Industrial Implementation of Hybrid Cellular Layouts designed using PFAST

This section describes a variety of layouts that were designed using PFAST (Production Flow Analysis and Simplification Toolkit). Production Flow Analysis (PFA) is an effective sequential strategy for analyzing the material flows at different levels in a single factory. Typically, during the design of a factory layout, PFA is implemented in four stages:

- Factory Flow Analysis (*FFA*)
- Group Analysis (*GA*)
- Line Analysis (*LA*)
- Tooling Analysis (*TA*)

Each stage in PFA seeks to improve the layout of a progressively smaller area of the factory. In *Factory Flow Analysis (FFA)*, the flows between shops (or buildings) on the factory site are evaluated to eliminate wastes due to transportation, communication delays, use of large containers to store WIP and use of bulk-handling material handling equipment to move the large containers over large distances. In *Group Analysis (GA)*, the flows between machines in *each* shop within the factory are evaluated to implement manufacturing cells to produce families of parts with identical (or similar) routings. In *Line Analysis* (*LA*), the flows between machines in *each* cell are evaluated. A layout for the cell is designed for efficient inter-machine material handling, multi-machine tending by any operator and minimum wasted motions by any operator. In *Tooling Analysis* (*TA*), the flows at *each* machine in a cell are evaluated to optimize the workstation layout for ease of machine operation and rapid execution of setup activities, such as machine loading/unloading, tool changes, fixture changes, parts inspection and cleanup.

Since PFAST uses a variety of algorithms to automate the manual methods of PFA, large datasets can be analyzed in relatively short periods of time. Most of the algorithms in PFAST are versatile, and can be used in one or more of the four stages of PFA. The single most radical departure from the classical facility layout methods by PFAST is that it uses manufacturing routings, not From-To Charts or Relationship Charts, as input data.

Next, we describe the different facility layouts that were designed using PFAST:

Factory Flow Analysis: This layout illustrates how PFAST was used to diagram material flows at the factory-level for a family of products. The flow paths of different products can be represented by lines of different colors. Similarly, the Annual Volume (or Annual Revenue from Sales) of each product can be captured by varying the thickness of each line. Such a spaghetti diagram for an entire family of parts allows for "group elimination" of wastes across multiple Value Streams during a *single* facility walkthrough. In addition, PFAST could generate From-To Charts and Flow Diagrams that capture the aggregate flow network for the entire factory.

Welding Cell: This layout illustrates how PFAST was used to identify a family of products, in this case welded assemblies, with identical, or similar, routings. The part family automatically identifies the group of machines that must be co-located in a cellular layout to produce the entire product family. In this application of Line Analysis, the flow paths of different products can be represented by lines of different colors. Similarly, the Annual Volume (or Annual Revenue from Sales) of each product can be captured by varying the thickness of each line. In addition, PFAST could generate From-To Charts and Flow Diagrams that capture the aggregate flow network for the entire cell.

Flexible Machining Cell: This layout illustrates how PFAST was used to design a Hybrid Flowshop Layout for a complex family of machined parts that contained dissimilar routings but could all be produced *within* this cell. In a traditional Flowshop layout, the machines would have been arranged in a strict linear sequence, which would have resulted in long by-pass or backtrack flows of several parts. However, in the Hybrid Flowshop Layout that PFAST helped to design, the same machines are distributed into a linear sequence of *only three* groups (or stages[1]) of machines. Each stage, also referred to as a manufacturing module or partial cell, is comprised of different machines. The proposed layout has *only two* clearly-defined supermarkets to store WIP, each located between two consecutive stages in the Hybrid Flowshop Layout.

Finish Machining of Castings: This layout illustrates how PFAST was used to design a standard Process Layout for the Finish Machining department in an investment (lost wax) casting jobshop. Using the routings and Annual Volumes for upwards of 500 different castings, PFAST was used to generate From-To Charts and Flow Diagrams to visualize the aggregate material flow network within the department. The spaghetti diagrams for the existing layout (Current State Map) and the proposed layout (Future State Map) clearly demonstrate a significant reduction in travel distances between all pairs of machines with significant material flows between them.

Make-To-Order Fabrication of Pipes: This layout illustrates how PFAST was used to decompose a large pipe fabrication facility into a hybrid layout comprised of a Cellular Layout, a Modular layout (or partial cells) and a Process Layout for the rest of the facility. We recommended that the two cells be immediately implemented. However, we did *not* recommend that the two manufacturing

[1] Alternatives terms for a stage are "manufacturing module" or "partial cell".

modules be implemented. The reason being that other PFAST outputs suggested a far more critical improvement in the layout – the "right-sizing" of the Monument (Workcenter #825), a large washing line, located in the center of the facility. Without eliminating it and replacing it with multiple washing stations (or smaller washing lines catering to different pipe geometries and size ranges), the WIP and queuing delays due to this "bottleneck" workcenter was inevitable. In addition, the PFAST Analysis Report indicated that there was unnecessary noise in the product mix i.e. the Sales department was accepting too many orders with different routings, low Annual Volumes and small profit margins. Therefore, in order to simplify the material flow network prior to further layout changes, we suggested that the product mix be rationalized to eliminate the large number of "cats and dogs" (or Strangers).

Assembly Of Industrial Scales: This layout illustrates how PFAST was used to design a complete Point-Of-Use-Storage layout for a Make-To-Order assembly facility producing industrial scales. PFAST was used to map the entire Bill Of Routings for the complete product assembly. Thereby, the connections between the cells making different families of components, the locations where kits of parts had to be delivered to build the subassemblies and the final assembly of all subassemblies and purchased parts were maintained throughout the layout design process.


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Layouts designed using PFAST

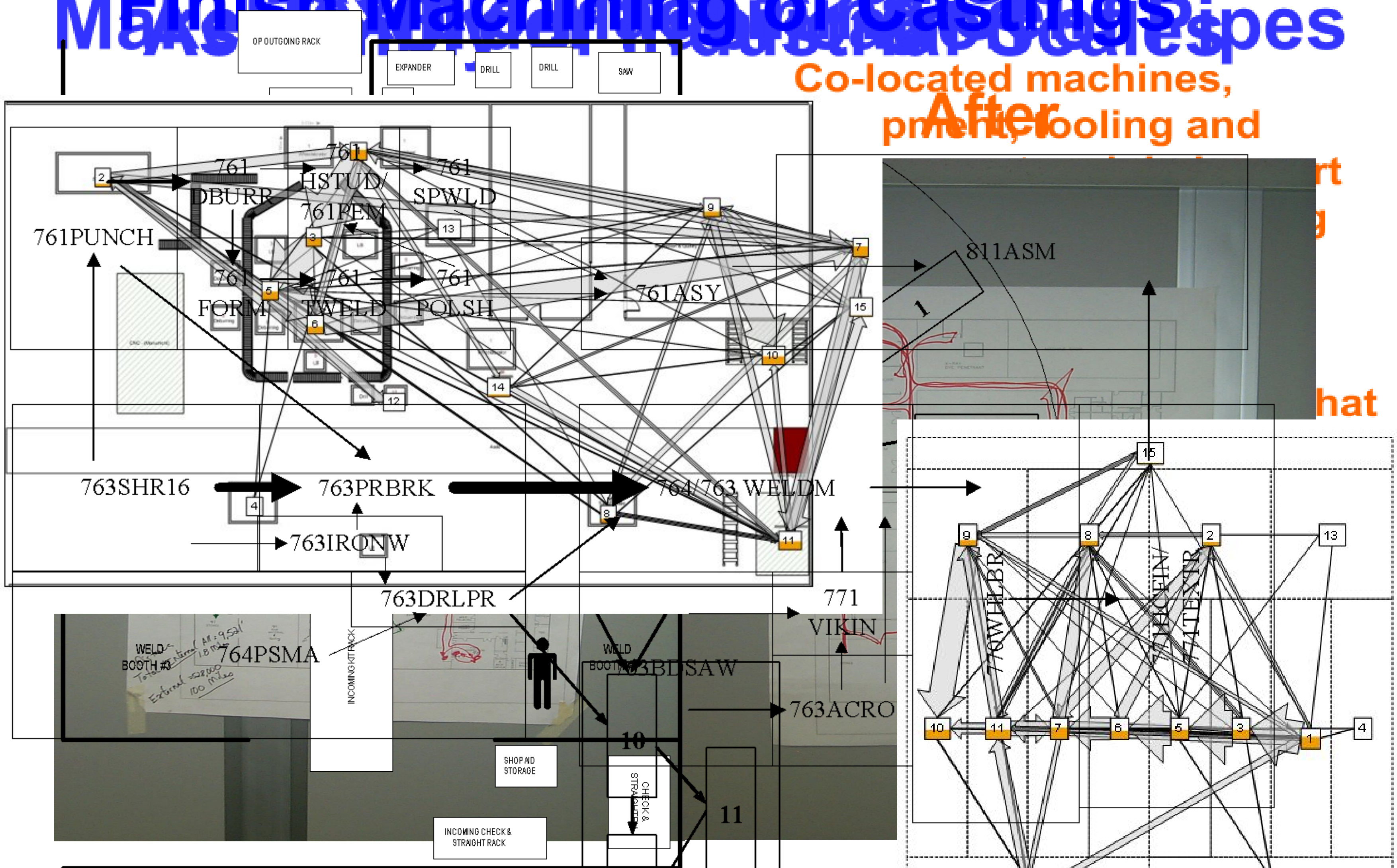
Welding Cell

Factory Flow Analysis

Finish Machining of Castings

Co-located machines,

pment, tooling and



	Before	After	% Redu
Lead Time	[illegible]	3.5 weeks	50
Cycle Time	8 hours	6 hours	25 %
Part Travel (ft.)	2,450 ft	1,578 ft	36%
Walking (ft.)	3,150 ft	1,578 ft	50%
WIP	360 pcs.	200 pcs.	44%

Waste Has No Place to ...