Overview of PFAST

Production Flow Analysis (PFA) provides an effective framework for analyzing the material flows at different levels of resolution in a factory. Historically, the four stages of PFA have been implemented manually, thereby limiting the detection and elimination of a large number and causes of chaos in the existing material flow network. PFAST uses a variety of computer algorithms (Figure 2.1) to automate the manual PFA methods, such that the implementation of PFA can be done for large datasets in significantly shorter periods of time. Most of the algorithms in PFAST are versatile, and can be used to automate different stages of PFA, as shown in Table 2.1.

PFAST could help to evaluate the strategic benefits of numerous other strategies for material flow simplification to support Lean Manufacturing, as shown in Table 2.2. Since PFAST uses three types of input data: operation sequences, machine-part matrices and From-To charts, it could be used for a variety of projects dealing with material flow analysis and simplification. Descriptions of these projects appear in Tables 2.3(a)-(d).

Figure 2.1  Algorithms in PFAST
Table 2.1 Algorithms to Automate Different Stages of PFA

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>FFA</th>
<th>GA</th>
<th>LA</th>
<th>TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pareto Analysis</td>
<td>*</td>
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<tr>
<td>Sorting</td>
<td>*</td>
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<tr>
<td>Cluster Analysis</td>
<td></td>
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<tr>
<td>String or Digraph Clustering</td>
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<td>Graph Partitioning</td>
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<tr>
<td>Traveling Salesman Problem</td>
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<tr>
<td>Quadratic Assignment Problem</td>
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<tr>
<td>Maximum Spanning Arborescence, Maximum Spanning Tree</td>
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<tr>
<td>and Maximum Weight Planar Graph</td>
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<tr>
<td>Strong Components</td>
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</tr>
</tbody>
</table>

* Stage in which algorithm is used

Table 2.2 Utility of PFAST for “Lean” Factory Design

- Value Network Mapping (VNM) for multiple interacting value streams
- Consolidation of buildings and departments
- Strategic duplication of equipment among departments
- Formation of manufacturing cells and focused factories
- Design of a network of material handling aisles
- Modification of process plans and product designs
- Systematic investment in Flexible Manufacturing Cells
- Choice of subcontracted operations and /or parts
- Reduction of variety of routings in the part mix
- Elimination of parts that complicate the flow network
- Enhancement of flexibility in routing products to utilize non-bottleneck machines

Table 2.3(a) Using PFAST for Material Flow Analysis

- Descriptive statistics for routing data based on P-Q Analysis, P-Q-S Analysis and P-Q-R-S Analysis
- Descriptive statistics for material flow network in facility
- Grouping of similar routings
- Detection of redundant variety in routings
- Identification of “misfit” (or outlier) routings
- Analysis of in-house vs. subcontracted material flows
- Elimination or reduction of poorly utilized material flow paths
- Detection of flow backtracking in routings
- Detection of flow backtracking in material flow network
- Detection of cross flows among aisles in the facility
- Detection of recurrent combinations (or sequences) of operations in routings
- Evaluation of current vs. desired flexibility of existing manufacturing equipment
- Creation of alternative routings for key products
### Table 2.3(b) Using PFAST for Cellular Manufacturing

- Feasibility assessment for implementation of manufacturing cells using SICGE classification of the machines
  - Shared machines that will be required in several cells
  - Parts whose routings contain *only* unshared machines
  - Parts whose routings contain *only* shared machines
  - Parts whose routings contain *both* unshared and shared machines

- Specific number of cells that could be implemented
- Parts that could not be produced in cells due to complexity of their routings
- Composition (machine group and part family) of each cell
- Complexity (number of different machines and parts) of each cell
- Homogeneity analysis of the part mix based on routing similarities
  - Parts that do not belong to any cell
  - Parts whose routings span more than one cell
  - Parts with “exception” (or outlier) operations external to their host cell
  - Parts that could be produced in more than one cell

- Duplication of equipment required in two or more cells
- Alternatives for the number and composition of the cells due to shared machines
  - For a fixed number of cells
  - For a variable number of cells

- Analysis of the stability of cell compositions due to changes in part mix
- Prioritization of Integrated Product and Process Design (IPPD) in order to eliminate intercell flows, exception operations and capacity sharing between cells

- Support of kaizen events for detailed planning of each cell
  - Capacity Requirements Planning
  - Machine allocation and load balancing, especially if intercell flows involved
  - Capital investment for purchase of new machines and technology upgrades
  - Layout, material handling and scheduling of *intra-cell* part flows
  - Layout, material handling and scheduling of *inter-cell* part flows
  - TOC analyses of capacity-constrained machines in each cell

- Support of what-if analyses to evaluate strategies to eliminate intercell flows
  - Redesign the parts to eliminate exception operations
  - Combine cells that require common machines
  - Subcontract, even eliminate, parts with exception operations
  - Buy extra machines to distribute among competing cells
  - Purchase multi-function centers to replace 2-3 machine sets in one or more cells
  - Put shared machines in a centrally located *Common Facilities* cell
  - Reroute operations on bottleneck machines to alternative machines in the cells
  - Design the overall facility layout to minimize inter-cell transfer delays
  - Speed up the material handling between the cells using visual signals
  - Adopt priority scheduling rules for parts that require inter-cell flows
Table 2.3(c) Detailed Computer-aided Design and Operations Analysis for a Pilot Cell

- Selection of the family of parts to produce in the cell
- P-Q Analysis and P-Q-$ Analysis of the “business” assigned to the cell
- Capacity requirements for the cell
- Machine requirements vs. actual allocations made to the cell
- Exception operations that cannot be done inside the cell
  → Machines that could not be assigned to the cell due to insufficient workload
  → Monuments that are external to the cell
  → Support services that are external to the cell
- Intercell flows
  → Due to exception operations
  → Due to machine overloads caused by fluctuations in customer demand
  → Access to identical machines in other cells when internal breakdowns occur
  → Access to identical machines in other cells where operators with similar skills work
- Line, U or S layout for the cell using STORM and PFAST software tools
- Flow Diagram for the cell
- Current and Future State Value Network Maps (VNM) for the cell using Visio and FactoryFlow software tools
- Performance evaluation of the cell using MPX and Arena simulation software tools
- Operations scheduling for the cell using PREACTOR or ASPROVA software tools

Table 2.3(d) Using PFAST for Facility Layout

- Pareto Analysis of parts using multi-criterion sampling
- Sorting of parts to identify those with identical routings
- Design of a block layout for a factory site, building, department or shop
- Design of a flowline or U-layout for a cell
- Design of non-traditional layouts
  → Hybrid Cellular Layouts
  → Cascading Cells
  → Modular Layouts
  → Virtual Cellular Layouts
- Strategic duplication of equipment in several shops or departments
- Strategic consolidation of shops or departments
- Design of a flexible layout using multiple samples of routings
- Design of a network of material handling aisles