7.A   PFAST

PFAST (Production Flow Analysis and Simplification Toolkit) is a program for machine grouping, part family formation, cell layout and shop design layout. PFAST emphasize over simplifying the material flow and handling aspects in the facility before undertaking the physical design of the layouts. PFAST was launched in 2000 by Shahrukh A. Irani et al. (Ohio State University); with the idea that algorithm for machine and part family grouping for cell formation could be applied to layout design.

PFAST algorithm works on the input requirements of parts' details to be manufactured, work centers information to manufacture those parts, & the routing information between parts and machines. Based on the inputs given to the algorithm, PFAST supports in analyzing the material flow, creating plan for cellular manufacturing and also for facility layouts. For Example in the material flow analysis we can have descriptive statistics for routing data, grouping of similar routings, Identification of "misfit" (or outlier) routings, creation of alternative routings for key products, etc. While in support if designing facility layouts it is helpful in designing non-traditional layouts, designing of a flexible layout using multiple samples of routings, etc. Similarly in planning for cellular manufacturing it is helpful in rapid assessment of the feasibility of conversion to manufacturing cells, analysis of the stability of cell compositions, etc.

To understand the working methodology of PFAST here we are mentioning a 12-machines and 19-parts example using the primary test version of PFAST (included in the disk). To solve this example we need to have the input data in the proper format (*.xls; Microsoft Excel Format) to fed into PFAST. As we mentioned earlier, following three different input datasets needs to be fed into PFAST in order to use the program.

Table 1 shows the data regarding the Parts' details, i. e., part number, part name, quantity required per unit of time, revenue obtained for the same time period, number of operations required to manufacture that part and production runs required to fulfill the demand.

Table 2, shows the information required regarding the work centers available in the facility. This dataset have the information regarding the work centers, i.e., work center name, description (if available), number of work centers available, area acquire by each work center and their availability.

Table 3, shows the routing information for the parts to be manufactured in the facility. It includes the information about the sequence a part goes through over different work centers to be manufactured, machine set up and processing time.

Part No	Description	Annual Quantity	Revenue	# of operations	# of Production Runs
1	Part 1	20	68	4	2
2	Part 2	50	9	6	5
3	Part 3	10	6	6	5
4	Part 4	20	134	4	5
5	Part 5	50	15	5	4
6	Part 6	20	49	4	8
7	Part 7	40	66	4	4
8	Part 8	90	91	7	5
9	Part 9	90	5	6	4
10	Part 10	70	56	4	3
11	Part 11	50	40	1	5
12	Part 12	70	143	3	2
13	Part 13	80	94	2	4
14	Part 14	60	130	3	5
15	Part 15	80	66	6	3
16	Part 16	40	5	6	6
17	Part 17	40	102	3	5
18	Part 18	30	109	3	2
19	Part 19	70	47	1	6

Table-1. Parts Data Set

Work Center No	Description	Quantity	Area	Availability
1	1	1	1	0.8
2	2	1	1	0.8
3	3	1	1	0.8
4	4	1	1	0.8
5	5	1	2	0.8
6	6	1	1	0.8
7	7	1	1	0.8
8	8	1	4	0.8
9	9	1	1	0.8
10	10	1	1	0.8
11	11	1	1	0.8
12	12	1	1	0.8

Table-2. Work center data set

No	Work Center No	Sequence No	Setup Time	Processing Time
1	1	1	0	11
1	4	2	0	23
1	8	3	0	22
1	9	4	0	20

No	Work Center No	Sequence No	Setup Time	Processing Time
5	6	2	0	16
5	10	3	0	26
5	7	4	0	19
5	9	5	0	16
6	10	2	0	19
6	7	3	0	27
6	8	4	0	22
6	9	5	0	10
7	6	1	0	27
7	4	2	0	22
7	8	3	0	27

Table-3. Sequencing Information Data Set

Now, with all this information available to us we can export this information in the PFAST using the Import External Data option from the 'File' menu. Once all the data is imported in the PFAST, we chose the option of Quick Excel Report from the 'Report' menu option.

The excel report obtained using the above shown data set gives us the following information instantly:

1. *Product Routing Map:*

   This map shows the whole manufacturing scenario at a glance. In this table we can see that which part need to go through which different work centers. It can be described as a quick reference guide to understand the diversity of product and machines in the facility.

Part	Quantity	Revenue	Routings						
1	20	68	1	4	8	9			
2	50	9	1	4	7	4	8	7	
3	10	6	1	2	4	7	8	9	
4	20	134	1	4	7	9			
5	50	15	1	6	10	7	9		
6	20	49	10	7	8	9			
7	40	66	6	4	8	9			
8	90	91	3	5	2	6	4	8	9
9	90	5	3	5	6	4	8	9	
10	70	56	4	7	4	8			
11	50	40	6						
12	70	143	11	7	12				
13	80	94	11	12					
14	60	130	11	7	10				
15	80	66	1	7	11	10	11	12	
16	40	5	1	7	11	10	11	12	
17	40	102	11	7	12				
18	30	109	6	7	10				
19	70	47	12						

Table-4. Product Routing Map

2. *P-Q Analysis:*

This analysis also referred to as 'ABC' or 'Pareto' analysis, sorts the parts in order of decreasing Production Quantity. Parts which are produced in higher quantities would appear first then those of in lower quantities. The advantage of this analysis can be have in reducing the material handling, WIP, queuing and operating costs for the larger quantity products so the production lead times for them.
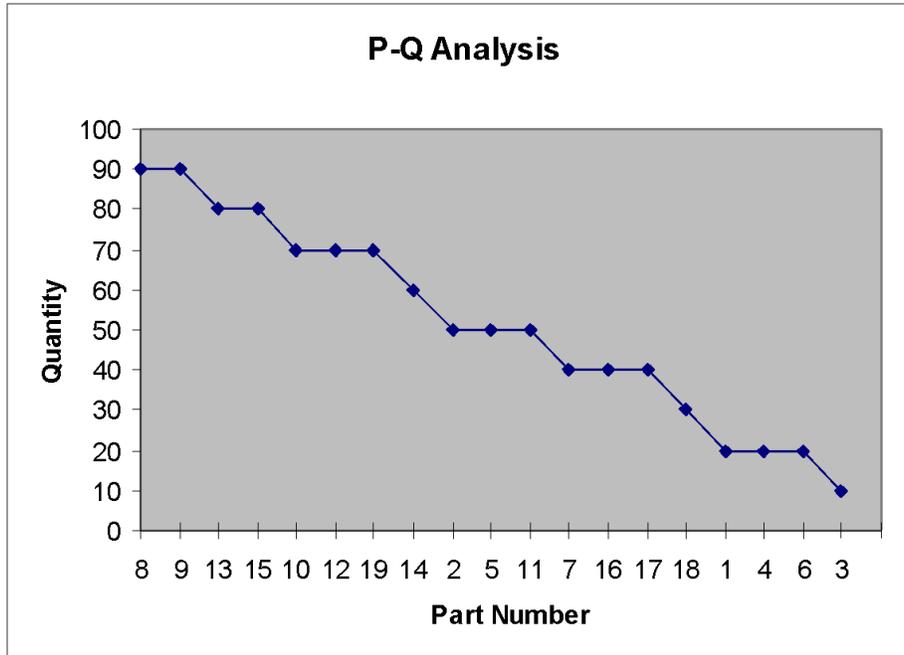
P-Q Analysis

Chart-1. P-Q Analysis

3. *P-Q-$ Analysis:*

The selection of facility layout depends upon the achievement of the requirement of implementing the concept of the Lean Manufacturing, to deliver parts on time as per the demand of customers.

In the P-Q-$ analysis, the dollar value or the revenue for the facility has been taken in to consideration since the design of the facility would be done based on the revenues earned by the major products. In P-Q-$ plot, all parts to be manufactured in the facility are plotted in a two dimension plot. Here X & Y-axis represents the revenue and quantities of a particular product respectively. By dividing the chart into a couple of small cells we can select a small but yet representative sample of parts representing a large proportion of quantities of the products manufactured and revenues earned.

Chart-2. P-Q-$ Analysis

4. *Flow Diagram:*

The flow diagram shown by the PFAST is the most suitable and optimal layout to fulfill the requirement of manufacturing the current set of products. Flow diagram (fig. 1) shows the best possible location for all the 12 work centers available in or for the facility.
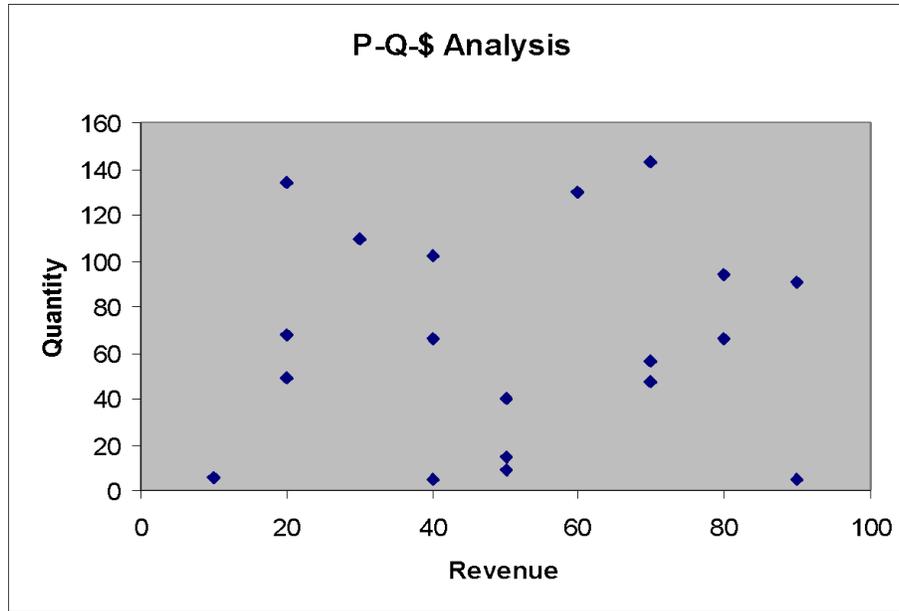
Thickness of the arrows between various work centers represents the intensity of the product traffic between them.
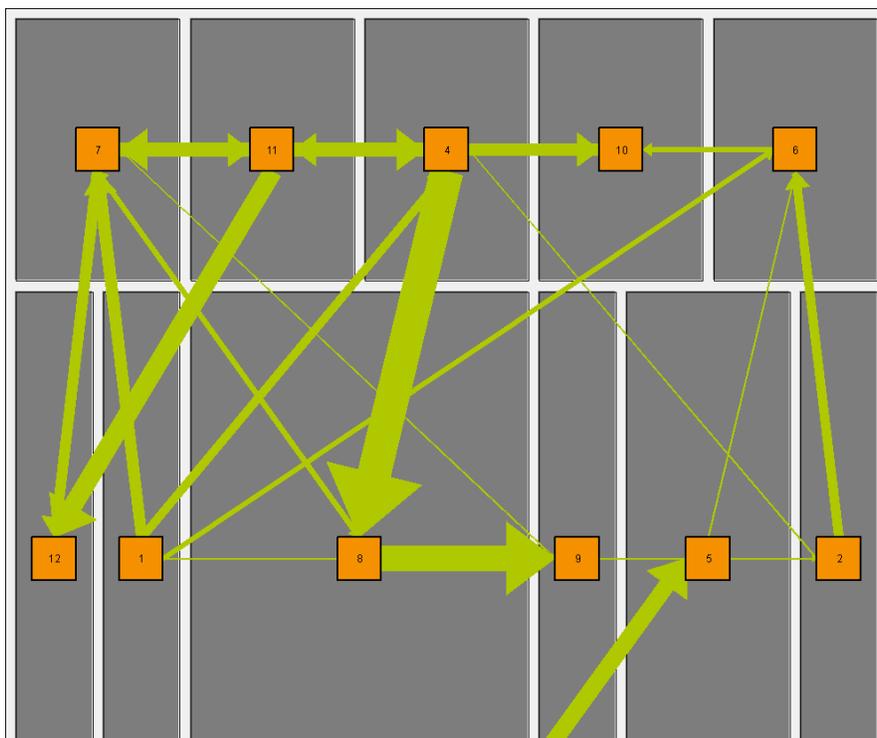
Figure-1. Proposed Flow Diagram

5. *From-To Chart:*

This chart can be predicted as the numerical representation of the product traffic flow showed in the Product Flow Diagram using the arrows. This table is a direct representation of the populated areas in the facility in terms of the material handling; we can definitely predict that in which areas we need to concentrate over the problems that may generate due to blocking or queuing of the WIP.

	1	4	8	9	7	2	6	10	3	5	11	12
1		90			120	10	50					
4			360		150							
8				270	50							
9												
7		120	30	70				90			120	110
2		10					90					
6		220			30			50				
10					70						120	
3										180		
5						90	90					
11					170			120				200
12												

Table-5. From-To Chart

6. *0-1 Matrix:*

This is the result generated by the Machine-Part Matrix Clustering (MPMC) algorithm in PFAST. This matrix lists the Part# down the rows and the Machine# across the column. PFAST arranges this table in such a way that parts that use similar or identical sets of machines get grouped together into blocks that form along the diagonal of the matrix. Each block, indicated by a set of consecutive rows and columns, represents a collection of operations for a family of parts that could, potentially, be produced in a manufacturing cell. We will see more about the 0-1 matrices in chapter 8, later.

	2	5	3	6	9	8	4	1	7	10	11	12
11					1							
8	1	1	1	1	1	1	1					
9		1	1	1	1	1	1					
7				1	1	1	1					
1					1	1	1	1				
3	1				1	1	1	1	1			
4					1		1	1	1			
2					1	1	1	1				
10					1	1		1				
6					1	1			1	1		
5			1	1				1	1	1		
18				1					1	1		
14									1	1	1	
15								1	1	1	1	1
16								1	1	1	1	1
12									1		1	1
17									1		1	1
13											1	1
19												1

Table-6. 0-1 Matrix

7. *Dendrogram:*

Figure-2, shows a clustering dendrogram. This helps in partitioning the operation sequences in to different clusters. In the following diagram at a certain threshold partitions can be seen with parts {8,9,7}, {1,3,4,2,10}, and {6,5,18}, etc. We will talk more about Dendrograms in chapter 8, later.
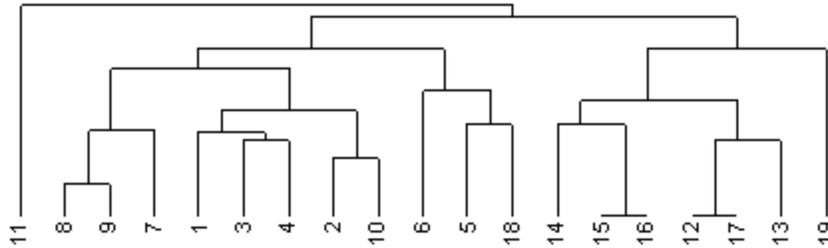
Figure-2. Clustering of Operation Sequences into Part Families

8. *Common Subsequences:*

Table-7, shows that each of the substrings of operations 4→8, 8→9 and 4→8→9 has a high frequency of occurrence in the original routings (Table 4). Subject to equipment design constraints, this string matching result could be used to replace the three single-function machines 4, 8 and 9 by a multi-function machining center. This planned introduction of flexible automation would eliminate inter-operation material handling, loading/unloading and setups for the following parts: 1, 2, 3, 6, 7, 8, 9 and 10.

Common Sub Sequences	Length	Frequency	%Qty	%Revenue
1->4	2	3	9.18	7.29
4->8	2	6	36.73	29.15
8->9	2	6	27.55	21.86
4->8->9	3	4	24.49	19.43
4->7	2	4	15.31	12.15
1->4->7	3	2	7.14	5.67
4->7->4->8	4	2	12.24	9.72
7->8->9	3	2	3.06	2.43
7->9	2	2	7.14	5.67
10->7	2	2	7.14	5.67
6->4->8->9	4	3	22.45	17.81
3->5	2	2	18.37	14.57
11->7	2	3	17.35	13.77
11->7->12	3	2	11.22	8.91
11->12	2	3	20.41	16.19
7->10	2	2	9.18	7.29
1->7->11->10->11->12	6	2	12.24	9.72

Table-7. Common Subsequences

As can be seen with the above given description that PFAST is capable of providing pretty much all the required information required to design and make decisions towards the

design of a new facility layout or to modify existing layouts. Though PFAST is available to use, its developers are still trying to modify it to serve all the variety of customers in a better way. In the upcoming versions of PFAST we are expecting to have more robust design power and algorithms to provide more data oriented conclusions, which we would be able to implement directly to our existing or new setups.