure 3.7: The area of each department in existing plant

The problem in detail is after inside and outside welding the product needs to move to painting department to receive the painting process and then move back to the welding process in order to get the welding process of the top of the product. Then transfer back again to the painting department to get the detail painting process again. Having product transferred back and forth between two processes, this increases the material handling work. It also, most of the time, cause the idle time from the waiting another department to be available. At this point of process, it can be said that it is the bottleneck of the flow. If the company can increase the space for these two areas and relocate these two departments the company can increase the capacity of the work and make the workflow move better.

The capacity of sandblasting room area can be working only 1 pontoon at a time, however the size is quite suitable and relate to the existing plant capacity. For the problem of lacking of space in existing plant area, increasing the capacity of existing plant area will consequence to the increasing of sand blasting afterward.

Currently, at the full capacity of worker, the company uses 45 workers because adding more workers does not increase the capacity of work because of the limitation of the space. Only overtime work will help to increase the capacity of work. In this project,

the worker will not be the constraint, since more workers will be available for added capacity of the new designed plant.

Also the position of the department located is one of the problems of the existing plant. The sand blasting area, which located in an unsuitable place, after the cutting process the sand blasting process will be followed. By looking at the location of these two areas, which are quite far apart from each other, this creates a lot of material transfer between these two processes.

Another problem is the limitation of the storage area. In the existing plant layout the space of the storage area, same area as a final painting area, is not quite enough to keep the finish product and to perform the final painting process. Maximum number of the product that can be kept in this area is 30 pieces of pontoon. By having this problem, the company has to deliver the product to the customer in order to have the space to keep the incoming of finished product. Many times that the finished product can not deliver out because the customer is not ready to receive the product, this leads to the non continuous work flow. The workers need to stop working until the finished product is delivered out to the customer.