SA1073 작업시스템 설계 및 분석

Work System Design & Measurement

1장. 작업관리의 개요

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Where We Are

1 부. 서론	2 부. 방법 공학	3 부. 작업 측정
작업관리의 개요	공정분석	표준시간(측정, 레이팅)
문제해결의 과정	작업분석	PTS
	연합작업분석	MTM
	라인작업분석	워크샘플링
	공정배치	표준자료법
	동작분석	
	동작경계의 원칙	
	표준작업방법	

목 차

- 공학과 산업시스템공학
- 작업관리의 대상과 범위
- 작업관리의 역사
- 공정 및 작업의 자동화

Engineering

- The profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to utilize **economically**, the materials and forces of nature for the benefit of mankind. [from ABET(Accreditation Board for Engineering and Technology)]

- 수학 및 자연과학 분야에 대한 연구, 경험, 실습을 통해 얻은 지식들을 사려 깊게 적용함으로써 인류공영을 위해 자연자원을 **경제적**으로 사용할 수 있는 방법을 개발하는 직종

- The origin of Economics: limited resources

Industrial Engineering

- Concerned with the design, improvement and installation of integrated systems of people, materials, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems. [from AIIE (American Institute of Industrial Engineers)]

- 인간, 물자, 장비 및 에너지로 이루어진 통합시스템의 설계, 개선 및 설치와 관련된 학문. 이같은 통합시스템으로부터 얻어질 결과를 명시, 예측, 평가하기 위하여 수학, 물리학, 사회과학 등으로부터의 전문지식 및 방법과 함께 공학적 분석 및 설계의 원리와 방법이 사용된다.

- The origin of IE: the principles of scientific management (by F.W. Taylor)

명칭 및 관련학과

- 산업공학과, 산업시스템공학과, 공업경영학과
- 경영공학과, 경영과학과, 경영정보학과
- 생산공학과, 시스템공학과, 생산시스템공학과
- Industrial Engineering & Operations Research
- Industrial & Systems Engineering
- Industrial Engineering & Management
- Etc.

System

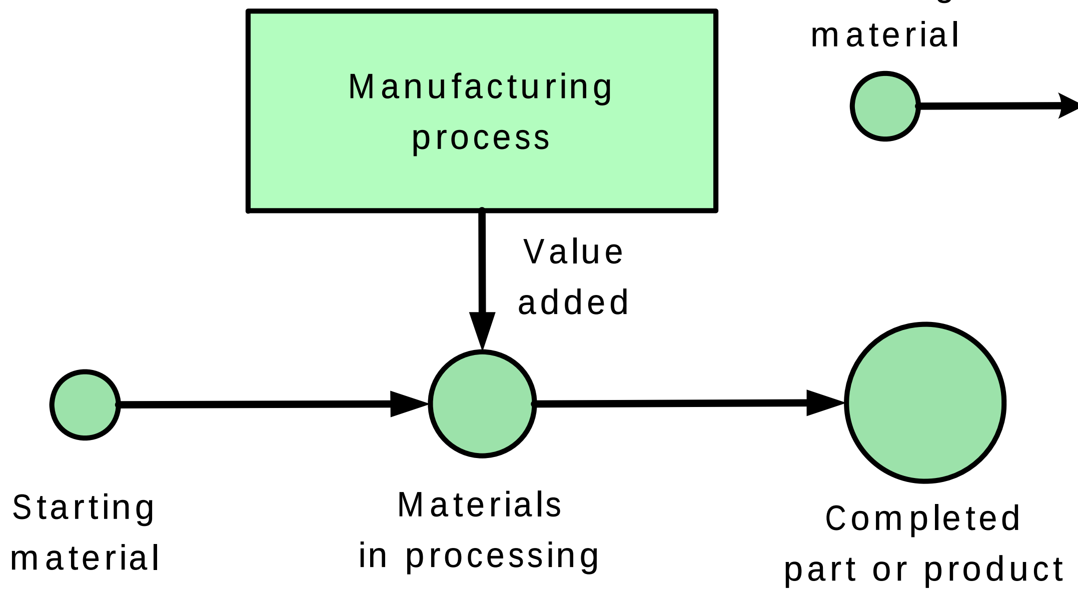
- A group of subsystems or elements integrated and interacts together to achieve a common goal.

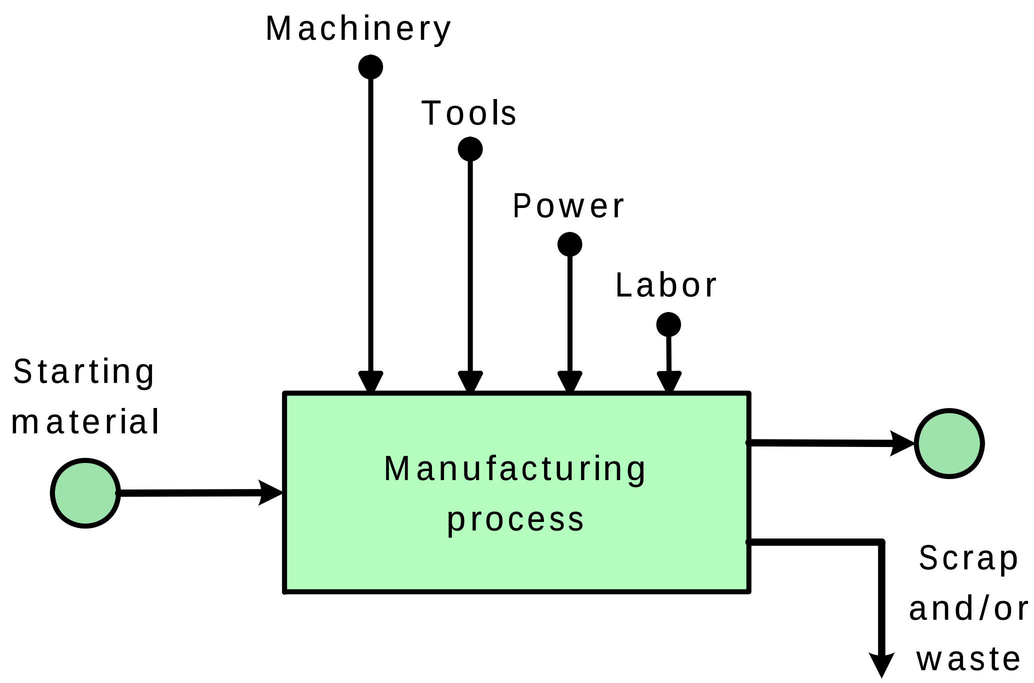
- Three keywords
  - Components
  - Interaction (communication link)
  - Common objectives

- 시스템 예시: 제조 공정
  - Components: 작업자와 기계 설비
  - Interaction: 작업자가 기계 설비를 조작
  - Common objectives: 양질의 제품 생산

Production

as an economic process



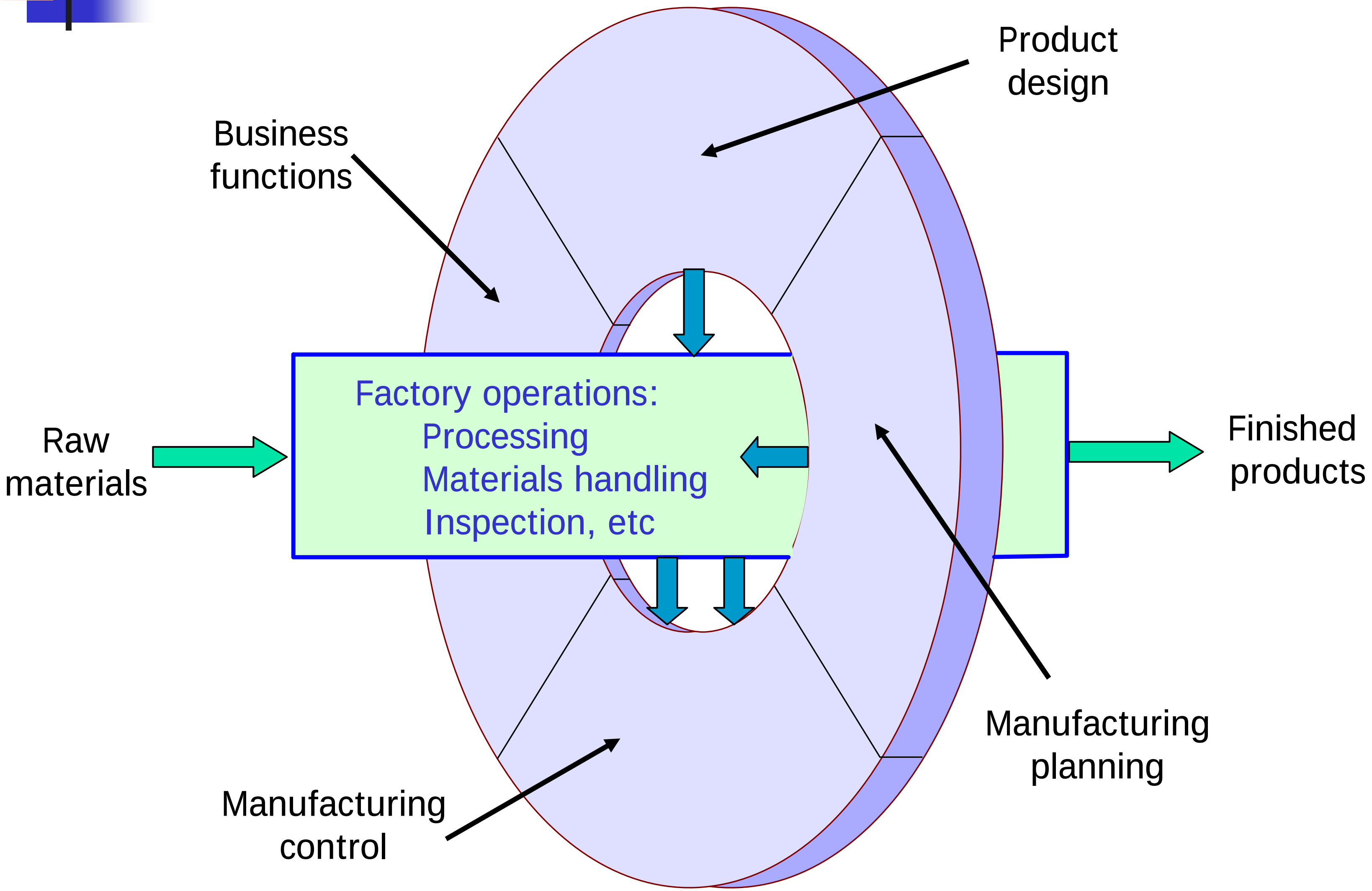


as a technological process

Production System

- Be used to manufacture products and parts assembled into those products
- The collection of people, equipment, and procedures organized to accomplish the manufacturing operations of a company
- Consists of facilities and manufacturing support systems
  - Direct labor people(technicians) are responsible for operating the facilities
  - Professional staff people(engineers) are responsible for the manufacturing support systems

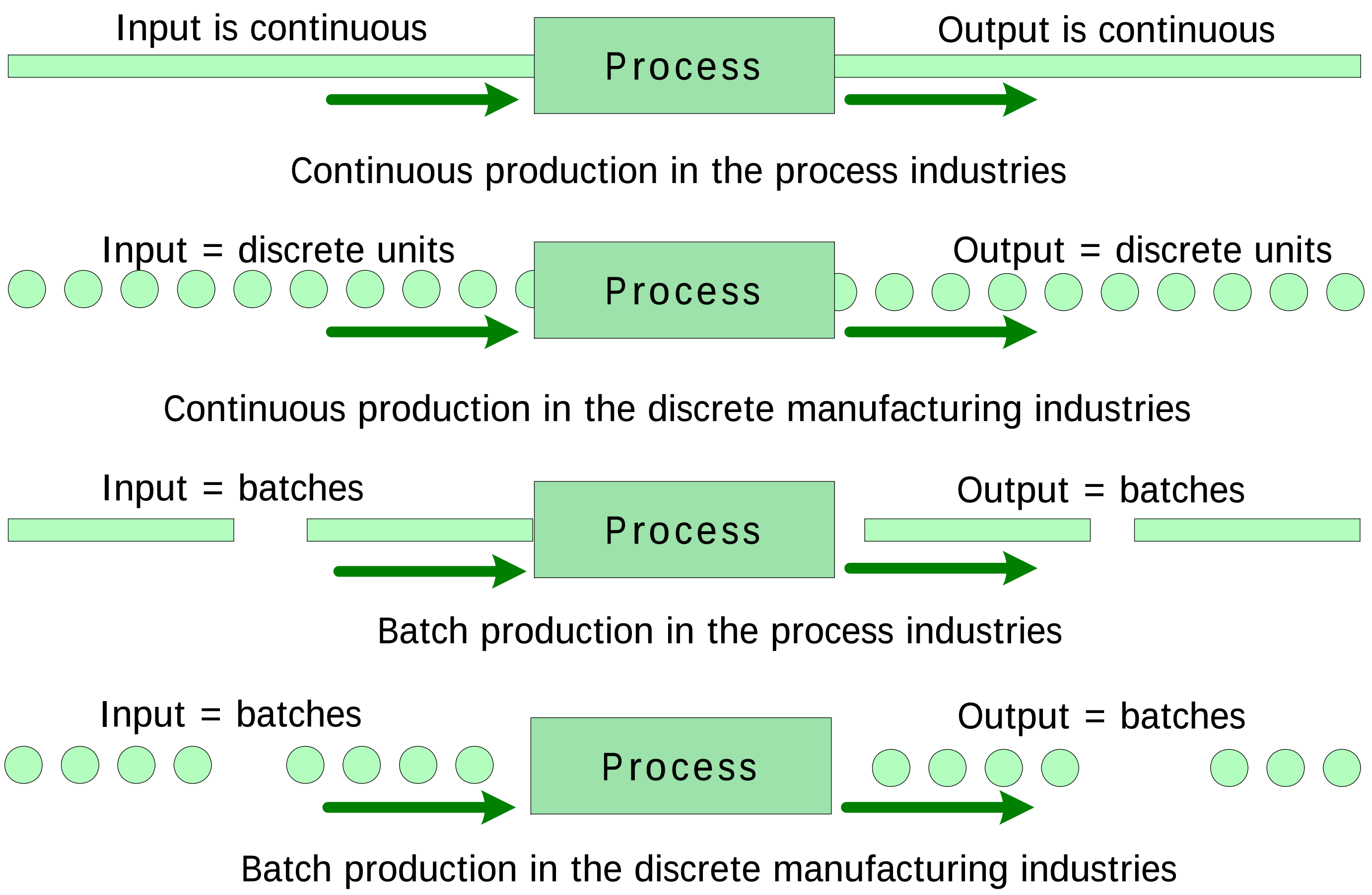
Production System



Manufacturing

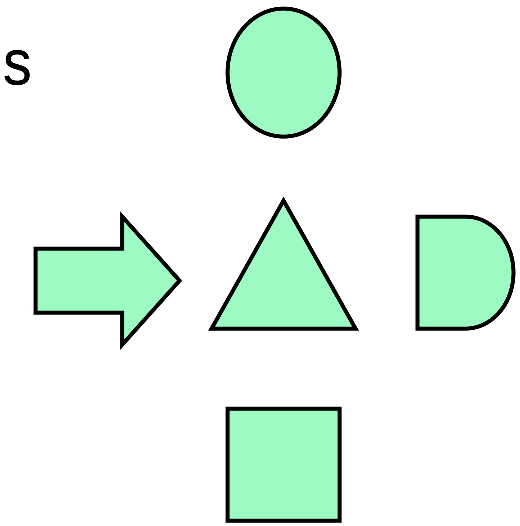
- Manufacture = *manu* (by hand) + *facere* (to make)
- Making of articles by physical labor or machinery, especially on a large scale (dictionary definition).
- The transformation of materials into items of greater value by means of one or more processing and/or assembly operations
- The application of physical and chemical processes to alter the geometry, properties, and/or appearance of a given starting material to make parts, or products.
- Also includes the joining of multiple parts to make assembled products

Types of Manufacturing



Manufacturing Operations

- Processing and Assembly operations
- Materials handling and Storage
- Inspection and Test
- Coordination and Control

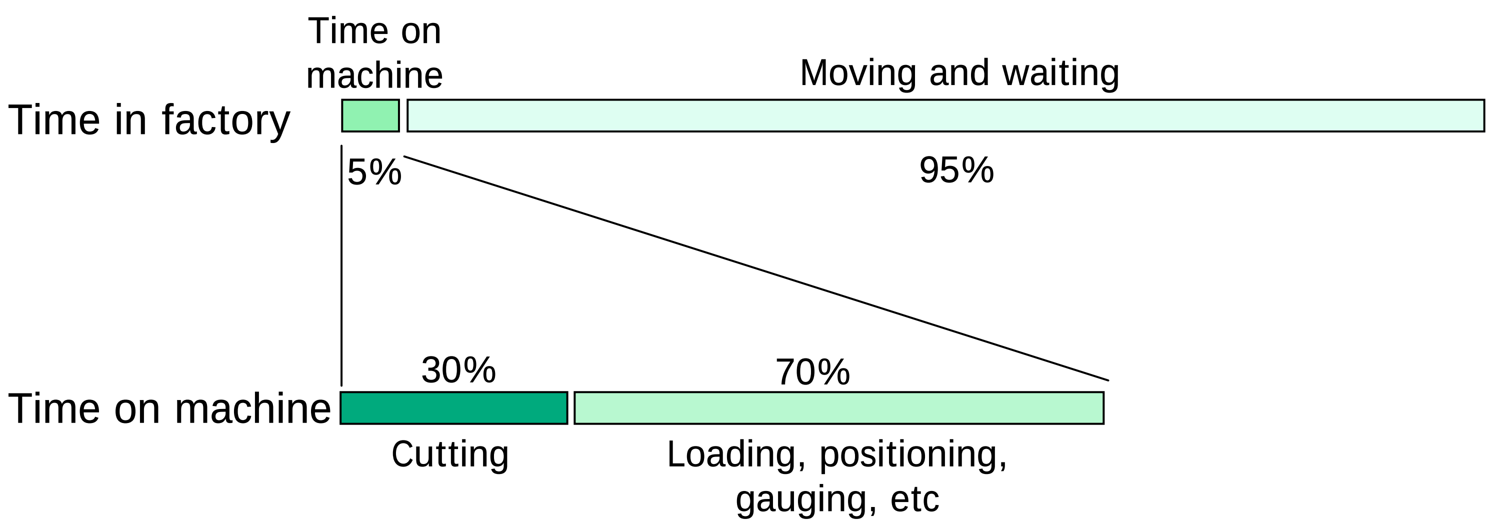


Performance Metrics

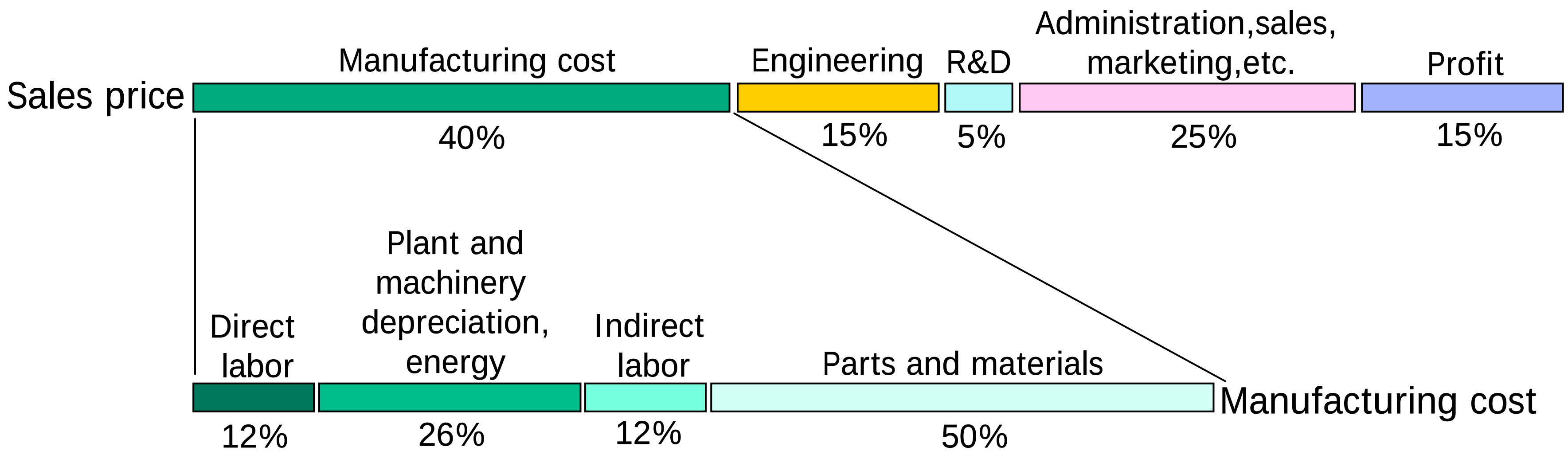
- Added-value: QCD
  - Quality
  - Cost
  - Delivery: Productivity

Manufacturing Lead Time

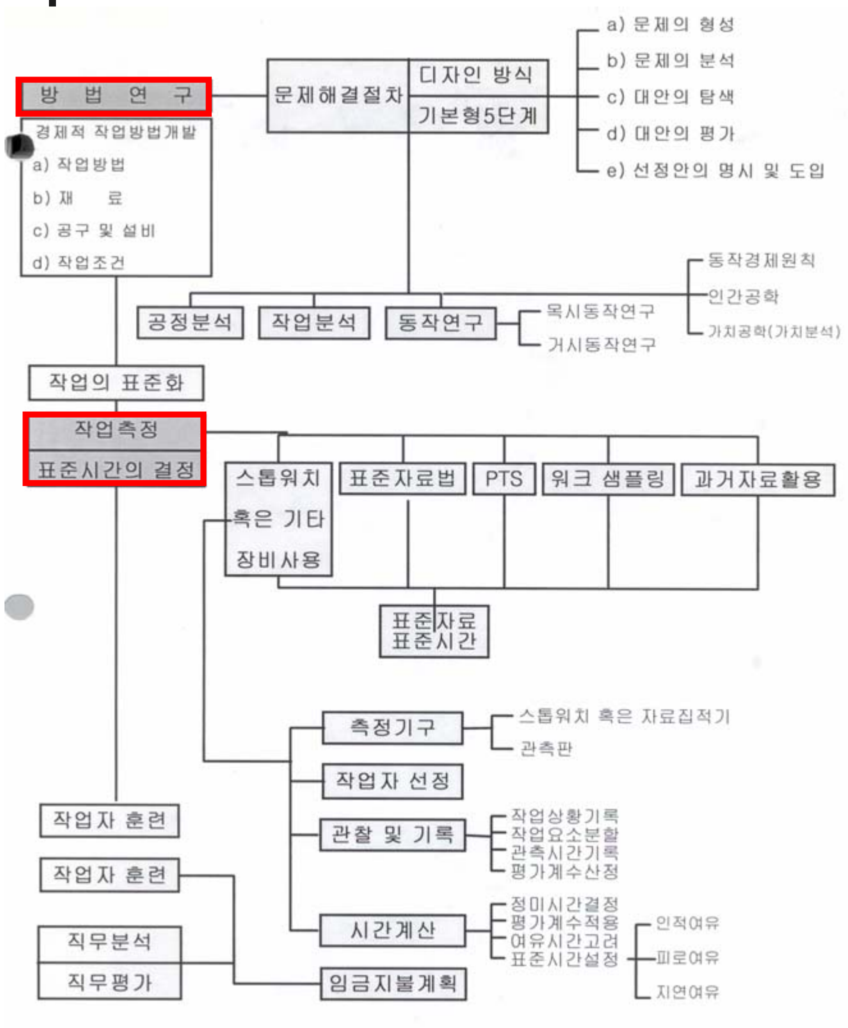
- The total time required to process a given part or product through the plant.
- Breakdown of the manufacturing lead time



Breakdown of Manufacturing Cost



작업관리의 범위



- 방법연구는 작업방법을 체계적으로 분석하여 개선
- 작업측정은 숙련된 작업자가 작업을 정상속도로 수행할 때 소요되는 표준 시간 측정

Brief History

연도	공헌한 사람 및 집단	IE 발전에 기여한 내용
1776	Adam Smith	분업의 경제적 이익 제창
1799	Eli Whitney	호환성 부품으로 조립생산 실험
1800	Watt & Boulton	생산계획 등 다소 과학적인 생산관리 시도
1832	Charles Babbage	분업사상을 관리적 측면에서 보강, 시간연구
1911	Frederick W. Taylor	시간연구, 과업관리, 과학적 관리법 제창
1911	Frank & Lillian Gilbreth	동작연구
1913	Henry Ford	이동조립법에 의한 대량 생산방식 확립
1913	Harrington Emerson	라인 스태프 조직이론
1914	Henry L. Gantt	Gantt Chart 창안
1915	F. W. Harris	EOQ Lot의 결정모델 제시

Brief History

연도	공헌한 사람 및 집단	IE 발전에 기여한 내용
1931	W. A. Schewhart	통계적 품질관리 (SQC)
1933	H. B. Maynard	동작연구를 방법공학으로 종합, MTM의 효시
1933	G. Elton Mayo	Western Electric의 호손공장에서 행동과학 연구
1934	L. H. C. Tippett	Work Sampling으로 작업측정
1940	Operation Research Group	복잡한 시스템 문제에 대한 계량분석
1946	Pennsylvania 대학	최초의 전자계산기 ENIAC 개발
1947	G. B. Danzig	Simplex Method에 의한 선형계획(LP)
1947	L. D. Miles	Value Analysis 창안
1951	UNIVAC	최초의 상업전자 계산기 UNIVAC 1 개발
1952	MIT 대학	수치제어(NC) 공작기계 개발

Brief History

연도	공헌한 사람 및 집단	IE 발전에 기여한 내용
1957	Bowman & Fetter	계량분석 중심의 생산관리론 제시
1957	M. R. Walker (듀퐁사)	Critical Path Method (CPM) 개발
1958	미해군 SPO와 록히드 항공	PERT 개발
1960	J. A. Orlicky (IBM)	Materials Requirement Planning (MRP) 개발
1960	A. V. Feigenbaum	Total Quality Control (TQC) 주장
1962	마틴사의 올랜도 사업부	Zero Defect (ZD) 프로그램
1962	일본 과학기술연맹	품질관리(QC) 분임조 주창
1969	일본 전장	Total Productive Maintenance(TPM) 실시
1970	도요타 자동차	Just In Time (JIT) 생산방식

Brief History

연도	공헌한 사람 및 집단	IE 발전에 기여한 내용
1972	Disney사	Customer Satisfaction (고객만족) 개념의 정립
1973	J. Harrington, Jr.	Computer Integrated Manufacturing(CIM) 정의
1981	Xerox	Benchmarking 기법의 활성화
1984	E. M. Goldratt	Theory of Constrains(TOC) 이론 개발
1987	Mikel Harry (Motorola)	Six Sigma 품질경영 기법 전파
1990	Boeing 사	CALS 기법의 도입
1996	Dell Computer	Supply Chain Management(SCM) 도입
1990	Wal-Mart	Customer Relationship Management(CRM) 도입
1999	P & G	Enterprise Resource Planning(ERP) 도입

Frederick Winslow Taylor (1856~1915)

- was born from a well-to-do Philadelphia family in 1856.
- passed Harvard law school entrance exam, but became a mechanist's apprentice because of eye trouble.
- promoted to chief engineer at the Midvale Steel Company.
- received a bachelor's degree in mechanical engineering from Stevens Institute.
- elected as the president of ASME in 1906.
- major contributions are time study, job design, personnel selection and training.
- is often referred as the "father of I.E."
- Principles of Scientific Management

Principles of Scientific Management

- The development of true science → backbone of motion and time study
- The scientific selection of the workman and his scientific education and development.
- Intimate friendly cooperation between the management and the workman.
- The division of work between the workman and the management.

A Case Study: Bethlehem Steel Company

- Analysis of shoveling tasks
  - Although there was a considerable variety of shoveling tasks (e.g., a shovelful of rice coal weighed only 3.5 lb., where as a shovelful of iron ore weighed 381 lb.), the same type of shovel was used for all tasks.
  - After some experiments, he found that 21.5 lb.(= 10 kg) seemed to represent an ideal weight, and designed shovels of different tasks such that in all cases a shovel load would weigh approximately the ideal amount.
  - Improvements

	Number of workers	average daily amount of output/man	wage/man/ day	materials handling cost/ton
Original	400~600	16 tons	$ 1.15	$ 0.072
Modified	140	57 tons	$ 1.88	$ 0.033

Frank B. and Lillian Gilbreth

- Frank B. Gilbreth was born in 1868, in Fairfield, Maine.
- He would like to enter the MIT, but because of budget he took a job as a bricklayer's helper at the age of seventeen.
- Became the owner of a profitable construction firm with offices throughout the world before he was thirty.
- He was always in search of one best way of doing work.
- Lillian M. Gilbreth was a Phi Beta Kappa psychology graduate of University of California and later received a Ph. D. from Brown University.

Techniques used by Gilbreths

- Micromotion study: 동작 촬영과 시간측정기구를 이용하여 작업자의 동작이 어떤 종류의 기본동작으로 구성되는지 파악
- Cyclegraph: 작업자의 동작 궤적 분석
- Chronocyclegraph: 작업자의 동작 궤적, 속도, 가속도 분석
- Process chart
- Therbligs (Gilbreths spelled backwards)

A Case Study: Brick Laying

- At the age of seventeen, he took a job as bricklayer's helper.
- He noticed that the man assigned to teach him how to lay bricks used three different motion patterns:
    1) when he was teaching someone how to lay bricks
    2) another set of motions for a slow pace
    3) a third set of motions for a rapid pace.
- He had very questioning attitude about his work. Why should a person use varying motion patterns? Was one method not better than another? Thus began the famous search for the "one best way" of doing work.

A Case Study: Brick Laying

- Instead of having a bricklayer bend over and pick up a brick from a pile of bricks on a relatively unadjustable brickstand, rotate the brick to find the best side, and then lay the brick by tapping with mortar of often poor consistency, he did otherwise. As the bricks were unloaded from the freight car, Gilbreth had low-priced labors sort and inspect them and make “packets”of bricks preoriented for laying. He then provided adjustable brickstand to avoid stooping and bending by the bricklayer. In addition, he arranged for the mortar to be kept of the proper consistency in order to eliminate the motion of tapping the brick into place with trowel. And by the proper location of bricks and mortar bricklayer could use their hand simultaneously.

- The results of Gilbreth’s studies led to an almost threefold increase in a worker’s bricklaying capacity – from 120 bricks per hour to 350.
- The number of motions required to lay a brick were reduced from 18 to 4.5 by eliminating and combining many motions.

Factory Operations & Mechanization

	수작업	1차 기계화	2차 기계화	3차 기계화	장래적 기계화
준비	수작업	수작업	수작업	수작업	기계작업
Loading/ Unloading	수작업	수작업	수작업	기계작업	기계작업
조작	수작업	수작업	기계작업	기계작업	기계작업
주가공	수작업	기계작업	기계작업	기계작업	기계작업
검사	수작업	수작업	기계작업	기계작업	기계작업
보전	수작업	수작업	수작업	수작업	기계작업

Reasons for Automation

- To increase labor productivity.
- To reduce labor cost.
- To mitigate the effects of labor shortage.
- To reduce or eliminate routine manual and clerical work.
- To improve worker safety.
- To improve product quality.
- To reduce manufacturing lead time.
- To accomplish process that cannot be done by manually.
- To avoid the high cost of not automating.

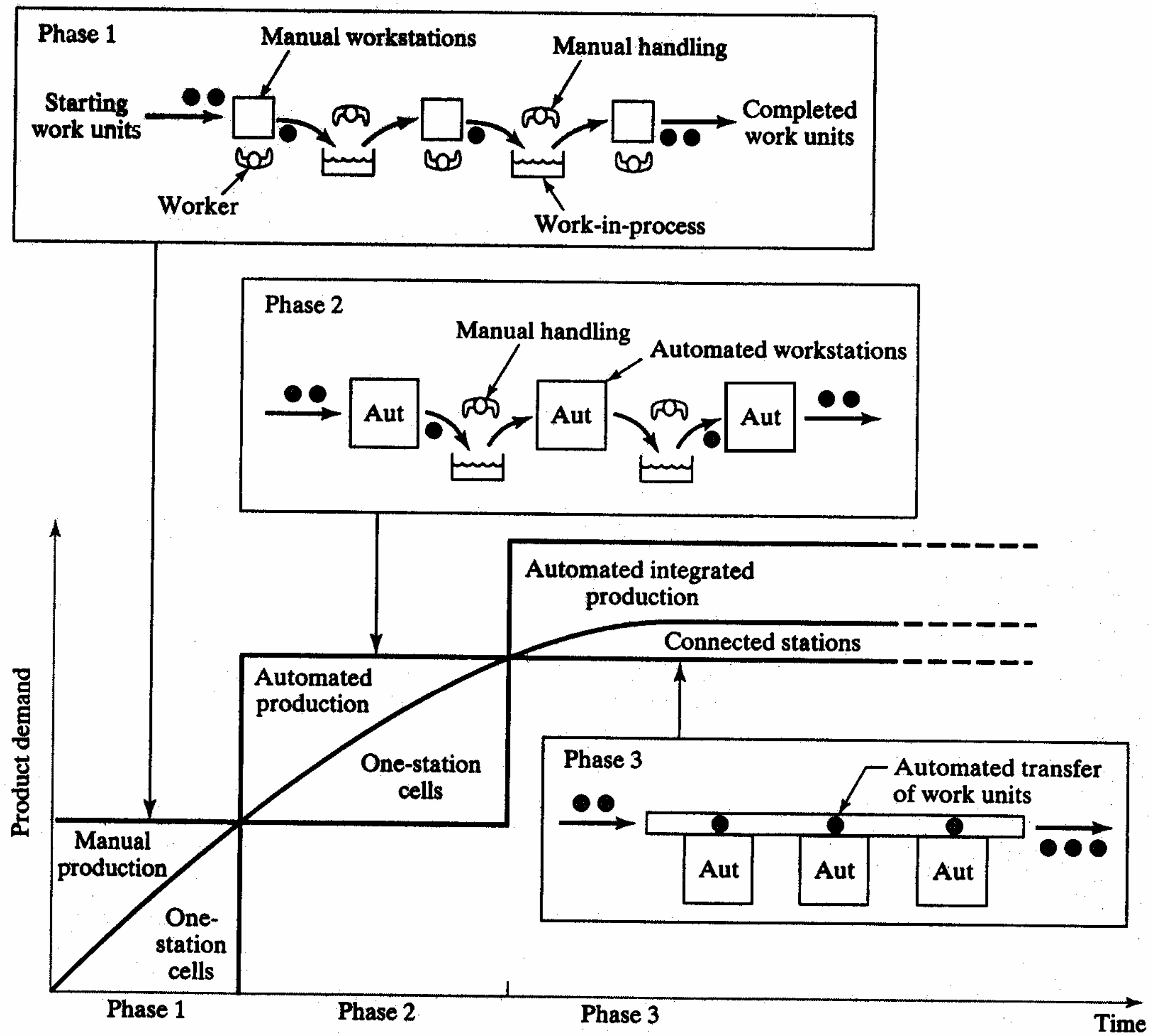
USA Principles

- *Understand* the existing process
- *Simplify* the process
- *Automate* the process

Ten Strategy for Automation

- Specialization of operation
- Combined operations
- Simultaneous operations
- Integration of operations
- Increased flexibility
- Improved materials handling and storage
- On-line inspection
- Process control and optimization
- Plant operations control
- Computer-integrated manufacturing

Automation Migration Strategy



산업 및 사회환경의 변화

- 가치관의 변천
  - 重厚長大(**중후장대**) ▶ 輕薄短小(**경박단소**) ▶ 美遊感創 (**미유감창**)
- 산업형태의 변천
  - 노동집약 ▶ 설비집약 ▶ 정보집약 ▶ 지식집약 ▶ 감성집약
- 생산시스템의 변천
  - 대량생산 ▶ 품질관리 ▶ 다품종 소량생산 ▶ 일품종 일품생산
- 컴퓨터의 발전
  - 수식계산 ▶ 문자처리 ▶ 지식처리 ▶ 감성정보처리