Industrial Engineering and Management

Spring 2023

Product design and Manufacturing V.S. Production Systems

Mechanical Engineers handle the design and manufacturing of one single product

Industrial Engineers concerns with the whole production system:

- product design, man, machine, method, material, money, working space, working environment ... etc.
- Suppliers – Manufacturers – Distribution network - customers
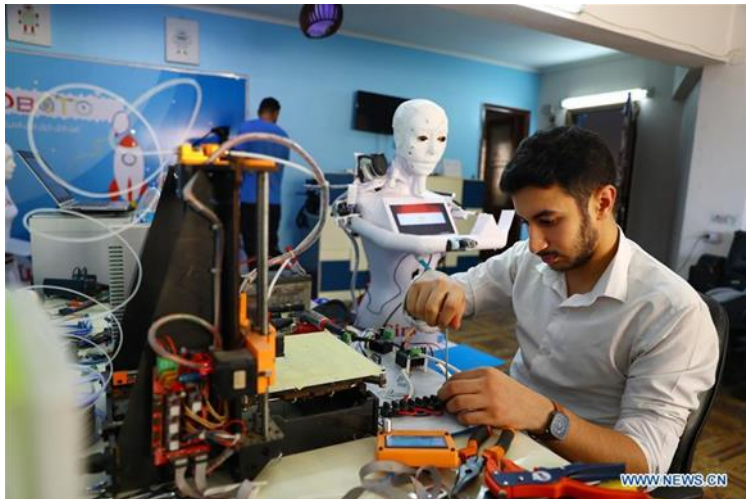
Key rules of IE in the Life of Production System

Birth of the System:
- What are the goals of the firm?
- How does OM strategy relate to the goals?
- How do you manage a project?

Product Design and Process Selection:
- What is the form of the manufactured product?
- How is it developed?
- How do you select the technology to make the product or service?
- How do you design a service?
- How do you achieve high quality?

Revise the System:
- How do you manage growth and change over time?
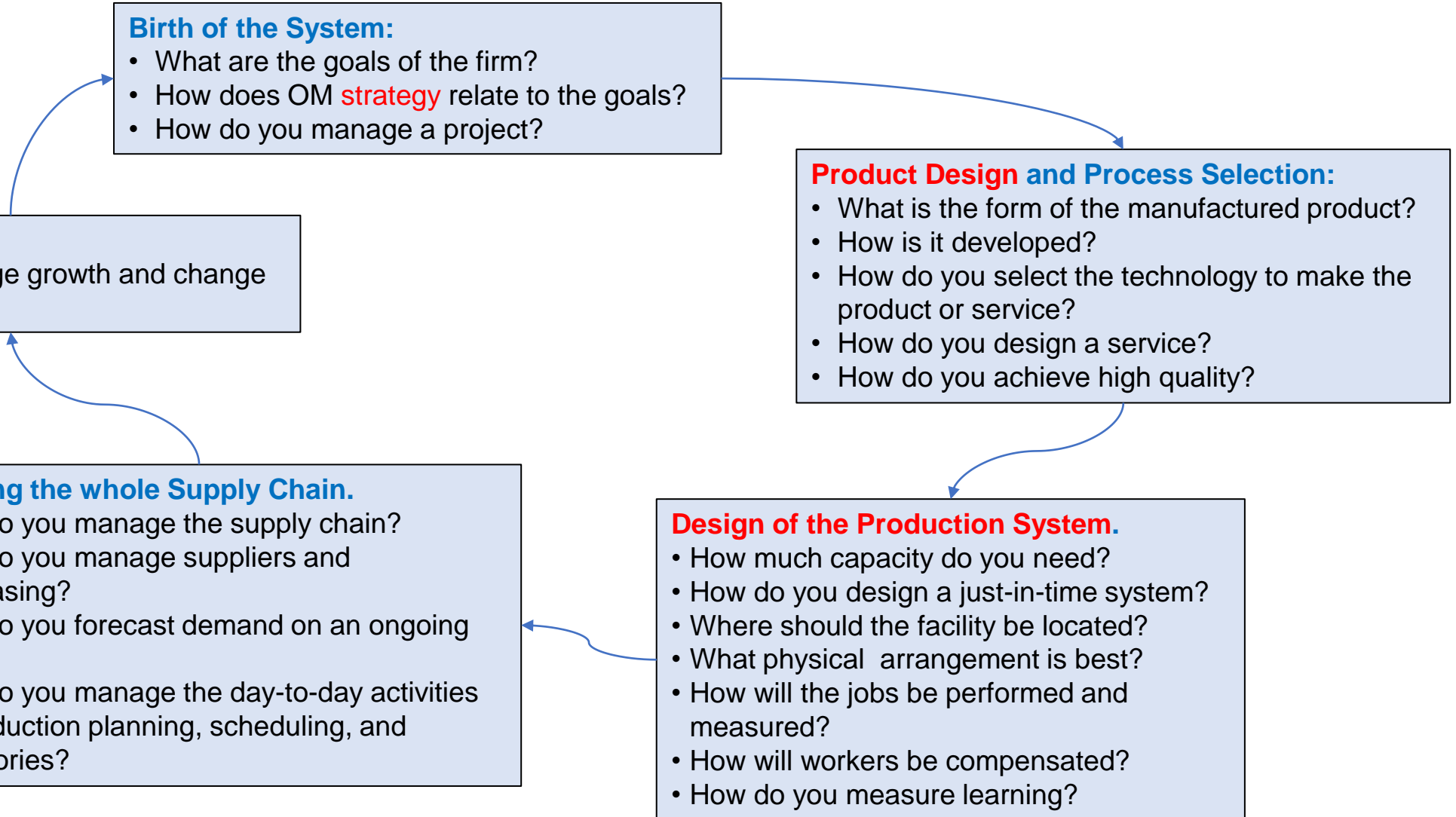
Design of the Production System.
- How much capacity do you need?
- How do you design a just-in-time system?
- Where should the facility be located?
- What physical arrangement is best?
- How will the jobs be performed and measured?
- How will workers be compensated?
- How do you measure learning?
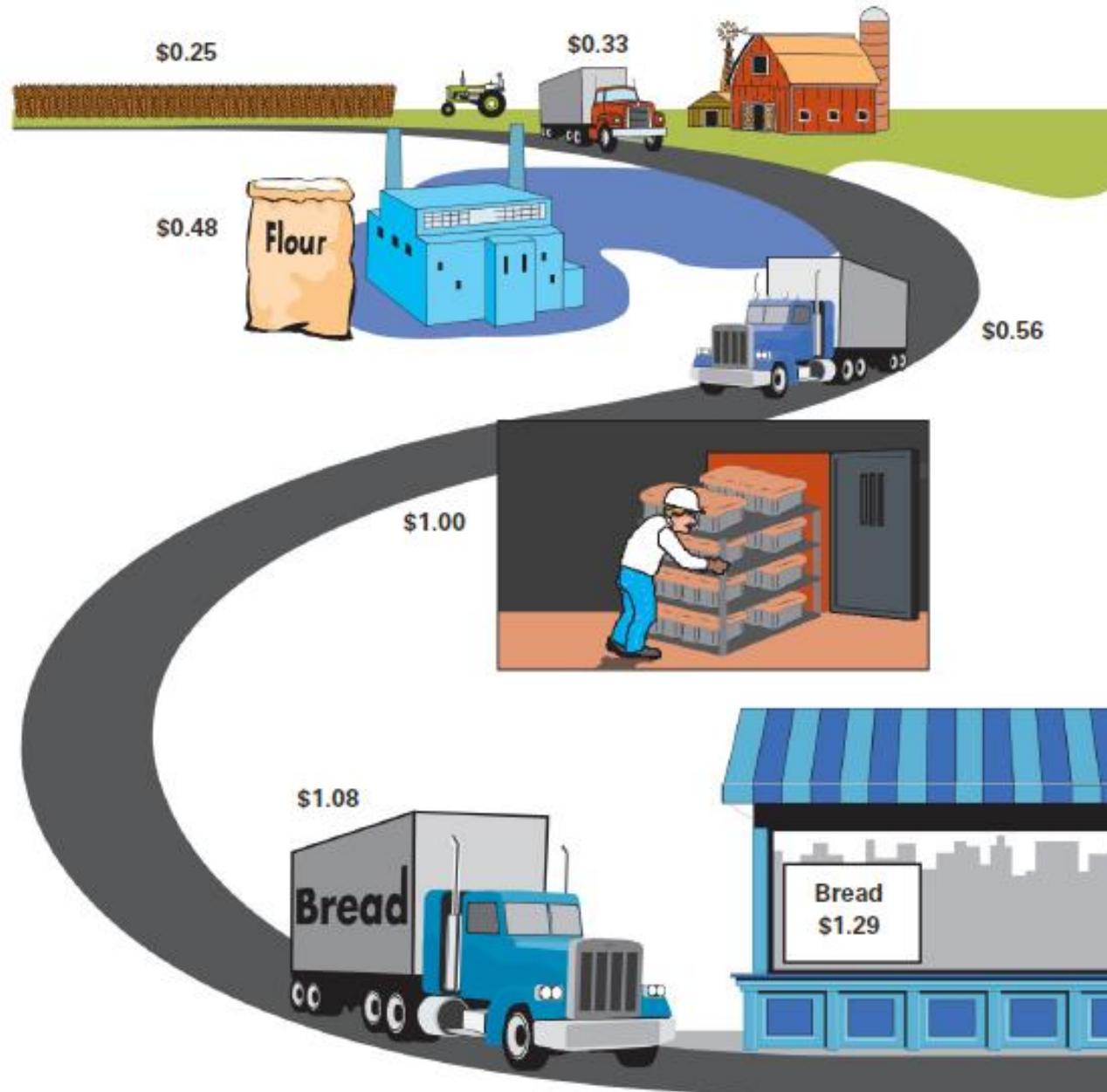
Managing the whole Supply Chain.
- How do you manage the supply chain?
- How do you manage suppliers and purchasing?
- How do you forecast demand on an ongoing basis?
- How do you manage the day-to-day activities of production planning, scheduling, and inventories?

$0.25

$0.33

$0.48

Flour

$0.56

$1.00

$1.08

Bread

Bread
$1.29

Industrial Engineers responsible for the design and operation of: A Warehouse

Merchandise

Merchandise Sorting and Storage Area

Picking and Packing Area

Gift Processing Area

Merchandise Receiving Area

Returned Merchandise Storage Area

Merchandise Measuring Area

Shipping Area

IE design systems e.g.,: Flexible Manufacturing Systems

Machine M1

Painting robot R4

Painting Station PS

Input buffer IB1

Conveyor Belt C1

Robot R1

Input buffer IB2

Conveyor Belt C2

Robot R2

Assembly Station AS

Robot R3

Output buffer OB
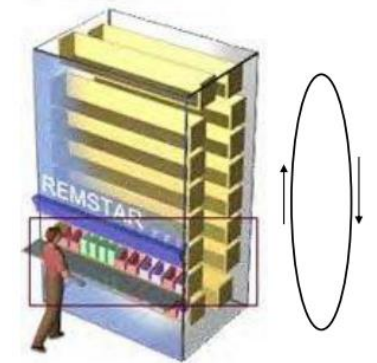
Machine M2
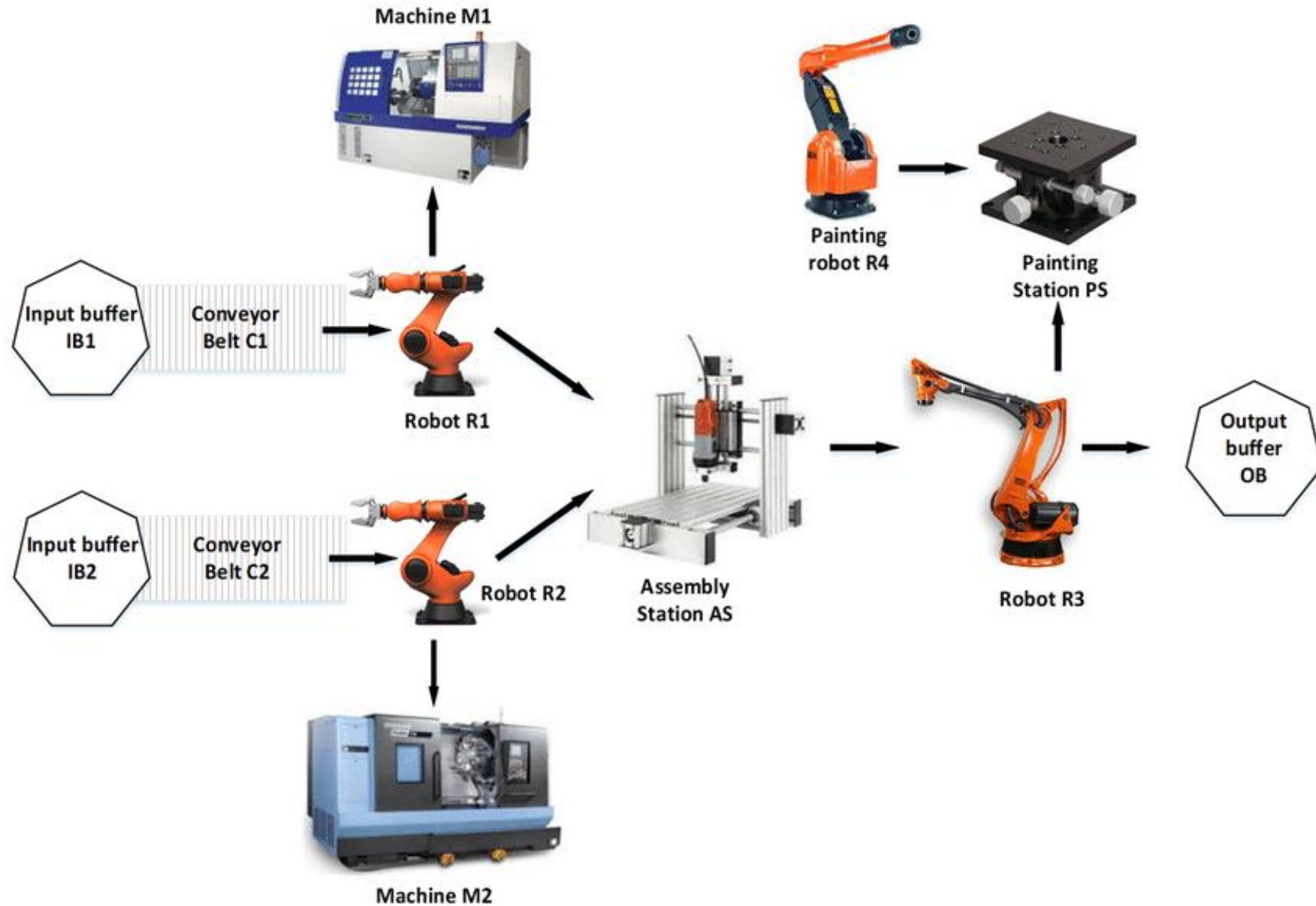
IE design systems including: Material Handling System

MH is the art and science of moving, storing, protecting, and controlling material.

PROVIDE

- Right **material**
- Right **time**
- Right **condition**
- Right **place**
- Right **position**
- Right **sequence**
- Right **cost**
- Right **methods**
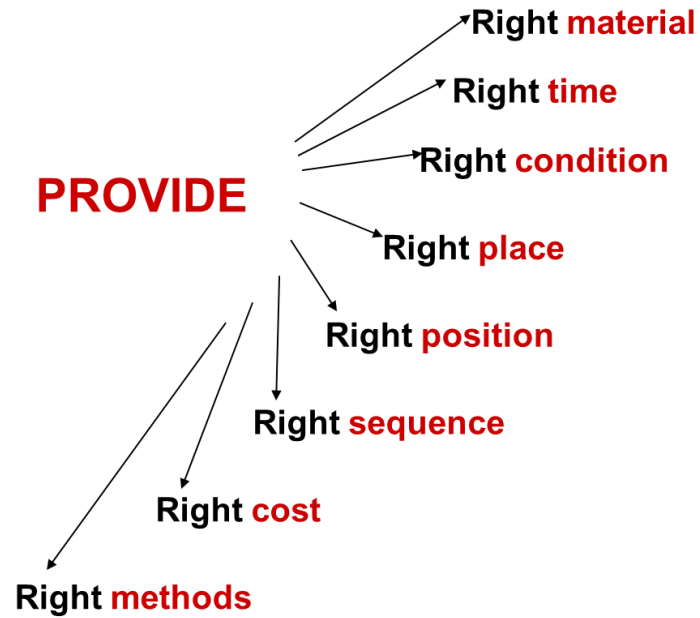
- Vertical carousel

- Miniload AS/RS
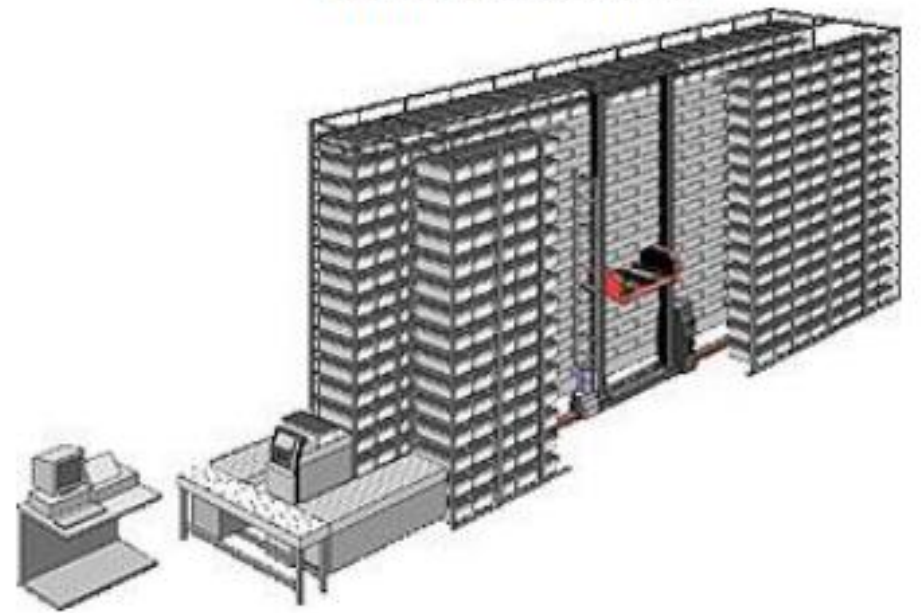
Industrial Engineers Improve: Working Conditions

Working Conditions:
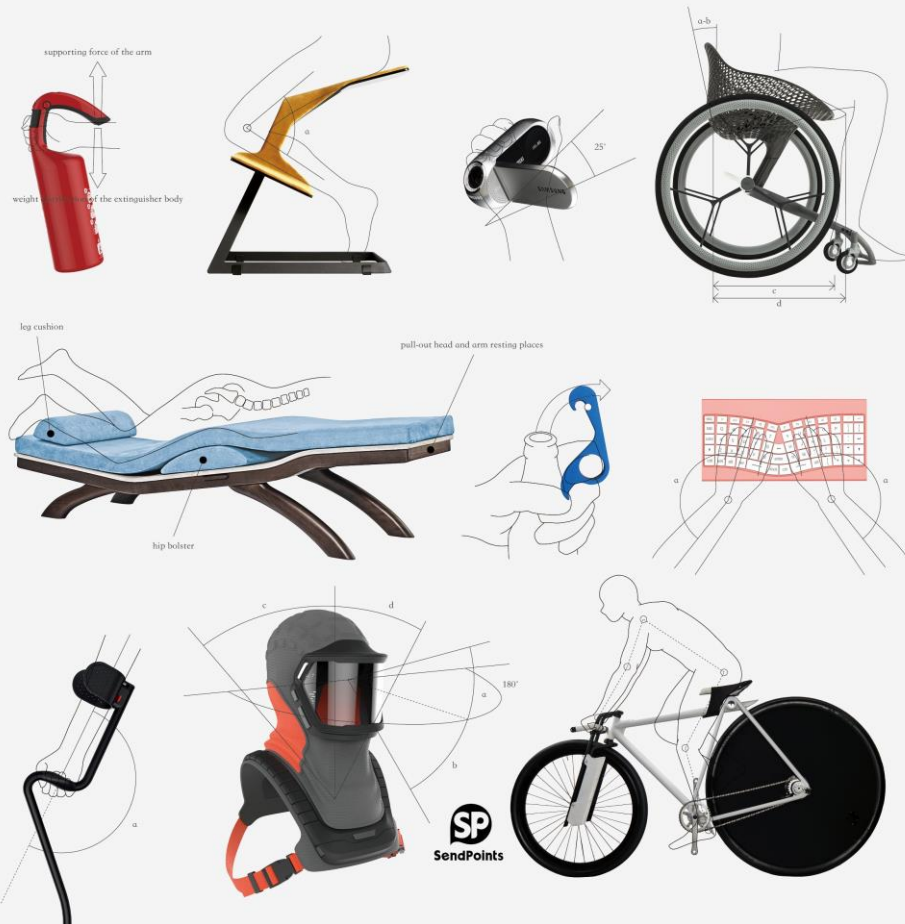
IE Improve performance applying: Lean Manufacturing

7 WASTES OF LEAN MANUFACTURING

THE 7 WASTES
- Overproduction
- Transport
- Motion
- Inventory
- Waiting
- Overprocessing
- Defects

The 8 Wastes of Lean

Identify these non-value-adding activities.
Reduce or eliminate them to become more efficient.

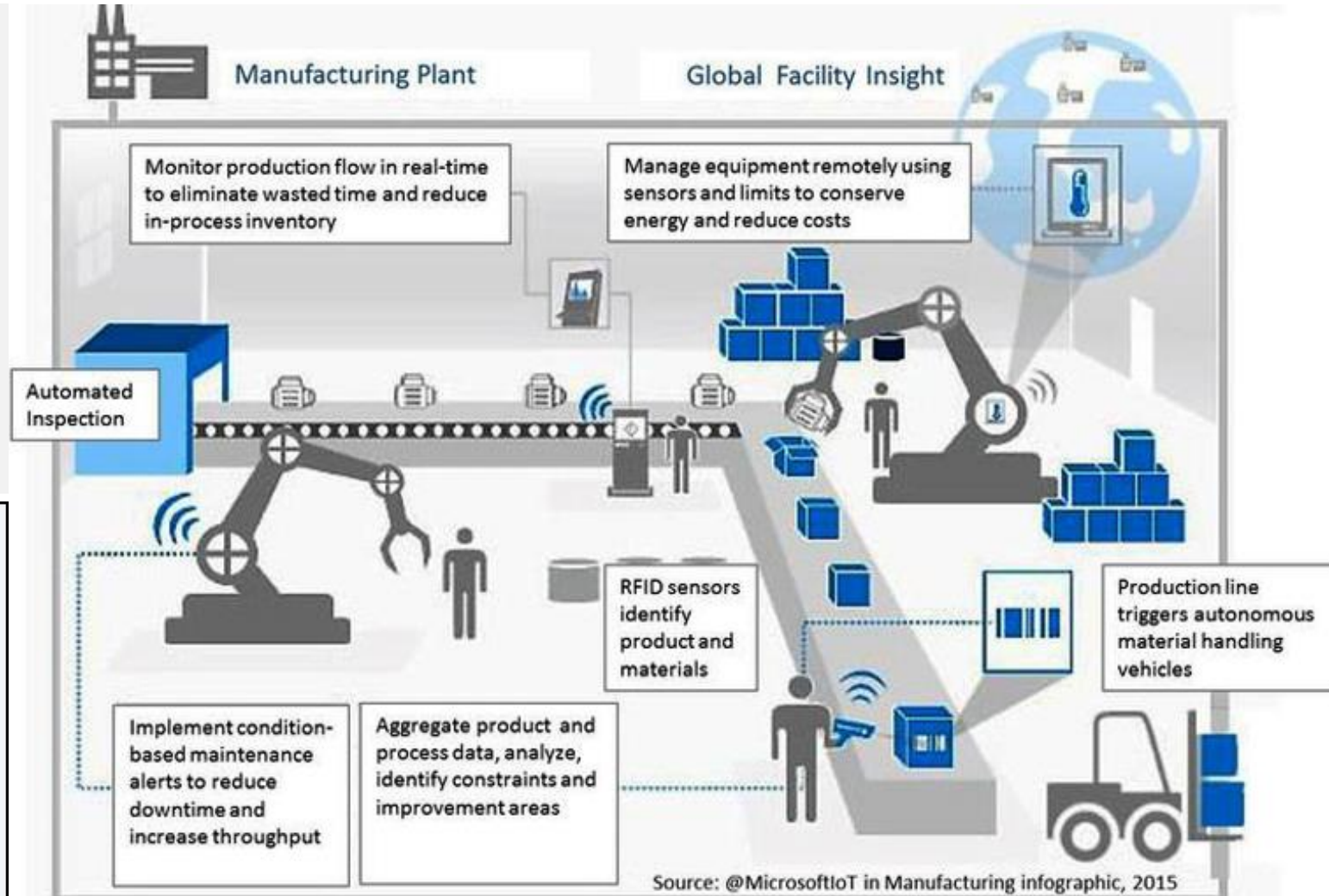- Non-Utilized Talents
- Extra Processing
- Waiting
- Motion
- Inventory
- Over Production
- Defects
- Transportation

Manufacturing Plant — Global Facility Insight

Monitor production flow in real-time to eliminate wasted time and reduce in-process inventory

Manage equipment remotely using sensors and limits to conserve energy and reduce costs

Automated Inspection

RFID sensors identify product and materials

Production line triggers autonomous material handling vehicles

Implement condition-based maintenance alerts to reduce downtime and increase throughput

Aggregate product and process data, analyze, identify constraints and improvement areas

Source: @MicrosoftIoT in Manufacturing infographic, 2015
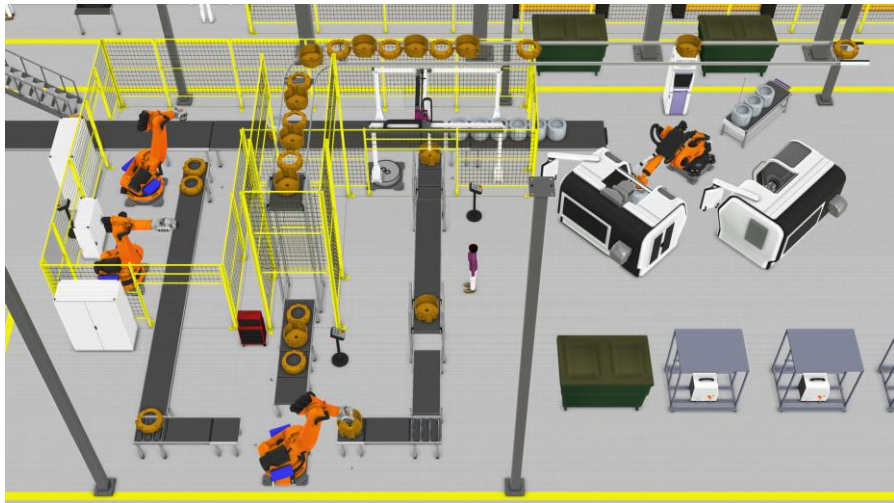
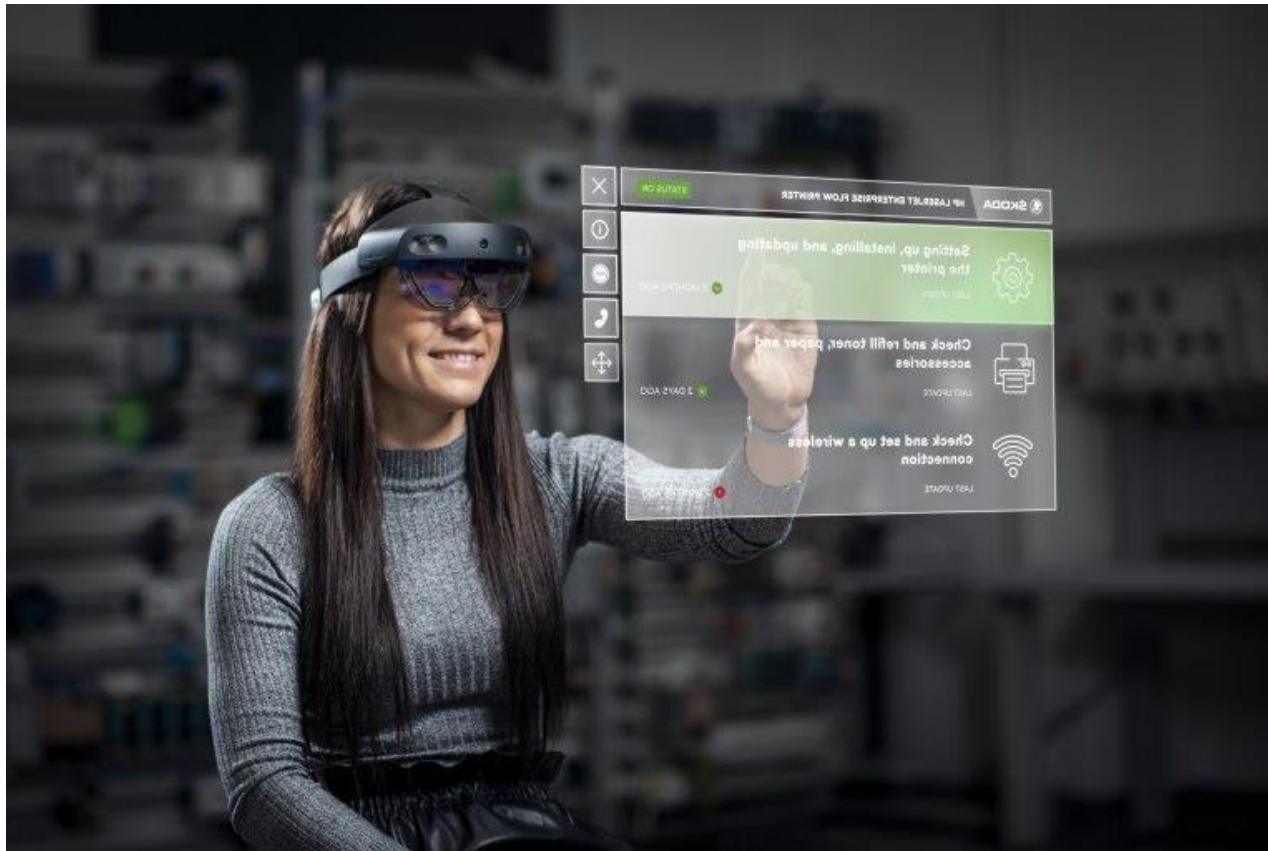# Industrial Engineers use tools e.g., Simulation
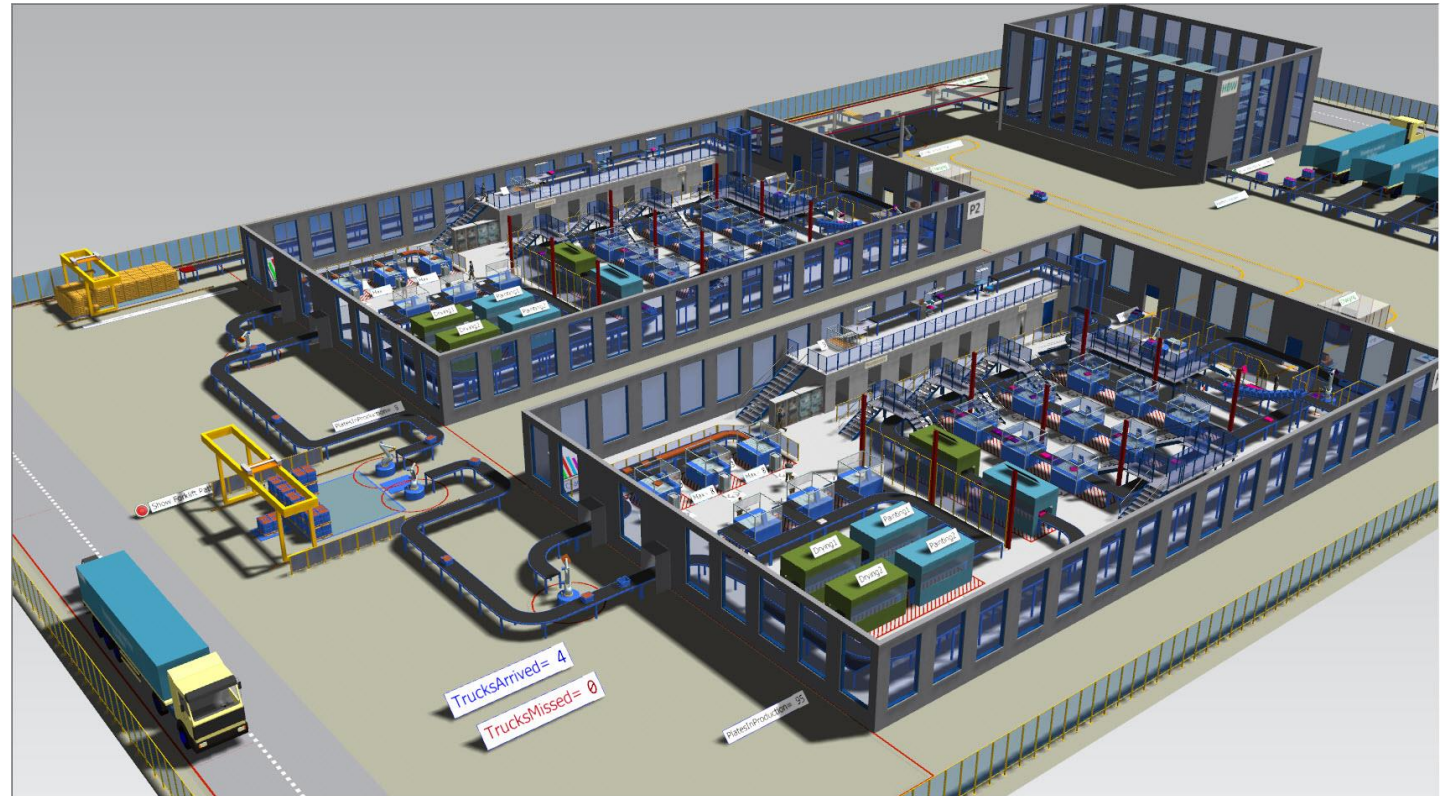
Industrial Engineers use tools e.g., Augmented Reality

**Augmented Reality glasses
for production line maintenance, and
technical training**

Industrial Engineers use tools e.g., Virtual Reality

Future virtual reality technology for innovative VR warehouse management. Concept of smart technology for industrial revolution and automated logistic control .
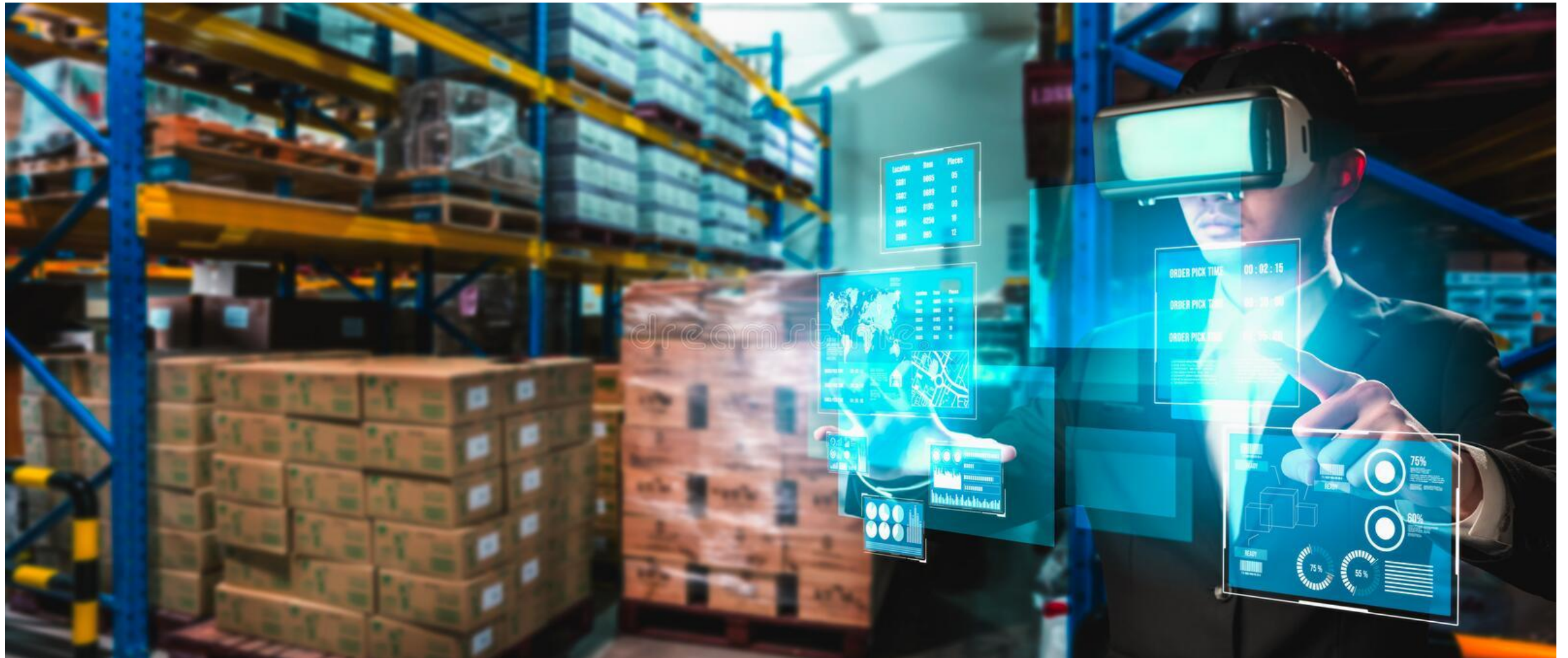
Recently, Industrial Engineers is responsible for the design of / move to and the operation of the Factory of the future (SMART Factory) - Industrie 4.0

FACTORY OF THE FUTURE

- IoT Sensors for Supply Chain Management
- Modular Equipment
- Unmanned Trucks
- Industrial Augmented Reality
- Computer Vision
- Predictive Machine Analytics
- Cobots
- Blockchain for Enterprise Resource Planning and Supply Chain Management
- Wearables

CBINSIGHTS
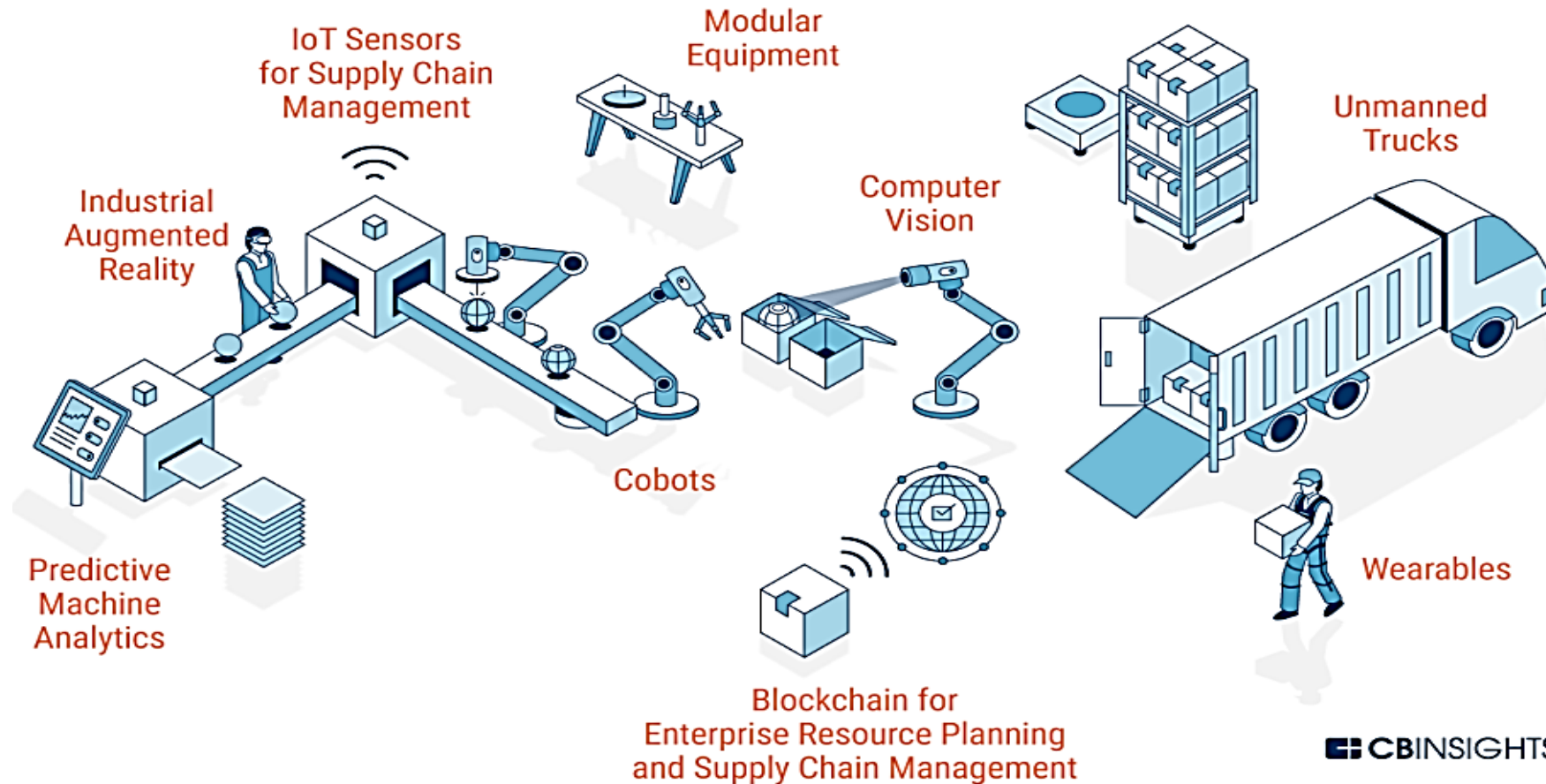
Industrial Engineers are responsible for the design and operation of Cloud Manufacturing systems.
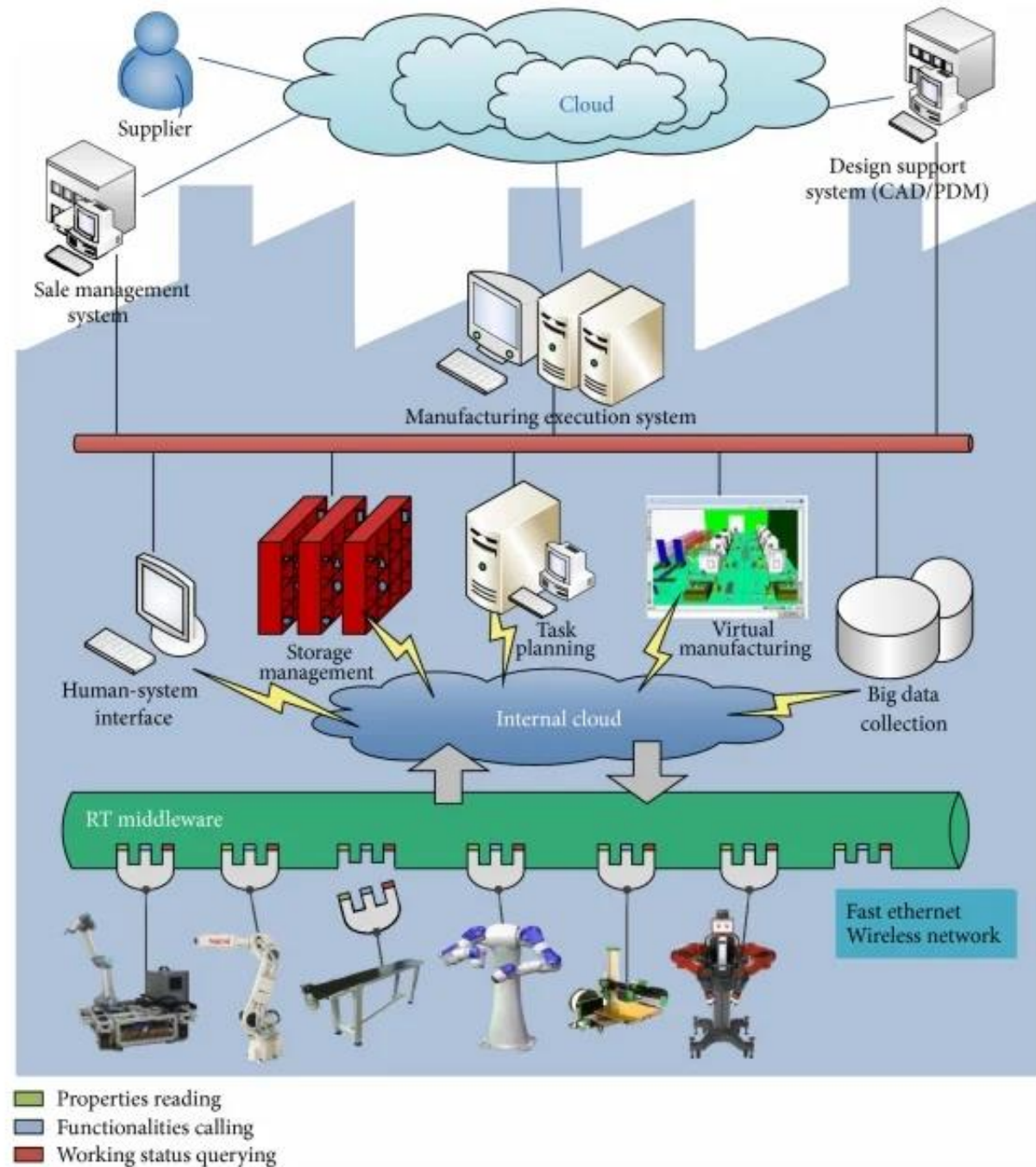
IEM Study Map

Need to Study:
- Basics of mechanical Eng. Topics,
- **IE necessary Tools**:
  - Economy and Cost Accounting,
  - Eng. Operations Research Techniques.
  - System modeling and Simulation,
  - Human Factor Engineering.

- **Basics**:
  - Facilities Planning
  - Time Study & Work Measurement
  - Production, Planning & Control,
  - Quality Management,
  - Maintenance Management,
- **Plus**
  - Automation, Computer Integrated Manufacturing

Elective Courses

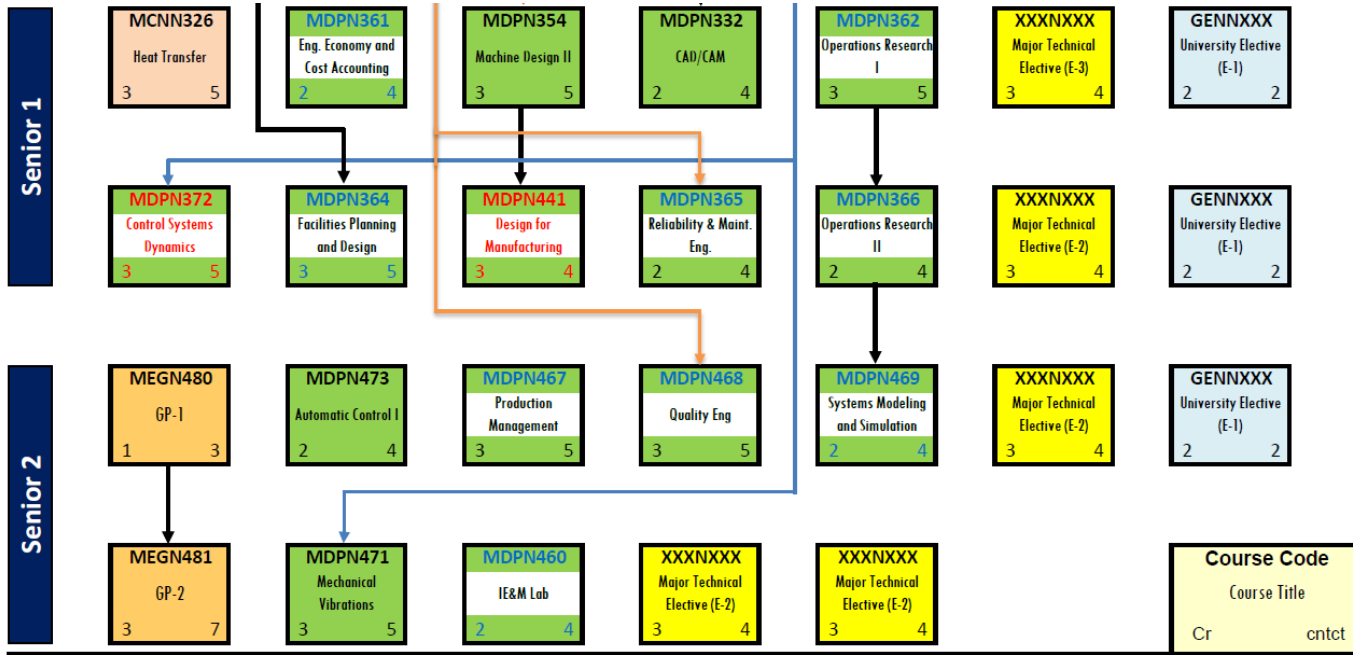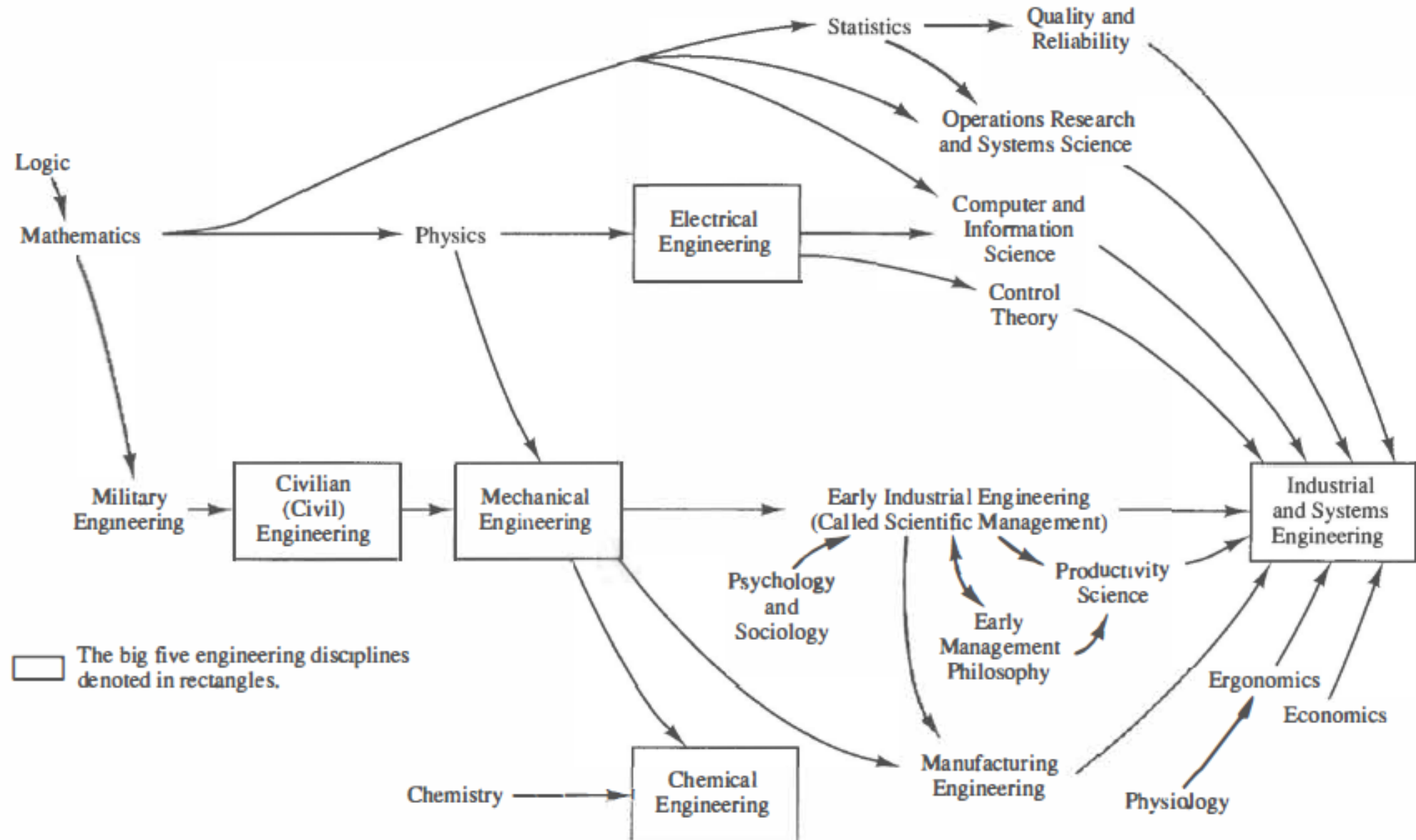| Course Title |
| --- |
| Safety Engineering |
| Ergonomics and Human Factor |
| Product Design and Development |
| Project Management |
| Sustainability and Design for Environment |
| Material Handling Equipment |
| Supply Chain Management |
| Computer Integrated Manufacturing CIM |
| Design of Experiments |
| Industrial Management |
| Industrial Information Systems |
| Manufacturing Systems Design |
| Process Control and Robotics |
| Image Processing and Computer Vision |
| Composite Materials: Design and Manufacturing |
| Advanced Topics in Materials Engineering |
| Turbo-machinery-I |
| Power Generation |
| Renewable Energy |
| Internal Combustion Engines |

Senior 1

| MCNN326 Heat Transfer 3 / 5 | MDPN361 Eng. Economy and Cost Accounting 2 / 4 | MDPN354 Machine Design II 3 / 5 | MDPN332 CAD/CAM 2 / 4 | MDPN362 Operations Research I 3 / 5 | XXXNXXX Major Technical Elective (E-3) 3 / 4 | GENNXXX University Elective (E-1) 2 / 2 |
| MDPN372 Control Systems Dynamics 3 / 5 | MDPN364 Facilities Planning and Design 3 / 5 | MDPN441 Design for Manufacturing 3 / 4 | MDPN365 Reliability & Maint. Eng. 2 / 4 | MDPN366 Operations Research II 2 / 4 | XXXNXXX Major Technical Elective (E-2) 3 / 4 | GENNXXX University Elective (E-1) 2 / 2 |

Senior 2

| MEGN480 GP-1 1 / 3 | MDPN473 Automatic Control I 2 / 4 | MDPN467 Production Management 3 / 5 | MDPN468 Quality Eng 3 / 5 | MDPN469 Systems Modeling and Simulation 2 / 4 | XXXNXXX Major Technical Elective (E-2) 3 / 4 | GENNXXX University Elective (E-1) 2 / 2 |
| MEGN481 GP-2 3 / 7 | MDPN471 Mechanical Vibrations 3 / 5 | MDPN460 IE&M Lab 2 / 4 | XXXNXXX Major Technical Elective (E-2) 3 / 4 | XXXNXXX Major Technical Elective (E-2) 3 / 4 | | Course Code Course Title Cr / cntct |

Relationship of IE to other engineering and scientific disciplines

The big five engineering disciplines denoted in rectangles.

Engineers: Employment, pay, and outlook (projected till 2026)

U.S. BUREAU OF LABOR STATISTICS

	New jobs, projected 2016–26	Employment, 2016	Median annual wage, 2016
Total, all engineers	139,300	1,681,000	$91,010
Civil engineers	32,200	303,500	83,540
Mechanical engineers	25,300	288,800	84,190
Industrial engineers	25,100	257,900	84,310
Electrical engineers	16,200	188,300	94,210
Engineers, all other	8,500	132,500	97,300
Electronics engineers, except computer	5,100	136,300	99,210
Petroleum engineers	5,100	33,700	128,230
Environmental engineers	4,500	53,800	84,890
Aerospace engineers	4,200	69,600	109,650
Computer hardware engineers	4,000	73,600	115,080

Industrial Engineering ranks third, following Civil Eng. (ranked first) and Mechanical Eng. (ranked second).

Table 1. New jobs for engineers, projected 2016–26, and employment and wages, 2016

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Environmental engineers	4,500	53,800	84,890
Aerospace engineers	4,200	69,600	109,650
Computer hardware engineers	4,000	73,600	115,080
Chemical engineers	2,500	32,700	98,340
Health and safety engineers, except mining safety engineers and inspectors	2,200	25,900	86,720
Biomedical engineers	1,500	21,300	85,620
Marine engineers and naval architects	1,000	8,200	93,350
Nuclear engineers	700	17,700	102,220
Mining and geological engineers, including mining safety engineers	600	7,300	93,720
Materials engineers	400	27,000	93,310
Agricultural engineers	200	2,700	73,640

Source: U.S. Bureau of Labor Statistics, Employment Projections program.