

Job Shop Lean: A Viable Approach to Adapt Lean for High-Mix Low-Volume Factories

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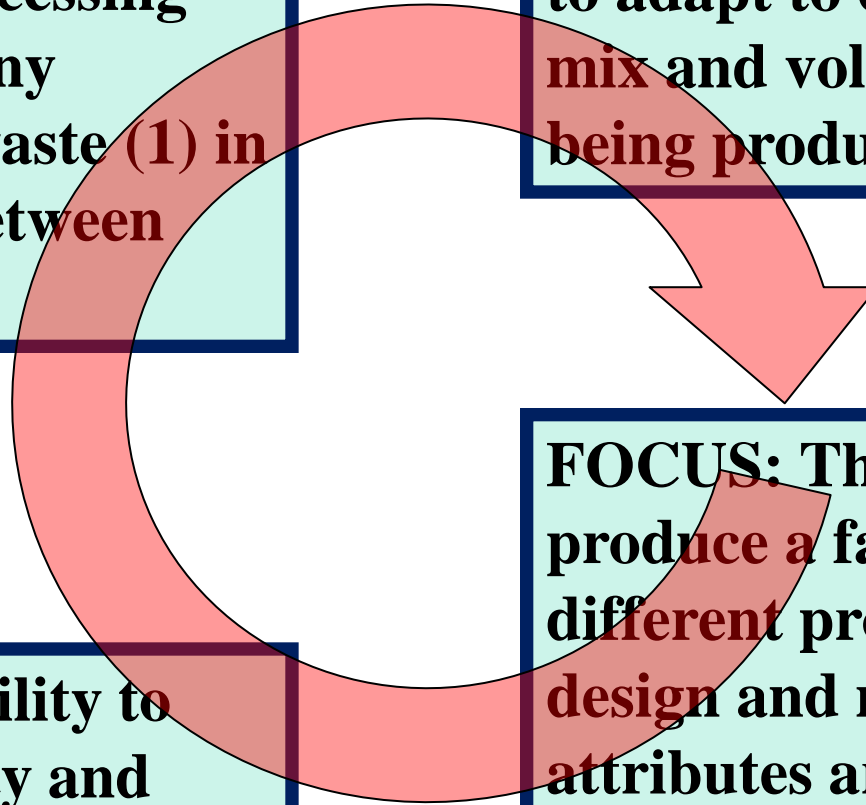
Job Shop Lean: A Blending of Best Practices

LEAN: The ability to execute all the processing steps to produce any product without waste (1) in any step nor (2) between consecutive steps

FLEXIBILITY: The ability to adapt to changes in the mix and volume of products being produced

AGILITY: The ability to trade-off Flexibility and Lean but remain profitable while controlling costs, quality and on-time delivery performance

FOCUS: The ability to produce a family of different products whose design and manufacturing attributes are similar enough for them to be produced in a multi-product manufacturing cell (or multi-product flowline)



Challenges of Implementing Job Shop Lean

Product mix consists of 100's of different products

Manufacturing routings differ in equipment, setup and run times, tooling, gauges, etc.

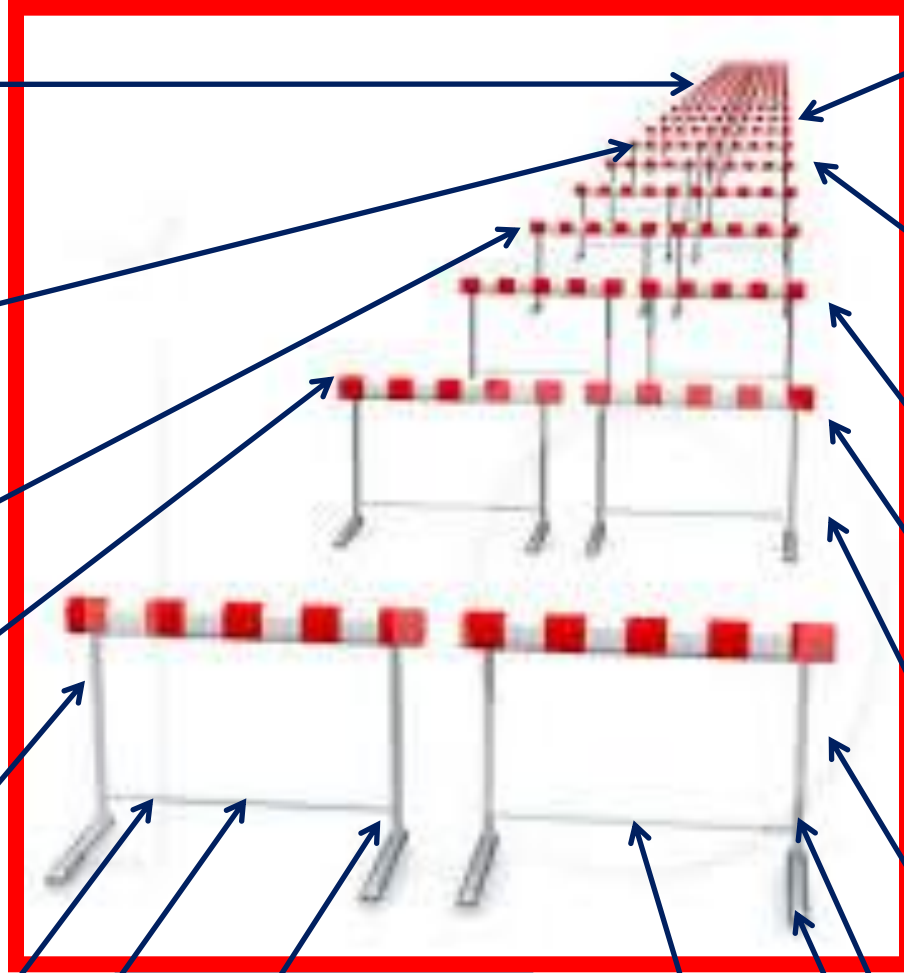
Facility has a Functional layout

Demand variability is high

Order lot sizes can range from 1 to 100's or 1000's

Multi-function flexible automation requires highly skilled operators and vendor support

Finding the product family associated with each Value Stream is a complex problem



Unreliable or incomplete demand forecasts

Suppliers do not deliver the right quantity at the right quality at the right time at the right price

Customer loyalty is not guaranteed

Employee loyalty is not guaranteed

Limited in-house resources for employee training

Production schedules are driven by due dates that are constantly subject to change

Planning, control and scheduling for Make-To-Order production is hard

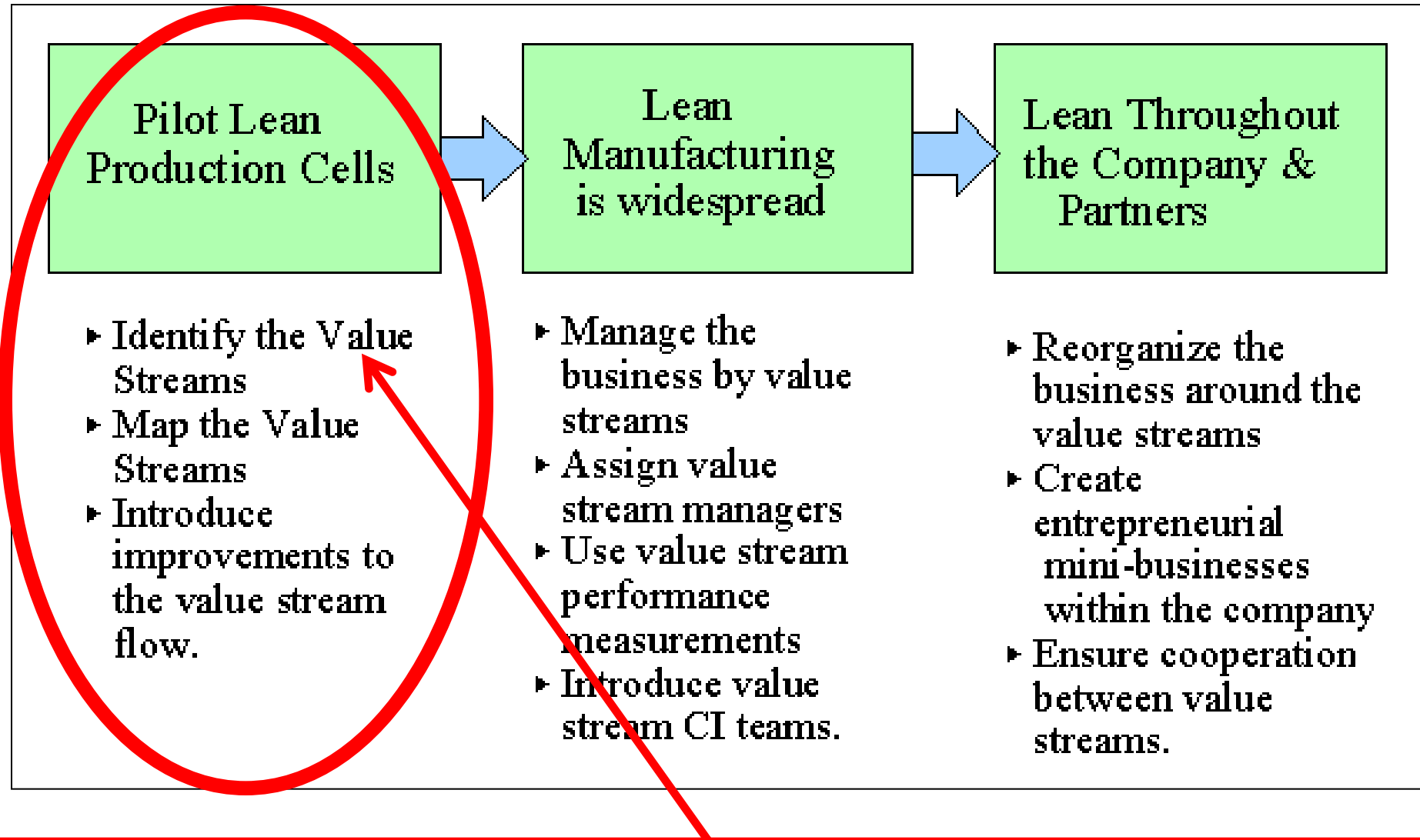
Cross-training and employee retention may work against each other

Maintenance of diverse equipment is hard

Production bottlenecks could shift almost daily

Strategy for Implementing Job Shop Lean

Phases in Implementing a Lean Enterprise

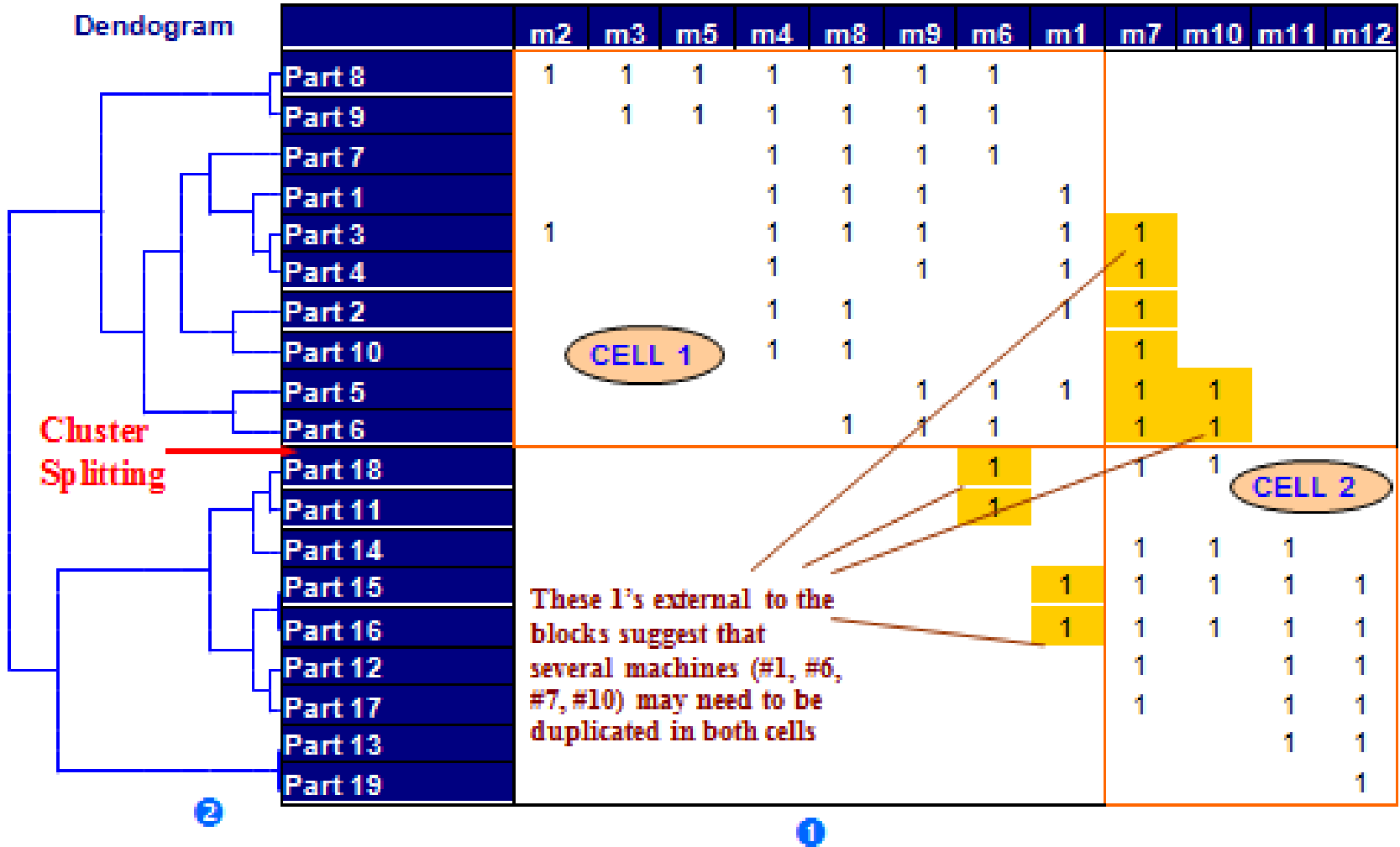


A cell or focused factory can be designed if and only if the product family that constitutes its Value Stream is clearly and correctly identified!

Identify Part Families and Machine Groups

Cluster Analysis

Dendrogram



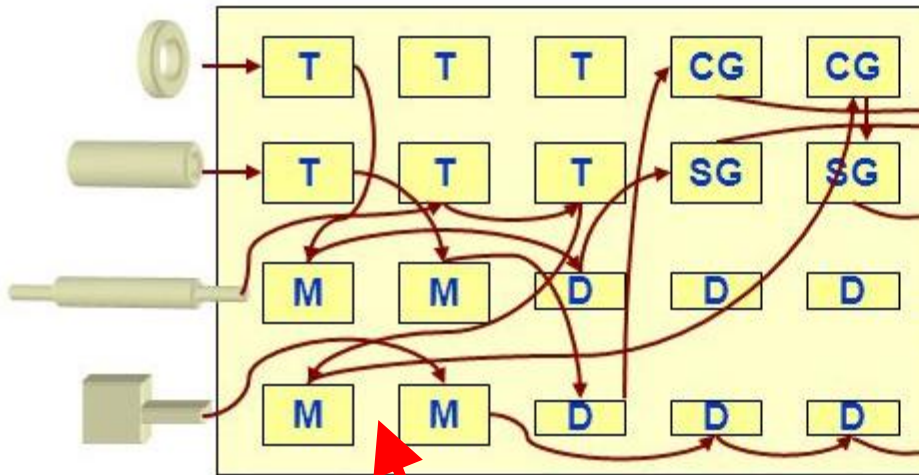
Click [here](#) to watch a video that shows how Production Flow Analysis is used to identify the product family for a manufacturing cell.

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Overview of Cellular Manufacturing

How Orders Flow In a Cellular Layout

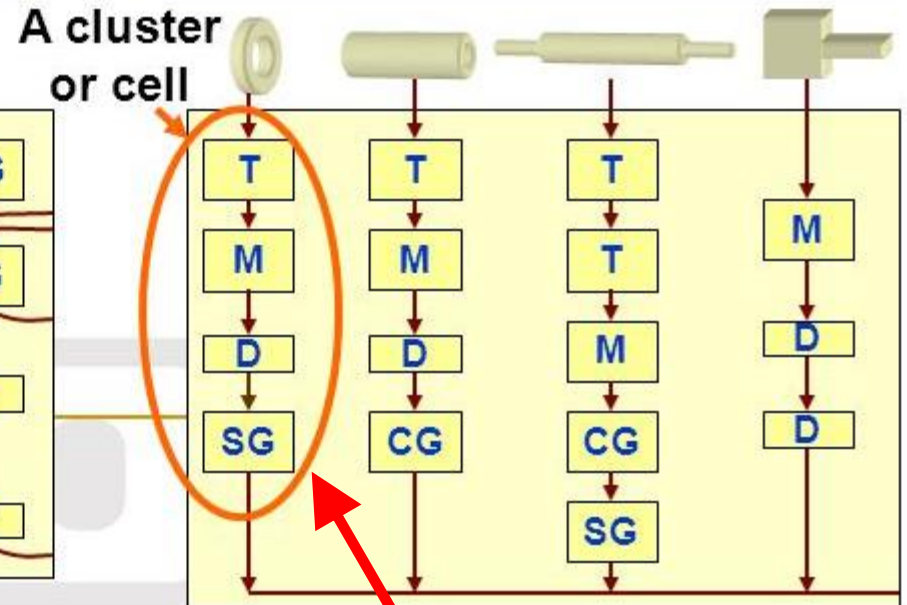
Process (Functional) Layout



Similar resources placed together

The shop layout IS NOT aligned with actual product flow

Group (Cellular) Layout



Resources to produce similar products placed together

The shop layout IS aligned with actual product flow

Benefits of Manufacturing Cells

Cells Significantly Reduce Batching (= WIP)

A Functional Layout is guaranteed to generate significant amounts of the Seven Forms of Waste



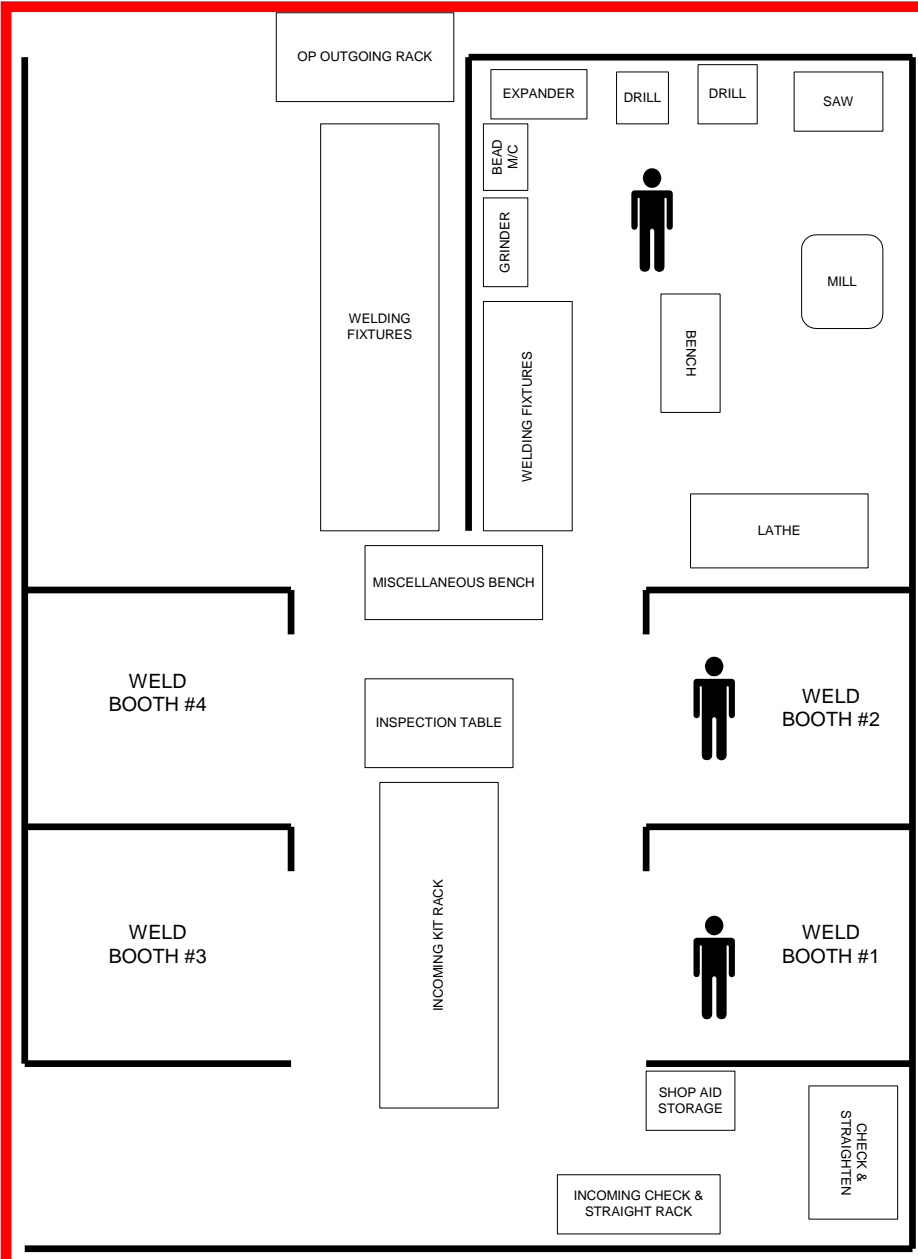
Cells Significantly Reduce Order Flow Times

The Flow Time for any order produced in a Cellular Layout will be significantly lower than if it were produced in a Functional Layout

WIP (Units) = Average Flow Time (days) * Throughput (Units/day)

This is Little's Law!

Management Benefits of a Manufacturing Cell



FOCUS: The cell's team can complete and ship any order for any part (or product) in its part (or product) family in any quantity to any customer to reach by an agreed-upon delivery date.

FLEXIBILITY: The cell can produce any part (or product) in its part (or product) family .

CONTINUOUS IMPROVEMENT CULTURE: The cell's team has full authority to do projects to achieve performance metrics (SQDPC) set by management.

ACCOUNTABILITY: The cell's team is responsible for achieving performance metrics (SQDPC) set by management.

OWNERSHIP AND AUTONOMY: The cell's team has full authority to establish cross-training programs, have a say in who gets recruited to work in their cell, partner with other cells to share resources as-and-when-needed, communicate directly with customers and suppliers, determine who does overtime on which days, etc.

CASE STUDY

Superior Completion Services

What Was *Easy To Do* To
Implement The Pilot Cell

Cell's Champion is a "4H" Leader

- **HEAD**

- Understands how JobshopLean is to be implemented
- Thinks though a problem after we have argued over its solution
- Patient
 - Not a hire-and-fire guy
- Not tight-fisted
 - Accepts hiring requests if sufficient justification is provided

- **HEART**

- Willing to let his reports learn by failing
 - Has faith in the ability of his reports to deliver
- Openly and often appreciates good work done by his immediate reports

- **HANDS**

- Leads off on a kaizen with goals and expectations then lets the team take over
- Has successfully implemented Lean practices in past jobs
- Demonstrates ideas with on-floor mockups and simulations
- Has no hang-ups about working on the floor as part of any CI team

- **HOOVES**

- Detests too many meetings
 - "Let's get out there on the floor to discuss this issue!"
- Does at least two gemba walks daily

New CNC Mill Bought for the Cell



BEFORE



AFTER

Point-Of-Use Storage of Jaws and Ring Gauges



Stenciling Machine Put In the Cell

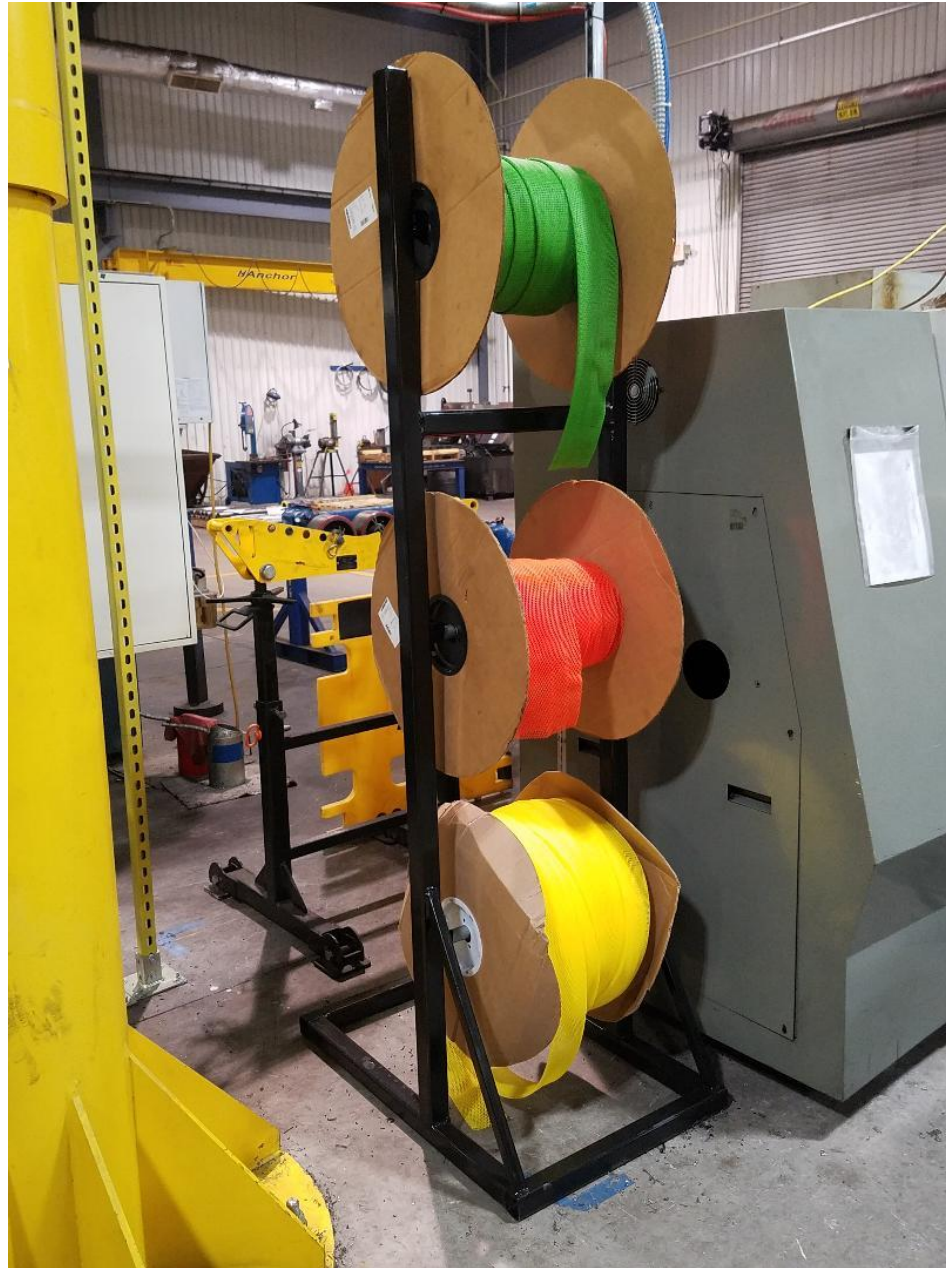


BEFORE



AFTER

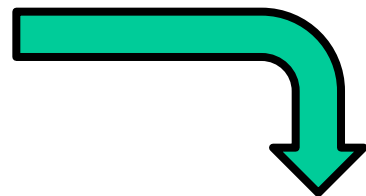
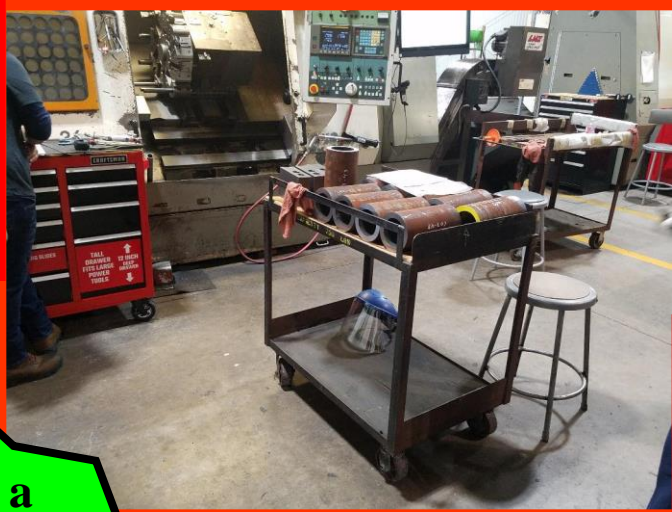
Thread Protector Stand Put In the Cell



Company-issued Standardized Toolboxes



Right-sized Storage Containers Inside the Cell



Transfer batches are a realistic alternative to one-piece flow if cycle times on different machines are unbalanced or demand lot sizes change day-to-day

“Water Spider” (Shop Logistics Lead)

Expert machinist who can fill in for another machinist on an as-needed basis

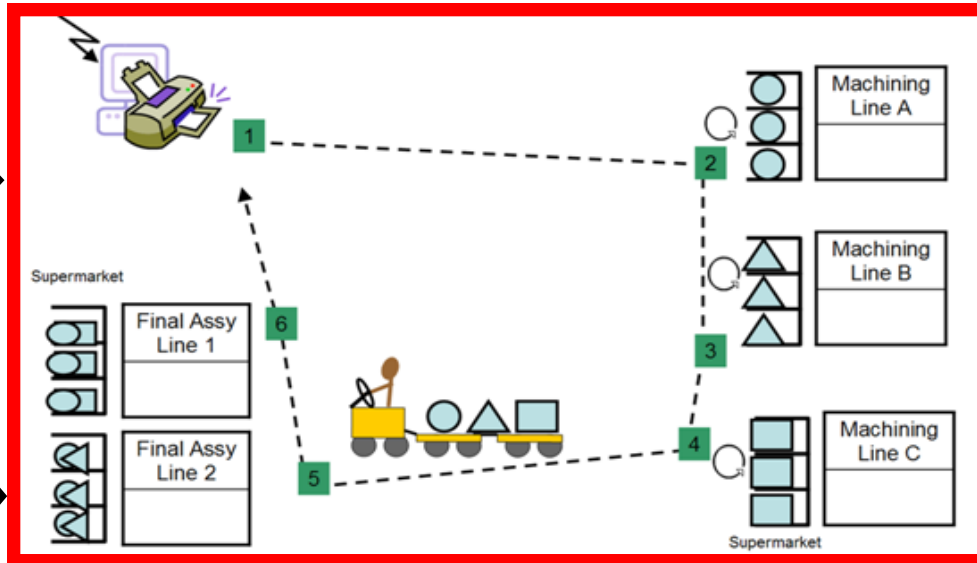
Constantly monitors the jobs in the buffer area at the shop’s bottleneck (Mills)

Re-assigns a machinist from one machine to another machine depending on job priorities

Delivers raw material pallets to every machine

Moves jobs from one machine to another machine

Switches jobs on machines on a JIT basis in response to sudden schedule changes, arrival of raw materials, etc.

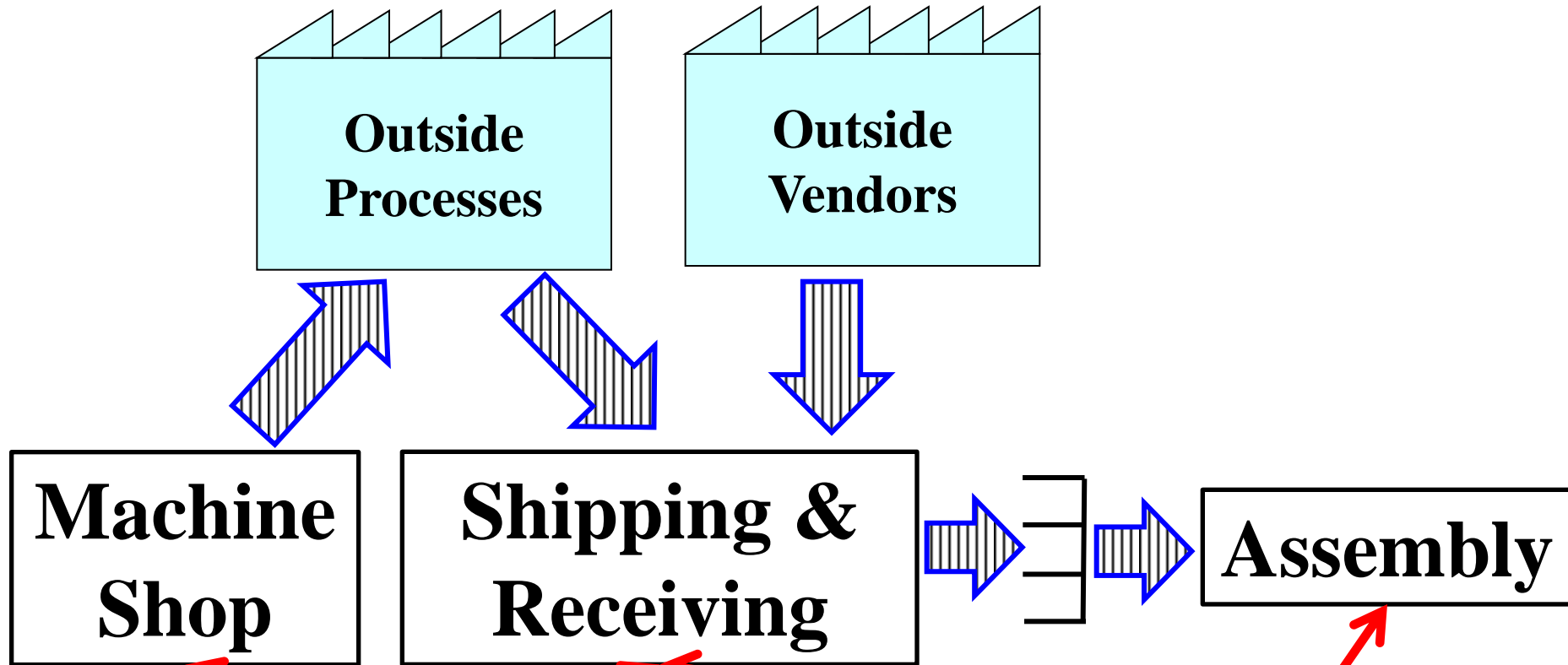


Advises Machine Shop Manager of NCR’ed parts

Works with all employees to keep the shop neat, clean and organized

Actively participates in (or leads) problem-solving and CI efforts

Cross-Fertilization Between Silos



- Two employees from S&R now report directly to the Machine Shop Manager.
- They coordinate/synchronize simultaneous processing of kits of components that go into the same Line Items

- Managers of both departments have daily morning huddles.
- Could one manager oversee both departments?

Production Controller and Shop Scheduler

Provides an estimate of Mfg Lead Time to Sales based on their customer quote

Plans Pre-Production Meeting with all departments (Estimating & CNC Programming, Purchasing, Machine Shop, Shipping & Receiving (Inventory “Cage”), Assembly and Quality) prior to the release of any job

Determines if there is capacity in the Machine Shop. If YES, then cuts a WO to process the job in-house; if NO, then places a PO with Outside Vendor (OSV)

Breaks down each job into categories of Line Items: (1) Long Lead Time, (2) Require Testing, (3) Does not require Testing, (4) Single Components, (5) Well Screens and (6) Buy Outs

- 1. Uses Rough-Cut Capacity Plan from TACTIC to issue a Dispatch List to the Water Spider**
- 2. Gives Dispatch List to Water Spider who uses (a) his machining expertise and (b) situational awareness of machine availability in the shop to dynamically load jobs on machines**
- 3. Coordinates with Water Spider to track job status at component level because each Line Item is an assembly that requires a specific kit of parts**

- 1. Does backward scheduling with TACTIC from Assembly → OSV/OSP → Machine Shop → Purchasing to generate a feasible schedule for every job down to the component (and raw material) levels**
- 2. Updates Job Board Tracker for every new job**

Communicates to the “Cage” to start tracing the kit of parts (and related documents) to build the batch of oil tools in a Line Item, consolidates each kit to one pallet and roll the batch of pallets into Assembly

Separate Queues of Orders for the Saw

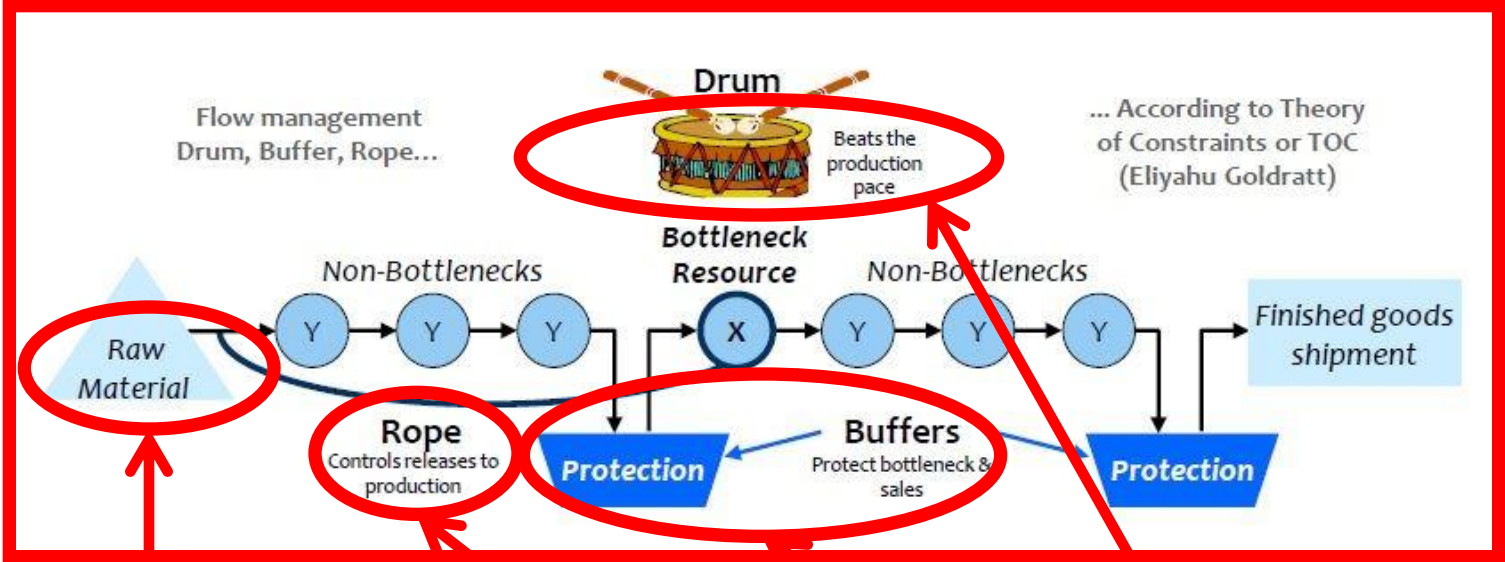


Staging Area for Jobs to Cell #1

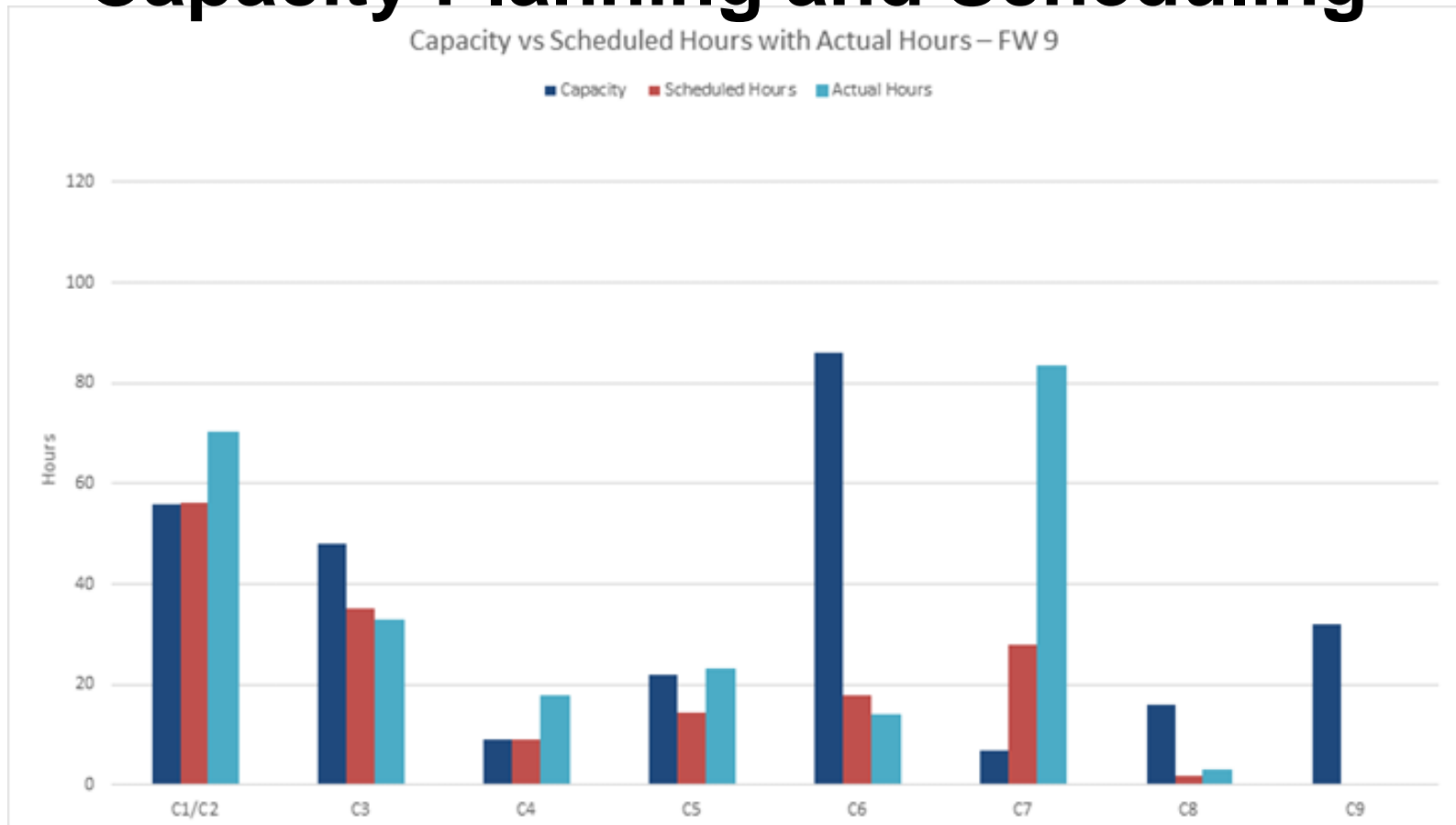


Staging Area for Jobs to Rest of the Shop

Shop Scheduling using DBR Method

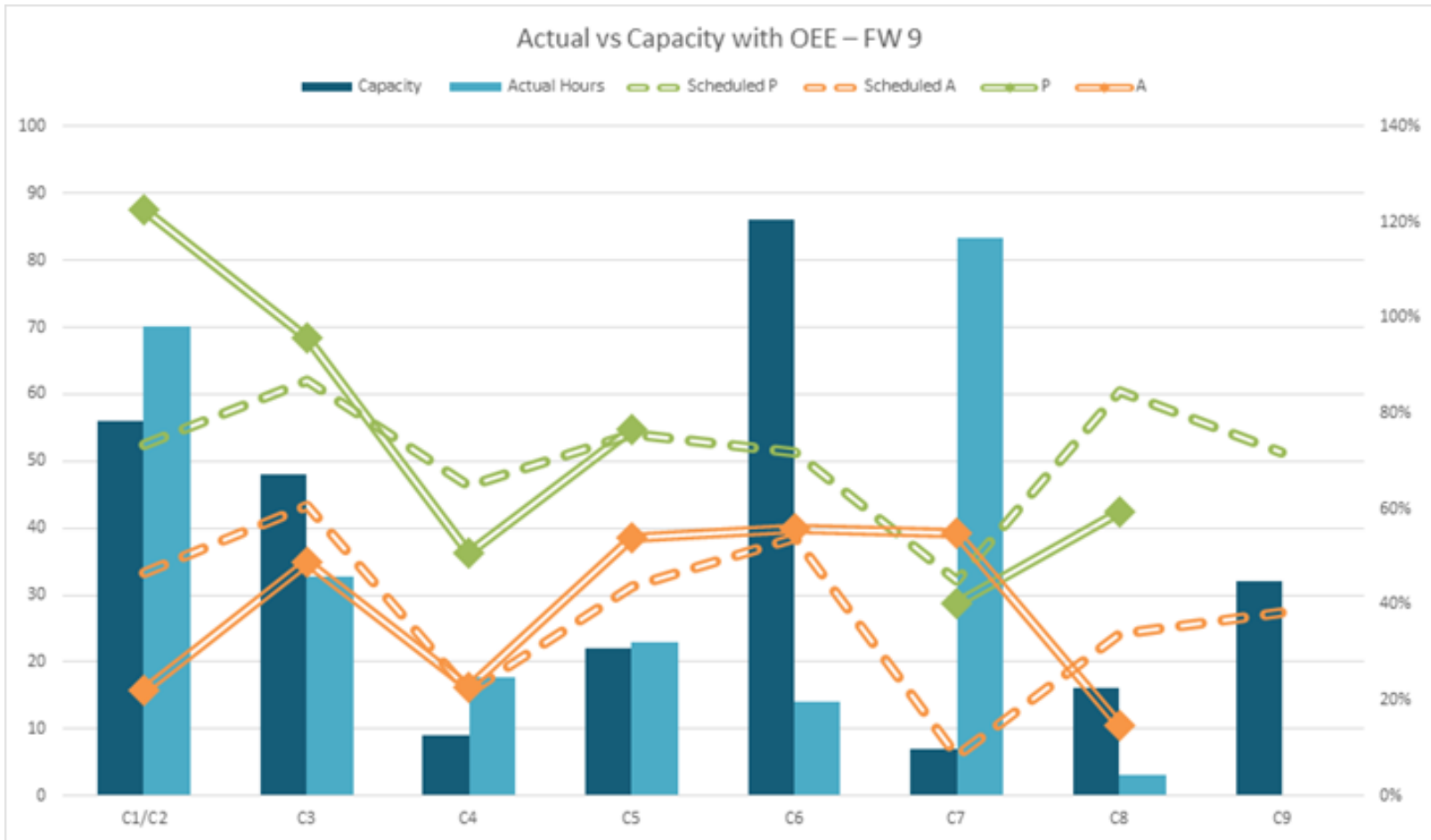


Capacity Planning and Scheduling



This chart helps to more effectively understand capacity planning and its impact on scheduling. Step one is gaging how close estimates match reality. The dark blue bars represent per-cell capacity (the total hours available for scheduling the lead-op. lathe). This is calculated by multiplying the combined cell's expected availability (uptime) by the total amount of time the shop is open for business. Here, for example, the team expected Cell 3 to be in cycle for 43% of the 98 hours it was open for business ($0.43 \times 98 = 48$). The red bars are scheduled hours i.e. a total of every scheduled part's lead-lathe, in-cut cycle time estimate. The light blue bars represent the same metric, but only for jobs that actually ran. Here, we can see that Cells 1 and 2 (which are virtually identical) both processed more unique part numbers than expected, while Cell 3 processed slightly fewer. With a perfect schedule, all bars will match.

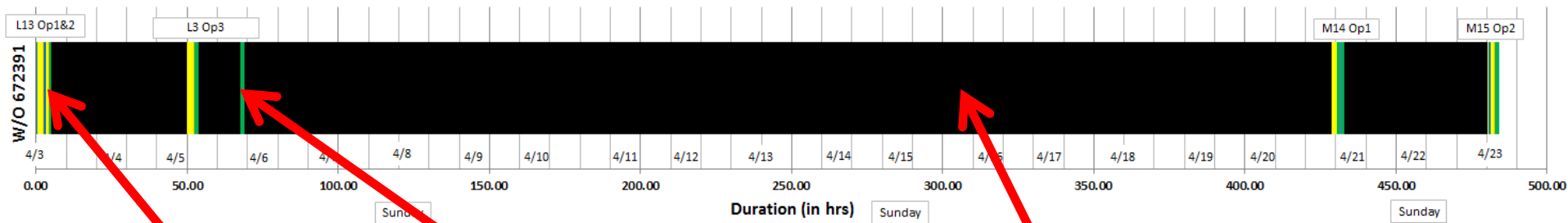
Shop Performance Monitoring using OEE



This chart uses overlays of OEE performance and availability metrics to illustrate why the blue bars do not match. For example, better-than-expected performance was not enough to make up for lower-than-expected availability on Cell 3, which could have processed more parts. In Cell 7, the more dramatic mismatch in the blue bars was due primarily to two factors: many parts with lengthy cycle times (which translates to fewer interruptions for setup), as well as moving a particularly skilled employee to that work station. Both boosted availability — and, by extension, the light blue, “scheduled hours released” bar — above initial estimates.

Order Flow Tracking

The raw data came from CIMCO



YELLOW ► Setup

GREEN ► In-Process

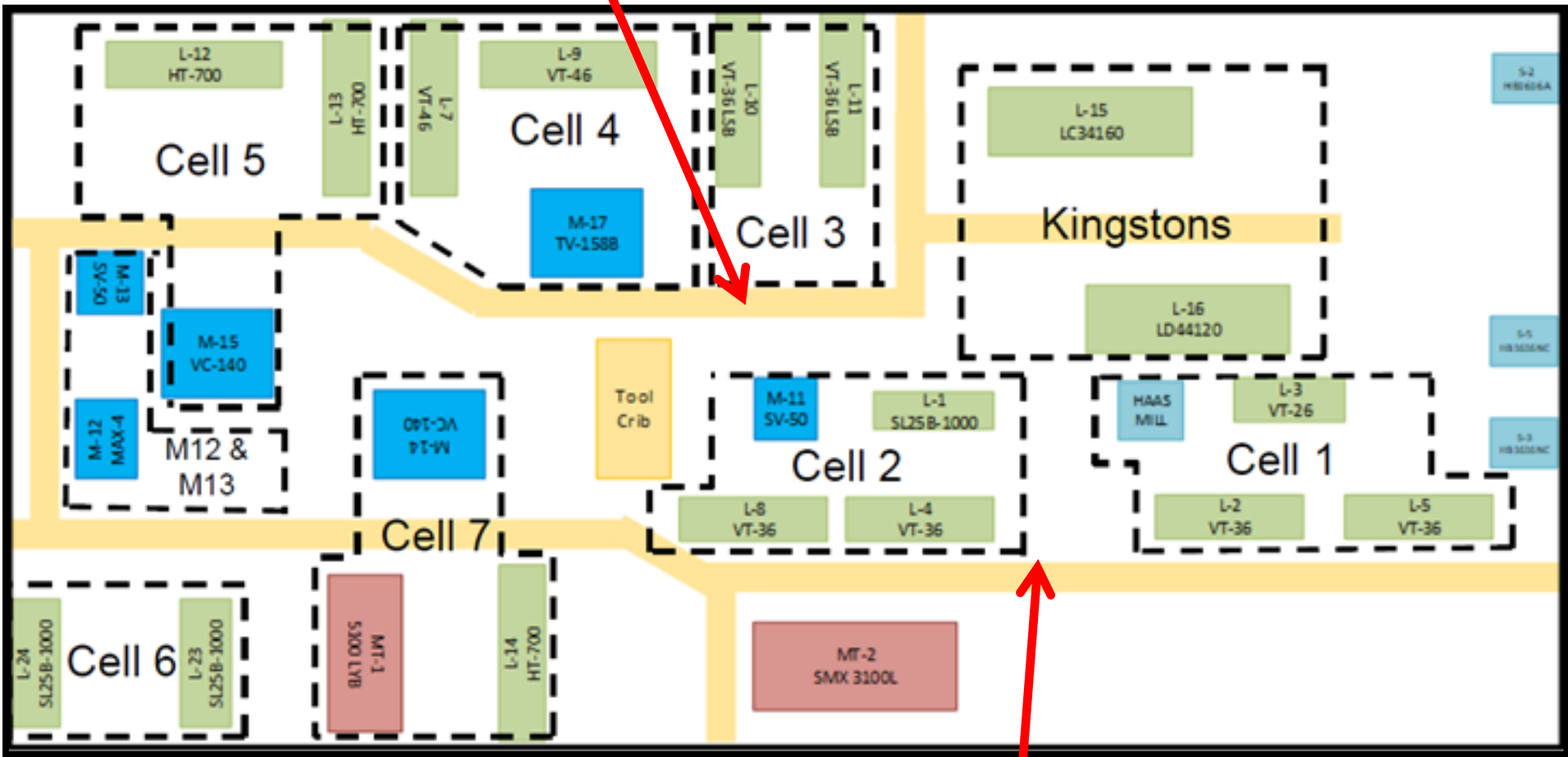
BLACK ► Non-Value Added Time

- **Traveling between machines**
- **Pre-empted on current machine by another job**
- **Machine breaks down**
- **In queue at the machine it needs**
- **Machine operator on break**
- **End-of-shift (Shop Closed)**
- **First Article Inspection**

**What Was *Hard To Do* To
Implement The Pilot Cell**

Cellular Layout for the Entire Shop

“Monster Highway”



“Minion Lane”