BEFORE INDUSTRIAL ENGINEERING

Engineering history lies back to the beginning of civilization.

Until the end of 17hundreds, production meant crafts (A craftsman used to treat material and assemble the pieces)

Until then a single person used to

• Plan
• Select and supply material
• Produce and control
INDUSTRIAL REVOLUTION

In 1776, James Watt invented the steam engine. (Turning steam power into mechanical power)

This is the beginning of industrial revolution.

Since then, first factories started to be established in USA and UK (United Kingdom)

Earlier factories were textile and metal working plants.
ELI WHITNEY

In 1798, received government contract to make 10,000 muskets

Showed that machine tools could make standardized parts to exact specifications

- Musket parts could be used in any musket
Adam Smith (1776): through his book titled Wealth of Nations laid foundation to **scientific manufacturing**.

Through his concept of **division of labour** which included the skill development, time savings and the use of specialized machine was able to influence.
James Watt (1864): Steam Engine advanced the use of mechanical power to increase productivity
CHARLES BABBAGE (1792-1871)

Patron saint of operations research and management science.

- Inventor of
  - difference engine, financial support from the state
  - analytical engine, no financial support
  - memory
  - arithmetical unit
  - punch card input system
  - conditional transfer (if statement)
Babbage’s inventions never became a commercial reality, largely because of the difficulty of producing parts to the necessary precision (hassas) and reliability. And he then had to visit many factories. His experiences were published in *On the Economy of Machinery and Manufactures*, 1832. E.g. how to measure the daily performance of a worker. The notion *a fair day’s work* is introduced.

*(Not to engineering management but important to know)* The most important collaborator of Babbage was **Lady Ada Byron** the daughter of the poet Lord Byron.

- Very gifted young lady interested in natural sciences.
- *The first computer scientist of the world!*
- Not obtaining money from husband for scientific books.
- ADA programming language was named after her.
FREDERICK W. TAYLOR

Known as ‘father of scientific management’

In 1881, as chief engineer for Midvale Steel, studied how tasks were done

• Began first motion & time studies

Created efficiency principles
FREDERICK W. TAYLOR

devised the system of “scientific management,” a form of industrial engineering that established the organization of work.

developed detailed systems intended to gain maximum efficiency from both workers and machines in the factory, relying on time and motion study to find the “one best method” to achieve a goal.

This sort of task-oriented optimization of work tasks is nearly ubiquitous today in menial industries, such as assembly lines and fast-food restaurants.

But Taylor believed there was a human side of industrialization; that employees and management should work together to make life better for both parties.
FREDERICK W TAYLOR (1859-1915)

was a mechanical engineer and initiated investigations of better work methods and develop an integrated theory of management principles and methodologies.

Proposed:

• Data Collection and standards for workers.
• Scientifically training of workers.
• Cooperation between management and labour for better production.
• Divide work between management and labour and assigning to those who are best suited.
TAYLOR: MANAGEMENT SHOULD TAKE MORE RESPONSIBILITY FOR

- Matching employees to right job
- Providing the proper training
- Providing proper work methods and tools
- Establishing legitimate incentives for work to be accomplished
FRANK & LILLIAN GILBRETH

Husband-and-wife engineering team

Developed work measurement methods

Applied efficiency methods to their home & 12 children!

(Book & Movie: “Cheaper by the Dozen,” book: “Bells on Their Toes”)

developed

• method study as a tool for work analysis.
• micro-motion study, a breakdown of work into fundamental elements called therbligs.
In 1903, created Ford Motor Company

In 1913, first used moving assembly line to make Model T
  • Unfinished product moved by conveyor past work station

Paid workers very well for 1911 ($5/day!)

HENRY FORD

‘Make them all alike!’
CONTRIBUTIONS FROM

- Human factors
- Management science
- Biological science
- Physical sciences
- Information science
HENRY L. GANTT

Work in the area of motivation field, development of task and bonus plan.

Measurement of management results by Gantt Charts (simple graphs that would measure performance while visually showing projected schedules)

Recognition of social responsibility of business and industry.

Advocated training of workers by management.

Invented a Wage Payment system that rewarded workers for above-standard performance, eliminated any penalty for failure, and offered the boss a bonus for every worker who performed above standard.

Emphasized Human Relations and promoted Scientific Management as more than an inhuman ‘Speed up’ of labor.
HARRINGTON EMERSON (1913)

Developed his managerial concepts simultaneously with Taylor, Gantt and Gilbreth.

Amongst his contributions is the Emerson’s Efficiency Bonus Plan, an incentive plan which guarantees the base day rate and pays a graduated bonus.

He also proposed twelve principles of efficiency.
L.H.C TIPPET (1937)

Developed the concept of work sampling to determine the equipment and manpower utilization and setting performance standards for long cycle, heterogeneous jobs involving team work.
Industrial engineering grew out of the industrial age, the result of studies popularized by management pioneer Frederick Taylor and the Gilbreths, Lillian and Frank.

Taylor, the Father of Scientific Management, proposed work methods designed to increase worker productivity.

Frank Gilbreth was known as the Father of Time and Motion Studies.

His wife Lillian was a psychologist. The couple believed, like Taylor, that there was “one best way” to accomplish a task, and their work established time and motion studies as a tool of industrial engineering.

Both Taylor and the Gilbreths focused their studies on the human side of the machine.

Mechanical engineering was already an established field, but the new science of industrial engineering looked at the operators of the machine.
<table>
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<tr>
<th><strong>HISTORY OF INDUSTRIAL ENGINEERING</strong></th>
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<tr>
<td><strong>Charles W. Babbage, a mathematics professor</strong></td>
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<tr>
<td>• Book: <em>The Economy of Machinery and Manufacturers</em> in 1832.</td>
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<td>• Developing <strong>the learning curve, the division of task</strong> and how learning is affected, and the effect of learning on the generation of waste.</td>
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<td><strong>Henry R. Towne and Fredrick A. Halsey</strong></td>
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<tr>
<td>• Developing <strong>wage incentive plans</strong> to the ASME (American Society of Mechanical Engineers) increase the productivity of workers without negatively affecting the cost of production.</td>
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<td><strong>Fredrick Winslow Taylor</strong></td>
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<td>• The best known of <strong>the pioneers in industrial engineering</strong>. He was done potential improvements to be gained through analyzing the work content (minimum amount of work required to accomplish the task) of a job and designing the job for maximum efficiency.</td>
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<tr>
<td><strong>Frank Bunker Gilbreth and his wife Dr. Lillian M. Gilbreth</strong></td>
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<td>• Worked on understanding <strong>fatigue, skill development, motion studies</strong>, as well as time studies.</td>
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<tr>
<td><strong>Henry L. Gantt</strong></td>
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<td>• Developing cost, selection of workers, training, good incentive plans, and scheduling of work. He is the originator of <strong>the Gantt chart</strong>.</td>
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**Cost Focus**

**Early Concepts 1776–1880**
- Labor Specialization (Smith, Babbage)
- Standardized Parts (Whitney)

**Scientific Management Era 1880–1910**
- Gantt Charts (Gantt)
- Motion & Time Studies (Gilbreth)
- Process Analysis (Taylor)
- Queuing Theory (Erlang)

**Mass Production Era 1910–1980**
- Moving Assembly Line (Ford/Sorensen)
- Statistical Sampling (Shewhart)
- Economic Order Quantity (Harris)
- Linear Programming (Dantzig) PERT/CPM (DuPont)
- Material Requirements Planning

**Lean Production Era 1980–1995**
- Just-In-Time
- Computer Aided Design
- Electronic Data Interchange
- Total Quality Management
- Baldrige Award
- Empowerment
- Kanbans

**Customization Focus**

- Globalization
- Internet
- Enterprise Resource Planning
- Learning Organization
- International Quality Standards
- Finite Scheduling
- Supply Chain Management
- Agile Manufacturing

**Quality Focus**
SIGNIFICANT EVENTS IN IE

- Division of labor (Smith, 1776)
- Standardized parts (Whitney, 1800)
- Scientific management (Taylor, 1881)
- Coordinated assembly line (Ford 1913)
- Gantt charts (Gantt, 1916)
- Motion study (the Gilbreths, 1922)
- Quality control (Shewhart, 1924)
## Significant Events - Continued

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<tr>
<th>Event</th>
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<td>CPM/PERT (Dupont, 1957)</td>
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<td>MRP (Orlicky, 1960)</td>
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<td>CAD</td>
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<td>Flexible manufacturing systems (FMS)</td>
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<td>Computer integrated manufacturing (CIM)</td>
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CHALLENGES IN IE

From

- Local or national focus
- Batch shipments
- Low bid purchasing
- Lengthy product development
- Standard products
- Job specialization

To

- Global focus
- Just-in-time
- Supply chain partnering
- Rapid product development, alliances
- Mass customization
- Empowered employees, teams
Teknik industri merupakan ilmu khusus dari departemen Teknik Mesin.

Teknik Industri yang pertama kali memisahkan diri adalah Departemen Teknik Industri di Universitas Pennsylvania State dan Universitas Syracuse pada tahun 1908.

Pilihan Teknik Industri dalam Teknik Mesin terdapat di Universitas Purdue pada tahun 1911.
Di Indonesia, keahlian Teknik Industri diperkenalkan oleh Matthias Aroef pada tahun 1958, sekembalinya dari Cornell University.


Di Universitas Sumatera Utara pada tahun 1965 bahkan telah dibuka jurusan Teknik Industri.