

# Chapter 1

## Total Framework of the Toyota Production Systems



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Summary



# 1.1 INTRODUCTION

- ❖ **Toyota Motor Corporation**, abbreviated **TMC**, is a Japanese multinational automaker headquartered in Toyota, Aichi, Japan.
- Sakichi Toyoda, the founder of the Toyota group of companies, started Toyota as a textile machine company.
- Kiichiro Toyoda, son of Sakichi, founded TMC in 1937.
- Taiichi Ohno, Toyota's chief of production in the post-WWII period. He was THE main developer of Toyota Production System (TPS). 
- Dr. Shigeo Shingo: A consultant to Toyota. 

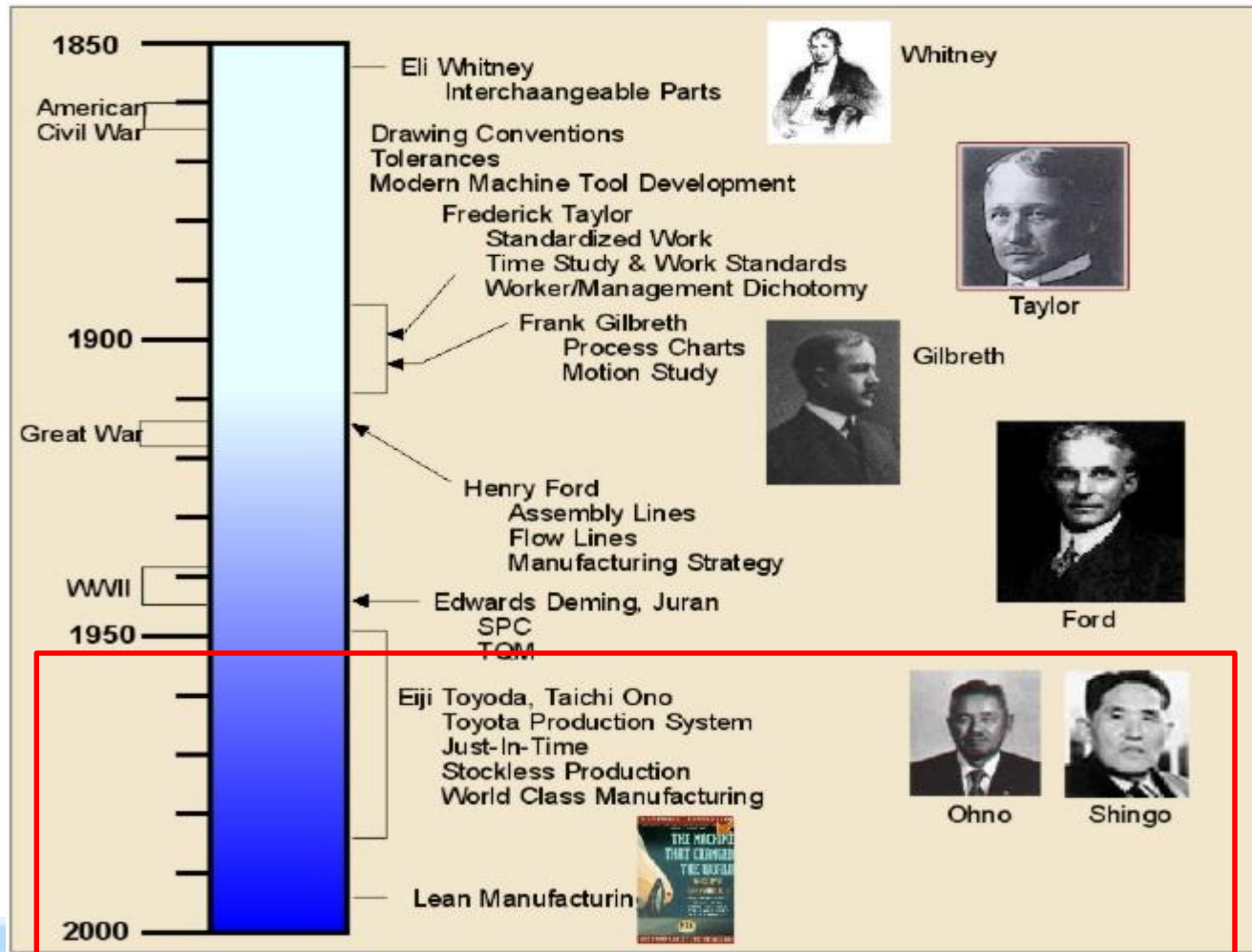
# 1.1 INTRODUCTION

- ❖ *Toyota Production System (TPS)* drew wide attention from the industrial community because Toyota was a profitable car company in Japan during and after the oil embargo in 1970s.
- ❖ Widespread recognition of TPS grew rapidly with the publication in 1990 of *The Machine That Changed the World: The Story of Lean Production*, the result led by the Massachusetts Institute of Technology (MIT).



# 1.1 INTRODUCTION

## ❖ Toyota's role in the history of manufacturing management

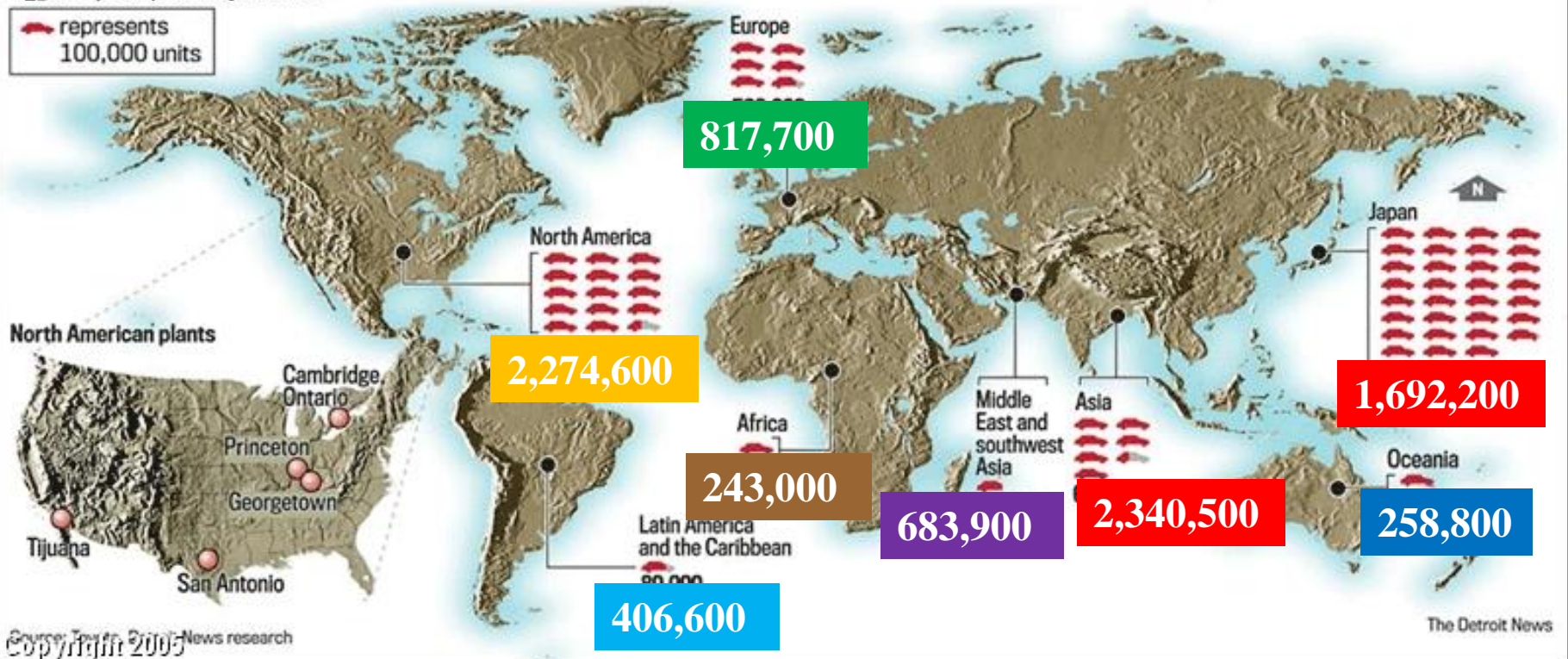


# 1.1 INTRODUCTION

❖ Toyota's worldwide sales (units) in 2012.

## A growing empire

[http://www.toyota-global.com/company/profile/figures/vehicle\\_production\\_sales\\_and\\_exports\\_by\\_region.html](http://www.toyota-global.com/company/profile/figures/vehicle_production_sales_and_exports_by_region.html)





# 1.1 INTRODUCTION

- In 2010, Toyota employed 325,905 people worldwide.
- In 2011, Toyota was the *third-largest automobile manufacturer* by production behind General Motors and Volkswagen Group.
- In July 2012, the company reported it had manufactured its 200-millionth vehicle.
- Toyota is *the eleventh-largest company* in the world by revenue.

# 1.1 INTRODUCTION



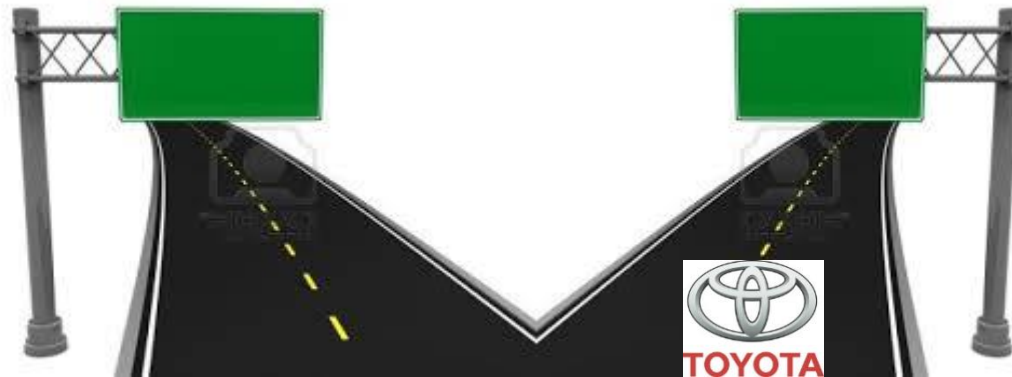


# 1.2 PRIME PURPOSE

❖ To achieve high profit, companies can

➤ increase the revenue

➤ decrease the cost



Costs in TPS include manufacturing costs, sales costs, administrative costs, and capital costs.

# 1.2 PRIME PURPOSE

- ❖ The principal consideration of the TPS is to reduce costs by completely eliminating waste.
  - Excessive production resources
  - Overproduction
  - Excessive inventory
  - Unnecessary capital investment

# 1.2 PRIME PURPOSE

❖ To reduce the costs, the following three sub goals must be met.





# 1.2 PRIME PURPOSE

❖ Key concepts for TPS.

➤ Just-in-time (JIT): produce the necessary units in the necessary quantities at the necessary time.



➤ Autonomation: support JIT by never allowing defective units from a preceding process to flow into and disrupt a subsequent process.

# 1.2 PRIME PURPOSE

❖ Key concepts for TPS.

➤ Flexible Work Force: vary the number of workers to demand changes.



➤ Originality and Ingenuity: capitalize on worker suggestions.

# 1.3 KANBAN SYSTEM

- ❖ In the Kanban (看板) System, the type of quantity of units needed are written on a card called a “kanban”, which is sent from workers of one process to workers of the **preceding** process.=> **Pull System**
- A kanban is a card which is usually placed in a rectangular vinyl envelope.
- Withdrawal Kanban
- Production-ordering Kanban



# 1.3 KANBAN SYSTEM

- A, B, and C: products
- *a* and *b*: necessary parts

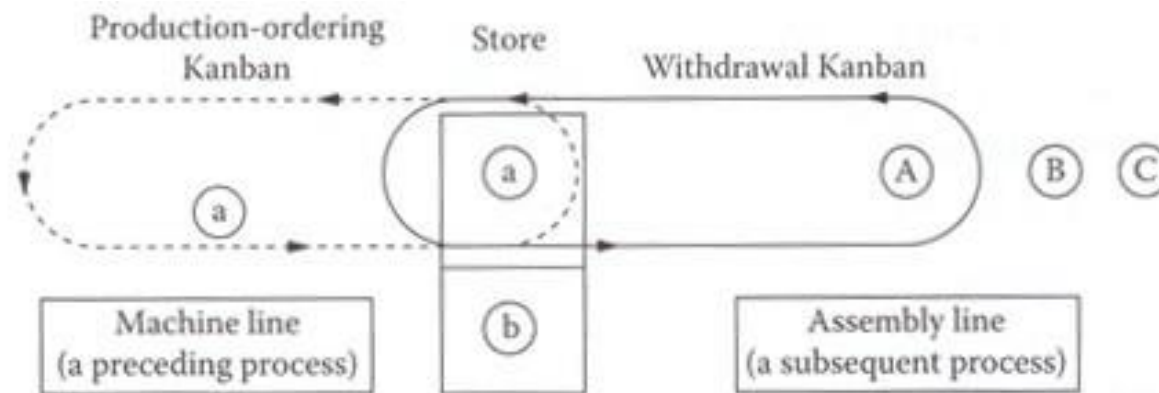


FIGURE 1.3  
The flow of two kanban.

# 1.4 PRODUCTION SMOOTHING

- ❖ With the smoothing of production, a final assembly line produces equally each kind of product based on its own daily cycle time.
- ❖ The variation in the withdrawn quantity of each part at each subassembly line is minimized.
- ❖ The subassemblies can produce each part at a constant speed or at a fixed quantity per hour.

# 1.5 SHORTENING SETUP TIME

- ❖ It is important to neatly prepare in advance the necessary tools and materials.
- ❖ The worker should concentrate on changing over the tools and materials.

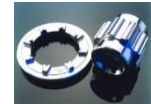


## Internal setup



# 1.6 PROCESS LAYOUT

- ❖ In the well-known Ford assembly line, each worker handles one machine.



# 1.6 PROCESS LAYOUT

- ❖ Under the TPS, each worker would handle several different machines.



# 1.7 STANDARDIZATION OF OPERATIONS

- ❖ A **cycle time** (or **takt time**) is the standard specified number of minutes and seconds that each line must produce one product or one part.

$$\text{cycle time} = \frac{\text{operating hours per day}}{\text{necessary outputs per day}}$$

$$\text{necessary output per day} = \frac{\text{necessary output per month}}{\text{operating days per month}}$$



# 1.7 STANDARDIZATION OF OPERATIONS

- ❖ Standard operations routine
  - the sequence of operations that should be taken by a worker in multiple processes
  
- ❖ Standard quantity of work-in-process
  - the minimum quantity of work-in-process within a production line

# 1.8 AUTONOMATION (自動化)

- ❖ Build in a mechanism to prevent mass-production of defective work in machines or product lines.
- ❖ The autonomous machine is a machine to which an automatic stopping device is attached.
  - mass production of defects can be prevented.
  - machine breakdowns are automatically checked

Cf. Mistake-Proofing: Pokayoke



# 1.9 IMPROVEMENT ACTIVITIES

- ❖ Quality Control (QC) circle.
  - Each worker has the chance to make suggestions and propose improvements.
- quantity control
- quality assurance
- respect for humanity

# 1.10 THE GOAL OF TPS

- ❖ The ultimate goal of TPS is to improve the efficiency in terms of “return on investment” (ROI) or “return on assets” (ROA).

$$\begin{aligned} \text{ROA} &= \text{Profit margin} \times \text{Asset Turnover} \\ &= (\text{Income}/\text{Sales}) \times (\text{Sales}/\text{Assets}) \end{aligned}$$



# 1.10 THE GOAL OF TPS

$$\text{ROA} = \text{Profit margin} \times \text{Asset Turnover}$$
$$= (\text{Income/Sales}) \times (\text{Sales/Assets})$$

❖ Cost must be reduced.

➤ target costing in the design phase

➤ TPS and “kaizen costing” in the manufacturing phase

# 1.10 THE GOAL OF TPS

$$\begin{aligned} \text{ROA} &= \text{Profit margin} \times \text{Asset Turnover} \\ &= (\text{Income/Sales}) \times (\text{Sales/Assets}) \end{aligned}$$

❖ Lead time must be reduced.

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Inventory}}$$



$$\text{Number of days' inventory on hand} = \frac{\text{Inventory}}{\text{Cost of goods sold per day}}$$

# 1.10 THE GOAL OF TPS

❖ Another measure of the integrated goal

-JIT Cash-Flows

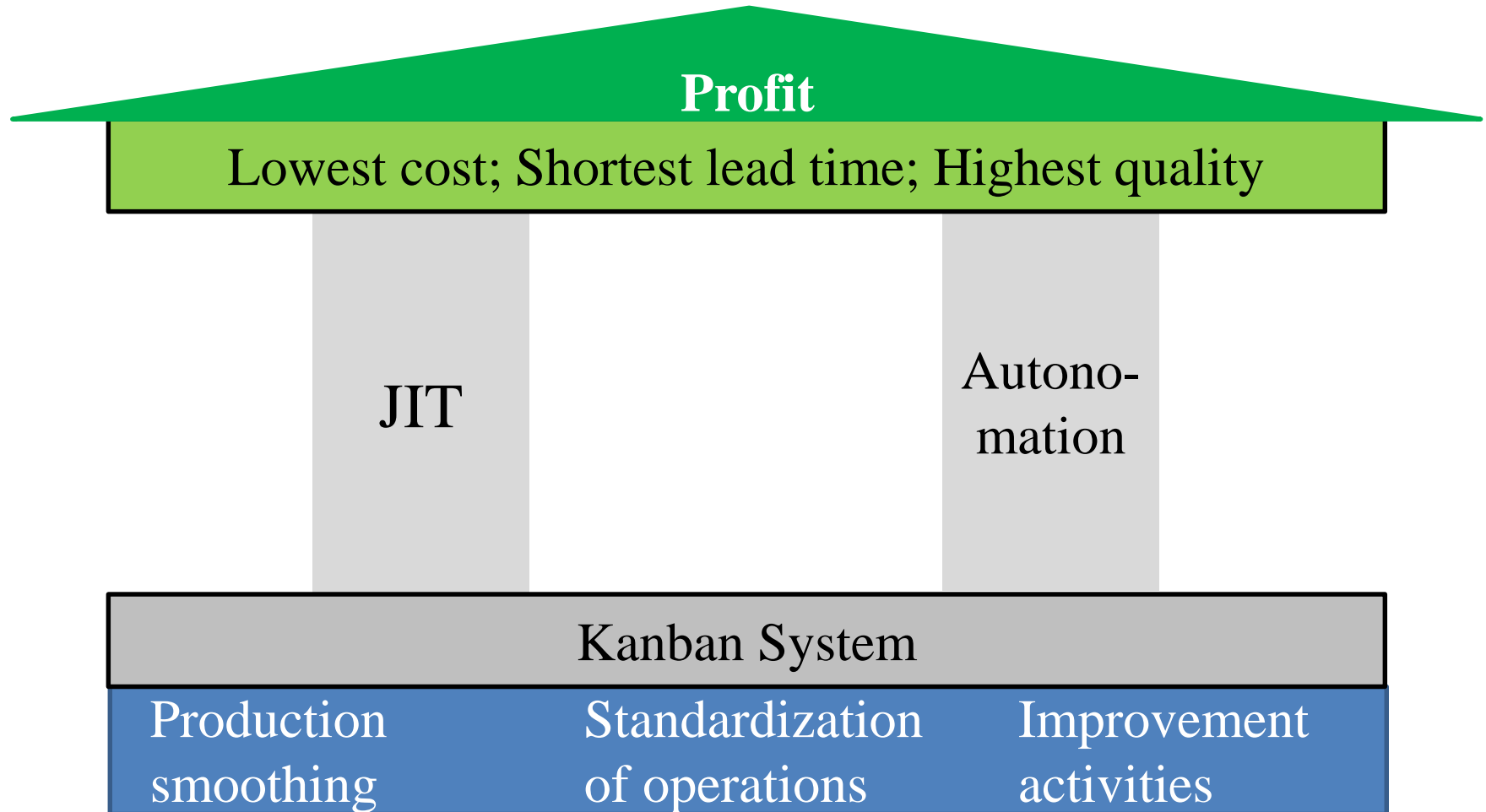
JIT Cash Flows = Operating income  
–(+ ) Inventory increase (decrease)

JIT Cash Flows = Sales amount  
–Amount of purchased direct materials  
–All of the cash-paid processing costs



# SUMMARY OF CHAPTER 1

## ❖ House of TPS





# 1.1 INTRODUCTION

TPS was born through our various efforts to catch up with the automotive industries of western advanced nations after World War II, without the benefit of funds or splendid facilities.

Our approach has been to investigate one by one the causes of various unnecessaries in manufacturing operations and to devise methods for their solution, often by trial and error.



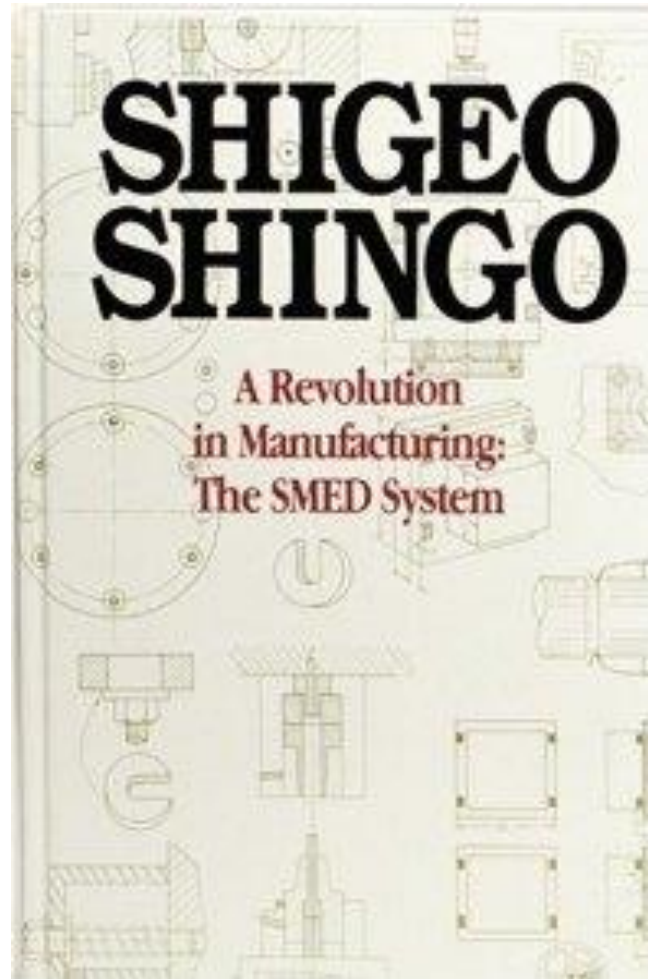
# 1.1 INTRODUCTION

- *Shingo Prize* is the highest manufacturing excellence award in the U.S. The prize is given both to companies and individuals who contribute to the development of manufacturing excellence.

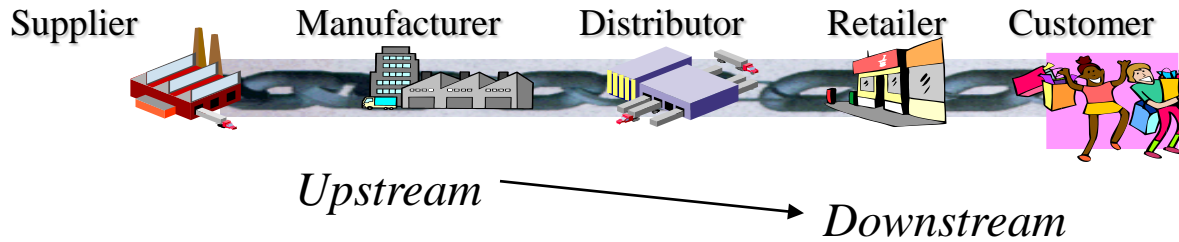


**THE SHINGO PRIZE**  
*for OPERATIONAL EXCELLENCE™*

# 1.1 INTRODUCTION



- A supply chain consists of



- aims to Match Supply and Demand, profitably for products and services



**SUPPLY SIDE**

**DEMAND SIDE**

- aims to achieve



**The right Product**



**The right Price**



**The right Store**



**The right Quantity**



**The right Customer**



**The right Time**



**Higher Profits**



# WHY IS MATCHING DIFFICULT?

- ❖ Why is matching supply with demand difficult?  
=> **Demand can vary and supply is inflexible!**

Successful companies continually strive for that goal!



# URNS AND DAYS-OF-SUPPLY AT WALMART IN 2010\*

\* All figures in \$Million from 2010 balance sheet and income statement

→  →

I = Inventory = \$33,160

R = COGS = \$304,657

- *COGS = Cost of Goods Sold = Flow Rate*
  - The Flow Rate is not Sales (which was \$405,046) because inventory is measured in the cost to purchase goods, not in the sales revenue that may be earned from the goods.
  - Note: Some companies use the term “Cost of sales” to mean COGS
- Annual turns =  $\$304,657 / \$33,160 = 9.19$
- Days-of-supply =  $\$33,160 / (\$304,657 / 365) = 39.7$

Table 1. The Gartner Supply Chain Top 25 for 2012

| Rank | Company               | Peer Opinion <sup>1</sup><br>(173 voters)<br>(25%) | Gartner Opinion <sup>1</sup><br>(37 voters)<br>(25%) | Three-Year Weighted ROA <sup>2</sup><br>(25%) | Inventory Turns <sup>3</sup><br>(15%) | Three-Year Weighted Revenue Growth <sup>4</sup><br>(10%) | Composite Score <sup>5</sup> |
|------|-----------------------|--|--|---|---------------------------------------|--|------------------------------|
| 1    | Apple                 | 3241   | 651  | 20.2%   | 74.1                                  | 51.5%  | 9.69                         |
| 2    | Amazon                | 2713   | 435  | 4.4%  | 10.0                                  | 37.7%  | 5.40                         |
| 3    | McDonald's            | 1121   | 283  | 16.0%   | 142.4                                 | 7.2%   | 5.37                         |
| 4    | Dell                  | 2131   | 546  | 6.8%  | 35.6                                  | 2.7%   | 5.30                         |
| 5    | P&G                   | 1940   | 622  | 9.2%  | 5.5                                   | 2.5%   | 5.05                         |
| 6    | The Coca-Cola Company | 1818   | 372  | 13.0%   | 5.8                                   | 19.7%  | 4.85                         |
| 7    | Intel                 | 1006   | 406  | 16.2%   | 5.0                                   | 17.8%  | 4.63                         |
| 8    | Cisco Systems         | 1243   | 582  | 8.4%  | 11.0                                  | 5.5%   | 4.46                         |
| 9    | Wal-Mart Stores       | 1874   | 410  | 8.8%  | 8.3                                   | 4.2%   | 4.24                         |
| 10   | Unilever              | 1043   | 534  | 10.2%   | 6.0                                   | 5.5%   | 4.21                         |
| 11   | Colgate-Palmolive     | 697  | 342  | 19.6%   | 5.3                                   | 4.2%   | 4.17                         |
| 12   | PepsiCo               | 917  | 427  | 10.2%   | 7.7                                   | 17.6%  | 4.05                         |
| 13   | Samsung               | 1014   | 291  | 9.4%  | 17.1                                  | 15.9%  | 3.67                         |
| 14   | Nike                  | 1073   | 278  | 13.3%   | 4.6                                   | 5.2%   | 3.55                         |

