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Pull system implementation in a welding area

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Abstract

Our project took place in a welding area which supplies two production lines of a large company in Puerto Rico. The company is divided in four areas: fabrication, welding, assembly and molding. Management wants to implement the pull system and decided to begin with the welding area. Afterwards they will implement the system in the other areas of the company.

that are "person moveable"; the ideal container quantity should be no more than 10% of a day's usage of the part.[1]

Our project consists in establishing the pull system in the welding area for production lines TQD and TQDL. We will determine the approximate cost for the implementation of the pull system and using different techniques or concepts of industrial engineering we will fulfill all the objectives of the project.

Project description

Some steps must be followed to implement the pull system. First, the flow of materials, capacity, demand, bill of materials, the operation process, inventory (work-in-process) and scrap percentage must be analyzed.

After analyzing the present situation, we will begin implementating the pull system by designing the signal cards, the containers, and the new layout. The signal card will have the necessary information, such as the part number, part name, lot quantity, container name, card number and the work center the part comes from or goes to. The design of the container requires the lot size and its measurements. To determine the lot size, we need to balance the line. The lot size should not exceed 10% of the daily demand to maintain a minimum inventory or 44 pounds if it is necessary for a person to move the container. Each container will have a signal card. The design of the new layout will take into consideration the reduction of the material handling and the better use of the space available.

Finally, after studying different alternatives, we will select the most suitable and simulate them to investigate all possible results.

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[1] Wantuck, K. A., 1989, *Just in Time for America: Common Sense Production Strategy*, Forum, Milwakee, WI, pages 261-266

Objectives

Every company has the goal of maximizing profits. One way to do this is by increasing the sales while simultaneously reducing the inventory and operational costs. To reach the goal in this project we must comply with the following objectives:

- Keep all of the manufacturing activities synchronized (production schedule).
- Establish a minimum balanced inventory
- Establish direct communication between the different departments
- Maintain control of the materials and improve their flow
- Reduce the costs of production and inventory
- Perform the simulation of the proposed system for validation
- Reduce the handling of materials

Project justification

Because a company must watch for the constant improvement in maintaining a competitive level, it must update and analyze its processes. For this reason the administration of this plant wants to make some changes in the different sections of the plant.

There are many reasons to justify this project. The most important is that management wants to implement the pull system in all its plants in Puerto Rico. Other reasons that justify the implemention of this project are:

- Reducing costs of production and inventory by about 50%

number of poles because we need a sub-assembly per pole.

We performed a work sampling to know the capacity, idle time and equipment used over the TQD and TQDL areas. During the sampling, 21 observations per welder were recalled, that is, 252 observations in total. Table 5 shows the idle percentage per welder.

Table 3. Present distribution of welding machines and overtime

Welder	P/N	Hours/oper.	Hours/day	Overtime (hrs)
1	OP2-141G?	13.14	13.14	6.74
2	793A268G2	4.752	4.752	N/A
3	793A105G5	6.312	---	---
	793A105G6	7.364	13.676	7.276
4	OP1-139G3	11.76	11.76	5.36
5	OP1-141G?	15.66	15.66	9.26
6	OP1-511G?	3.696	3.696	N/A
7	OP1-511G?	4.144	---	N/A
	192A7872G1	1.088	5.232	N/A
8	793A141G?	9.4875	9.4875	3.0875
9	567B511G?	4.2	4.2	N/A
10	793A139G3	11.76	11.76	5.36
11	192A7286G1	0.416	---	---
	192A7286G2	0.416	---	---
	192A8110G1	1.032	---	---
	OP1-8110G?	0.808	2.672	N/A
12	567B505G7	0.532	---	----
	567B505G8	0.532	---	----
	192A7776G2	0.536	---	---
	192A7776G4	0.536	2.136	N/A

We analyzed the work sampling in general form, and concluded that the present use of the equipment was about 67% and the idle time was about 33%. During the work sampling, we took notes from the results of the idle time and we found that 11.9% of this time the welders were without material, 3.57% in breakdown and 4.37% in set-up. As can be seen, the present capacity is 80% of the total hours. Each welder can be used during eight hours (one shift) and we have 12 welders, but the capacity is not 96 hours because we need about 20% to cover the breakdowns, set up, etc. The actual capacity is 76.8

hours.

Also, we analyzed the manufacturing lead time of each sub-assembly. In the present system, the last operation of each sub-assembly will determine its lead time, because they have on inventory the previous operations: Table 6 shows the present manufacturing lead times of each subassembly.

Table 4. Annual demand of breakers

	Demand			
	1993		1994	
Month	TQD	TQDL	TQD	TQDL
January	120,443	9,154	91,848	6,744
February	75,199	8,142	77,298	6,650
March	73,959	7,398	87,806	6,844
April	104,350	8,596	103,039	8,762
May	83,341	7,006	95,135	7,804
June	89,358	10,040	96,068	8,676
July	122,395	6,340	120,594	9,638
August	99,693	10,462	106,579	8,192
September	95,743	5,942	97,968	7,806
October	114,559	8,068	123,041	8,672
November	95,194	7,294	85,518	7,422
December	63,534	7,554	90,080	8,964

Table 5. Idle time per welder (percentage)

Welder	Busy (%)	Idle (%)
1	95	5
2	67	33
3	67	33
4	76	24
5	100	0
6	38	62
7	90	10
8	86	14
9	0	100
10	76	24
11	43	57
12	71	29
Total	67	33

The pull system design takes into consideration the following:

1. 80% real capacity

   - One working day = 8 hr.
   - 12 machines * 8 hr. = 96 hr.-machine
   - 80% * 96 hrs.-machines = 76.8 hr.-machine
   - Each machine = 6.4 hr.-machine

2. 20% protective capacity

   - 96 hr.-machine - 76.8 hr.-machine = 19.2 hr.-machine
   - Each machine = 1.6 hr.-machine

The protective capacity is for machine down, material shortage, set-up and shutdown.

We analyzed the reduction of the lot size for reducing the inventory. Also, we considered the lot size to avoid creating a buffer in the working process. The only way to do this is using a continuous flow. The lot size should be as small as possible, because the employee union does not accept an operator loading parts.

Therefore, the analysis to decide whether to determine the lot size of a specific part may be done by balancing the lines. This means assigning two or three welding machines simultaneously for the operations because it is impossible to eliminate or to add elements to an operation.

We used assembly number 793A141G? and performed a welders distribution. A new material flow was obtained (appendix 1, figure 5). The welders are back to back in two rows. If any welder takes a part from the closer welder, he/she can take the parts with his/her hands. However, the welder is so far away that a conveyor must be used for transporting the part.

To make the production schedule we need the lot size and the standard times. The company gave us the real data for the years 1993 and 1994. With this in mind we made the forecast for year 1995 using the Statgraphics Software and the Winters Exponential Smoothing Method. The values of the smoothing constant for TQD were alpha = 0.21, beta = 0.01 and gamma = 0.11, and for TQDL were alpha = 0.1, beta = 0.36 and gamma = 0.1. Table 8 shows the production forecast for 1995.

Table 8. Production forecast for 1995

Period	TQD (Poles)	TQDL (Poles)
1	123,445	9,287
2	79,251	8,621
3	78,854	8,190
4	109,210	9,911
5	88,398	8,392
6	94,200	12,054
7	128,219	8,328
8	105,354	13,134
9	100,907	8,057
10	121,414	10,982
11	99,607	10,151
12	69,309	10,956

We used a daily average production, considering 240 production days per year. The daily average production for TQD was 5,000 poles and for TQDL was 492 poles for the year 1995. Using the forecast data we made the welders distribution, starting with the sub-assembly 793A141G?. We used 12 welders to make the welder sub-assemblies during 5.32 hours per day. With the rest of the time we made the other sub-assemblies, except for sub-assemblies 793A105G5 and 793A105G6. For these sub-assemblies we need two additional welders. Table 9 shows the welders distribution. The total hours required per welder in four machines exceeds the real capacity of 6.4 hours per day, but the excess time is negligible (the worst case was 14 minutes). The excess time is covered with the protective capacity. In this schedule we

Next, we performed the simulation of the sub-assembly 793A141G to see the possible results that can take in place. We studied several alternatives and found one with the smallest manufacturing lead time and better equipment use. Table 11 shows the proposed manufacturing lead times of each sub-assembly. The difference between present and proposed lead times is the result of the quantity of machines per operation and the quantity of parts.

Table 11. Proposed manufacturing lead times for each sub-assembly

Sub-assembly	Manufacturing lead time
793A141G?	5.32
567B511G?	1.82
793A105G5	6.18
793A105G6	5.97
192A8110G1	1.28
192A7776G?	154

From the simulation we obtained the idle, busy, and blocked percentage per welder during the 5.32 hours that took the sub-assembly 793A141G. We ran the simulation five times and calculated an average of the time that took the simulation and the idle, busy, and blocked percentage. After averaging the percentages we converted this to hours per day. Table 12 shows the results of the simulation per machine for the sub-assembly 793A141G.

To calculate the total idle time per welder, we added the idle time from simulation for 793A141G, the idle time from the others operations, and the protective capacity. We then converted the idle time and equipment use percentage from hours to percentages. Finally, we calculated an average idle and equipment percentage use, as table 13 shows.

Finally, we designed the signal card for the containers that came from fabrication or assembly lot. The signal card has the part number, part name, lot quantity, family group, card number, and work center from which it comes or from which it goes to.

Table 12. Results of the simulation for each machine for 793A141G

Welder	Idle (hr)	Busy (hr)	Blocked (hr)
1	0.094	4.452	0.771
2	0.078	4.763	0.475
3	0.077	4.768	0.472
4	0.000	5.106	0.211
5	0.000	5.000	0.211
6	0.103	4.935	0.280
7	0.112	4.922	0.283
8	0.313	5.014	0.000
9	0.297	5.020	0.000
10	1.180	4.137	0.000
11	1.029	4.288	0.000
12	3.678	0.810	0.192
13	0.430	5.970	0.000
14	0.220	6.180	0.000

Table 13. Average idle time and equipment use

Welder	Idle (hr)	Idle (%)	Equipment capacity (hr)	Equipment capacity (%)
1	2.800	35	5.200	65
2	1.910	24	6.083	76
3	2.479	31	5.518	69
4	2.211	28	5.786	72
5	1.891	25	6.000	75
6	1.783	22	6.215	78
7	2.035	25	5.962	75
8	1.843	23	6.164	77
9	2.317	29	5.680	71
10	3.20	40	4.797	60
11	2.989	37	5.008	63
12	5.470	68	2.530	32
13	2.030	25	5.970	75
14	1.820	23	6.180	77
Total		31		69

Appendix 1

Figure 1. Total cycle flow

Figure 2. Operation process charts

Figure 3. Operation process chart

Figure 4. Present layout

Figure 5. Proposed material flow

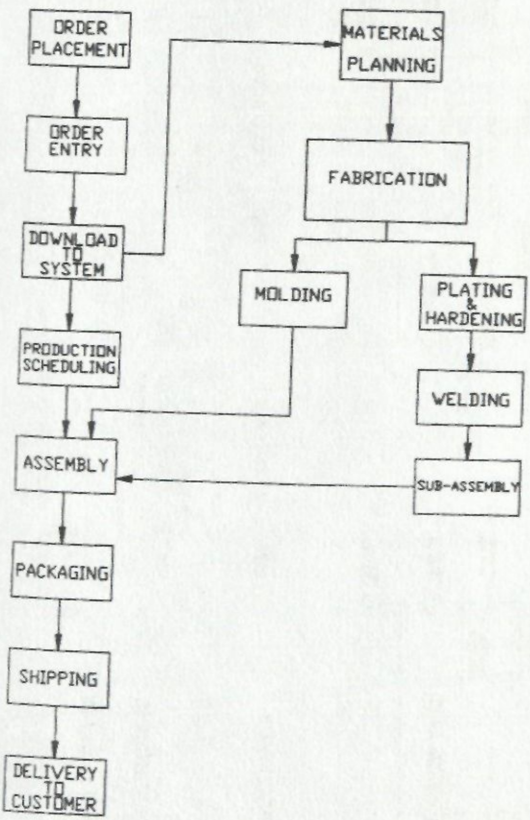

Figure 1. Total Cycle flow

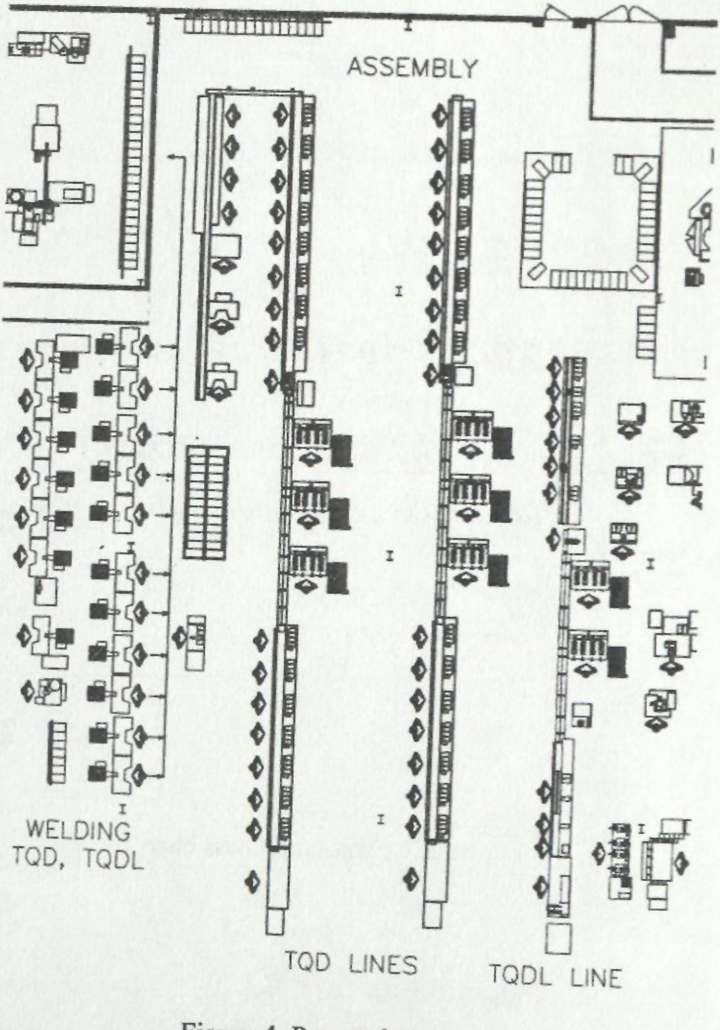

Figure 4. Present layout

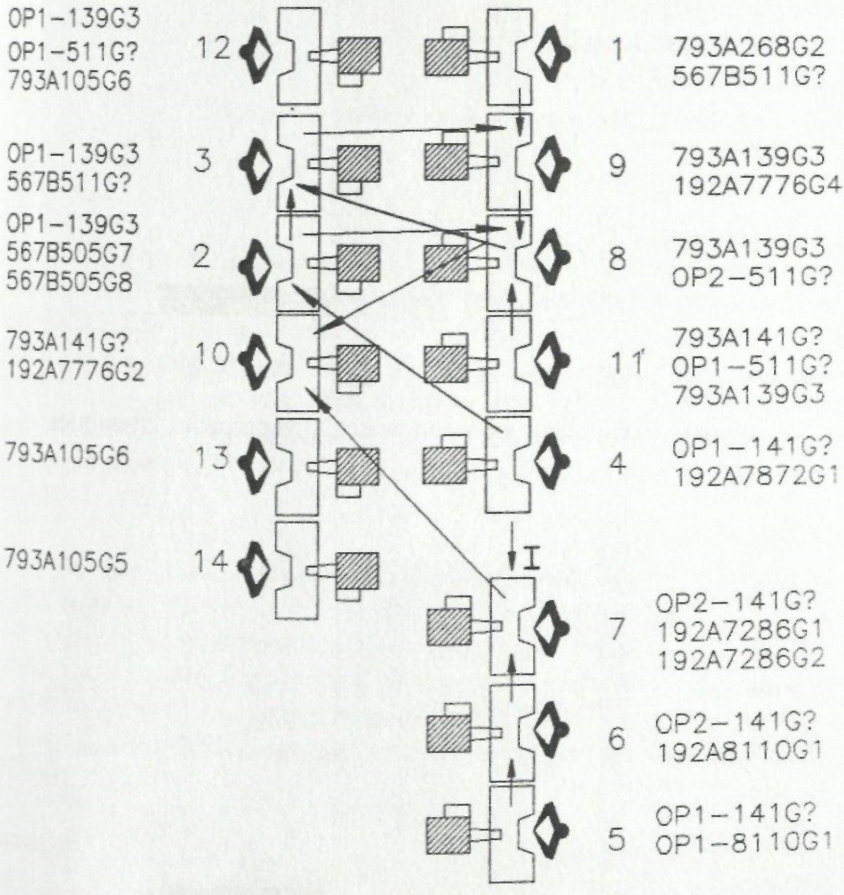

Figure 5. Proposed material flow