RC Technology and Operations Management Fall 2025

Module 1 Wrap

Module 2 Introduction

(These slides will be posted on Canvas)

Harvard Business School

RC TOM Modules

1. Operating Model Fundamentals

Assess performance, identify metrics, diagnose problems, propose solutions, align incentives

2. Managing Process Improvement and Innovation

Approaches to driving continuous improvement, identifying customer needs, idea generation and selection, experimentation, and evaluation

3. Managing Supply Chains

Interdependencies between operating models, information asymmetry, incentives, coordination, inventory pooling, sustainability

Process Analysis Simulation

Shad Exercise

Beer Game Exercise

Problem Sets and Quiz

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Module 1: Operating Model Fundamentals
Understanding and diagnosing operating models

- **Develop a "process view": A structured approach to analyzing problems that acknowledges the interdependencies between different tasks and activities**

- **Define and understand the requirements of your operating model:**
  - What is the firm's value proposition and underlying business model?
  - How does the operating model support this business model?

- **Assess the performance of an operating model, using appropriate metrics**

- **Be familiar with different operating models and the trade-offs involved with each**

Process Analysis

Mapping Processes

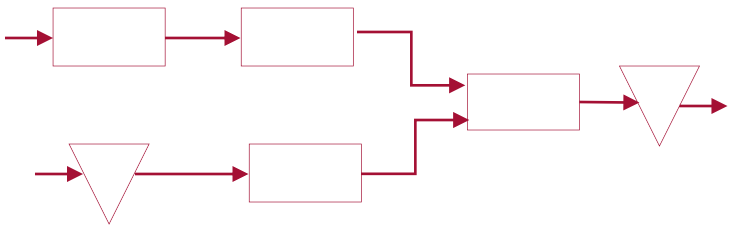
- Characterizing process steps
- Topology of how they are connected
- Material flows and information flows

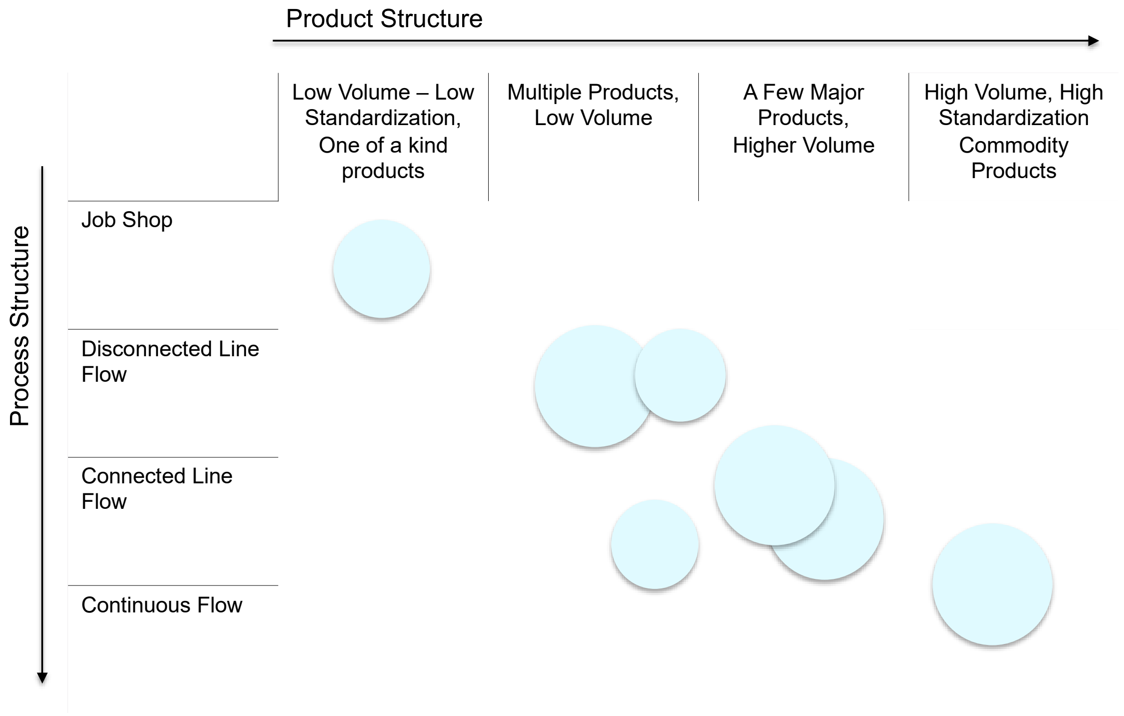
Choosing Processes

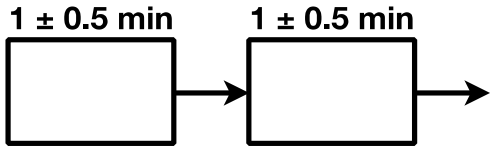
- Catalog of process archetypes
- What, why, where to use each type
- Assessing process performance

Variability

- Impact on process performance
- Choosing to reduce vs. accommodate







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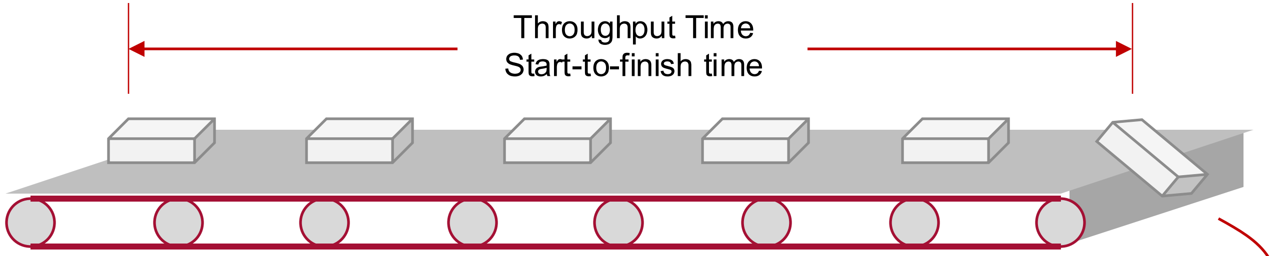
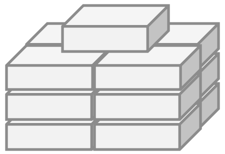
Metrics for Assessing a Process



Output

Cycle Time
time between successive units



Output Rate & Capacity
units/time

Efficiency

- Labor utilization
- Machine utilization

Quality Assurance

- Defect rate
- Yield

Linking Metrics

Operational Performance ⟷ **Financial Performance**

Profit = Revenue – Cost

Revenue:
- Output rate
- Responsiveness
- Quality
- Flexibility

Cost:
- Utilization rate
- Labor content
- Rework
- Inventory cost

Output Metrics

“kerchunk”

Cycle Time: Avg. time between successive units

- If a part is completed every 10 seconds, CT= 10 sec/part

Output rate: Units produced per time period

- The output rate of the process above is 6 parts per minute

Capacity: Maximum output rate

- Bottleneck: resource limiting capacity (machine, labor, input arrival rate, etc.)
- Capacity of a process: determined by the capacity of the bottleneck task
- Cycle time of process: determined by the cycle time of the bottleneck task
- Bottleneck may shift depending on order size, variability, etc.

Efficiency Metrics

Labor

Labor content	Amount of time workers work on product
Idle time	Time a resource (labor/machine) is not working on product
Labor utilization	= (Labor content) / (Labor time available)
Labor time available	= (Labor content) + Idle time
Labor cost	= Amount paid to workers = (Labor content + Idle Time) x (Wage rate)

Machine

Machine utilization	= (Machine time utilized) / (Machine time available)

Quality Metrics and Drivers

Quality Metrics

- Defect rate = (# defective units) / (# total units)
- Rework rate = (# reworked units) / (# total units)
- Customer Return Rate = (# of returned units) / (# of shipped units)

Quality Drivers:

- Work standardization
- Worker training and incentives
- Machine maintenance and wear
- Many of the drivers of variability we discussed

Responsiveness Metrics

Throughput time (TPT): Time from start to finish

- Requires defining boundaries: start what? finish what?
- TPT for a line = (Time part leaves line) – (Time part enters line)
- We usually care about average TPT in Steady State (ignore initial/transient conditions)
- Calculating TPT depends on your material handling policy

When batch size is 1 (process by the unit), what is capacity, TPT, and WIP?

Capacity = 1 unit/min. TPT = 3 min. WIP = 3 units

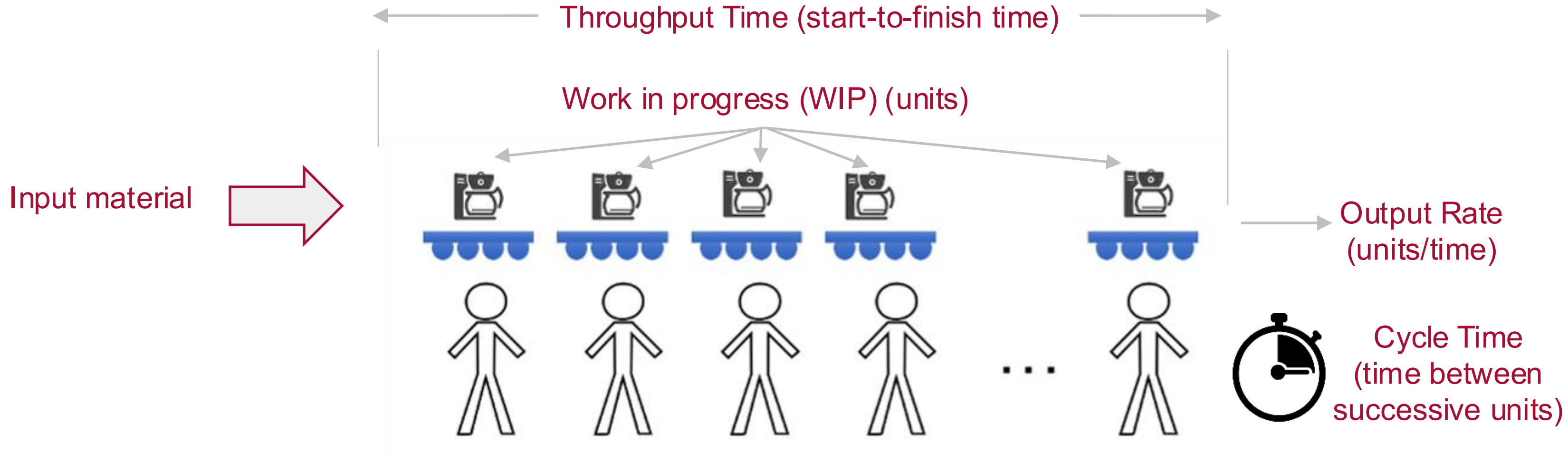
When batch size 10 (process by the batch), what is capacity, TPT, and WIP?
(assume stations have enough space to store the batch)

Capacity = 1 batch (or 10 units) per 10 min = 1 unit/min. TPT = 30 min. WIP = 30 units

Little's Law: Relationships among key metrics

WIP = (Output Rate) x (Throughput Time)

Throughput Time = (WIP) x (Cycle Time)



Holds for all operations, on average, under steady state conditions

Little's Law

Relationship holds true across a process or any subset of a larger process when the process is running at steady state.

Example	*Output Rate*	*WIP inventory*	*Throughput Time*
Benihana	# customers finishing dinner per hour	# customers in the dining area	Time from customer seated to finish the dinner
HBS MBA Program	# students graduating per year	# RC and EC students	Years a student is in the MBA program
Manufacturing Process	# items completed per hour	# unfinished items being processed and in buffers	Time for an item to complete the entire process

Note that ***any*** *operational metric* can be defined for an entire process or a subset of a larger process; hence you need to define the scope of your analysis before you start

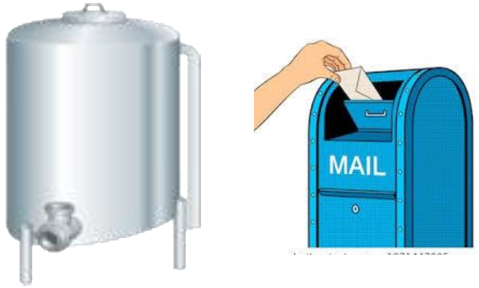
Managing Variability: Examples

Reduce Variability

- Newer equipment
- Preventative maintenance
- Limit target customer range
- Require reservations for customers and supplier arrivals

Accommodate variability

- Physical buffers
- Slack (inventory, time, budget), sometimes referred to as buffers
- Cross training (allows workers to redeploy in face of varying demand)
- Add capacity (to cope with peaks in demand)



Physical Buffers

Time Buffers

Consider the costs and benefits of various options to manage variability. How does reducing or accommodating variability deliver on the business model's value creation?

Managing Inflow and Outflow

Potential Process Symptoms:

(Inflow > Capacity)

- Long wait times
- Overflowing buffers

(Inflow < Capacity)

- Excess Capacity
- Idle workers

Solutions

- Increasing processing capacity
- Increasing buffer size
- Managing inflow

Long Wait times

Overflowing buffers

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Module 2: Managing Process Improvement and Innovation

- Continuous improvement (*e.g.*, Toyota Production System)
- Applying continuous improvement to service operations
- Improving service operations through predictive analytics and leveraging AI in operations
- Combining process-focused and people-focused approaches
- Managing innovation as a process:
    - Using design thinking to understand customer needs and rapidly test ideas
    - Managing innovation portfolios
    - Understanding exploration vs exploitation
    - Designing data-driven operating models

Reminder

9-696-023
REV: JUNE 26, 2020

ANN E. GRAY
JAMES LEONARD

Process Fundamentals

Imagine that, upon graduation, you take a job managing a business whose operating processes need improvement. Perhaps you need to help management understand how to increase the value that operations provides to customers and to improve the profitability of an operation. Or imagine that upon graduation, you take a job in marketing and you need to understand how the decisions made to improve operations will affect your new marketing programs, or how your new marketing programs will affect the ability of operations to do what they need to do. Perhaps you are an executive in a start-up and you are concerned with both sets of issues.

Operations management is about designing, managing, and improving the set of activities that create products and services and deliver them to customers. We call the activities, the people, the technology, the knowledge, and the procedures that dictate how work is organized the ***operating system***. (In this context, when we talk about operating systems, we're usually not talking about Windows, Mac OS, or Android.)

The basic building block of operating systems is the ***process***. Most operating systems consist of multiple processes. A process takes inputs (e.g., raw materials, energy) and uses resources (e.g., labor, capital equipment, knowledge) to create outputs that are of greater value to customers (and, thereby, of greater value to the organization).

This note is an introduction to ***process analysis***, a set of concepts and tools that will enable you to describe, measure, diagnose, and improve operating processes.

As a simple example, suppose your mission is to improve a large bakery that supplies supermarket chains with products ranging from breads to pies.

How will you start? First, you have to develop a good understanding of the current operation: the activities that transform flour, water, yeast, and other ingredients into baked goods, and the efforts involved in each activity—such as the labor, materials, and equipment required at each step. You will also need to understand the different products the bakery offers, as well as the business's competitive priorities, that is, the reasons that customers buy from you rather than your competitors. Does the bakery offer lower prices, faster delivery, higher quality, or a better product line that allows its customers to buy all their bakery needs from one source? Only after understanding the physical process

Professor Ann E. Gray and Research Associate James Leonard prepared this note as the basis for class discussion, and it has been edited by Professors Srikanth Jagabathula, Willy Shih, and Michael Toffel. It is a rewritten version of an earlier note by Prof. Paul W. Marshall, "A Note on Process Analysis," HBS No. 675-038.

9-618-023
REV: AUGUST 7, 2019

WILLY SHIH
MICHAEL W. TOFFEL

Production Processes

The first module of RC TOM examines several ways to arrange production, ranging from job shops that are tailored to producing customized products, to assembly lines where items are processed in a linear sequence and often transported between steps with a conveyor belt, to continuous flow processing. The cases are set in factories that make different kinds of products. Factories are an appealing setting to assess and improve processes because producing physical goods makes it easier to visualize process steps and work flow.

This note describes four broad categories of process architectures and then examines the nature of task assignment that typically would be found in a factory organized along the lines of each process type. We will then delve more deeply into work flow policies, materials handling, and line pacing for the assembly line, since this process architecture is so widely used for the mass production of everything from smartphones to automobiles.

Production Process Types

Job shops, line flows, and continuous flow are some of the most common production processes deployed in factories around the world. [1]

1. *Job Shops* produce a large variety of products that require many different production steps and/or sequences between production steps. Job shops tend to be physically laid out by clustering workstations by equipment type, for example by placing all 3D printers in one area and all the drills in another. A product's routing through a job shop depends on the physical location of where specialized processing steps occur. Job shops often feature product routings that are referred to as a *jumbled flow*, because each product's routing can be distinct, depending on the particular set and sequence of processing steps it requires. (For example, one product might require steps performed at workstations A, B, then C, whereas another might require only steps at workstations C then A.) When an individual unit or batch of work arrives at a job shop workstation to have a particular task performed, setups are common (that is, the equipment must be adjusted to work on that specific

[1] Robert Hayes and Steven Wheelwright, "Link manufacturing process and product life cycles," *Harvard Business Review* (January-February 1979): pp 133-140.

Professors Willy Shih and Michael W. Toffel prepared this note as the basis for class discussion.

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WILLY SHIH

Conducting a Kaizen

Kaizen (改善), meaning "change for the better" in Japanese, is a set of activities directed at improving standardized work, equipment, and procedures for carrying out daily production or other business operations.

Kaizen as a quality improvement process had its roots in post-World War II Japan, when the auto maker Toyota implemented quality circles, groups of workers who met regularly to identify, analyze, and solve work-related problems. Inspired by W. Edward Deming's call to "improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs," Toyota adapted his Plan-Do-Check-Act cycle (see **Exhibit 1**) and formalized it as kaizen—a continuous improvement process. Toyota viewed kaizen as a way to engage its workers in generating improvement ideas. At Toyota, kaizen has become an integral part of the Toyota Production System (TPS).

Kaizen Foundations—Underlying Practices

There are many practices that provide the underpinnings of TPS. Toyota uses these as a foundation, and then uses kaizen to improve upon them.

5s (pronounced as "5" and the letter "s") refers to a set of basic desirable customs and manners, deriving from traditional Japanese behaviors at home and at school.[a] **Exhibit 2** illustrates these principles:

- **Sort**. One makes work easier by eliminating obstacles and unnecessary items, and removing all parts and tools that are not in use. Unwanted materials are segregated from the work space.
- **Set in order**. Items are arranged so that they can be easily selected and used. Work is arranged so that everything is in close proximity to avoid wasted motion. It should be easy to find and pick up items. Components should be placed according to where they will be used, with those most frequently used the closest. The workflow should be smooth and easy.

[a] 5s is an adaptation of the Toyota Production System teaching of 4s. The idea of sustaining did not come into Toyota's version of kaizen because it was so thoroughly embedded in the company's culture. In other places, it was taught, so the "s" was added.

Professor Willy Shih prepared this note as the basis for class discussion.