Methods Engineering & Layout Planning

Part II

Chapters:

8. Introduction to Methods Engineering and Operations Analysis
9. Charting Techniques
10. Motion Study and Work Design
11. Facility Layout Planning and Design

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by Mikell P. Groover, ISBN 0-13-140650-7.

Introduction to Methods Engineering and Operations Analysis

Chapter 8

Sections:

1. Evolution and Scope of Methods Engineering
2. How to Apply Methods Engineering
3. Basic Data Collection and Analysis Techniques
4. Automation and Methods Engineering

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Methods Engineering

- Analysis and design of work methods and systems, including the tooling, equipment, technologies, workplace layout, plant layout, and work environment
- Other names for methods engineering:
  - Work study
  - Work simplification
  - Methods study
  - Process re-engineering
  - Business process re-engineering

Objectives in Methods Engineering

- Increase productivity and efficiency
- Reduce cycle time
- Reduce product cost
- Reduce labor content

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Other Objectives

- Improve customer satisfaction
- Improve product and/or service quality
- Reduce lead times and improve work flow
- Increase flexibility of work system
- Improve worker safety
- Apply more ergonomic work methods
- Enhance the environment (both inside and outside the facility)

Operations Analysis

- Study of an operation or group of related operations for the purpose of analyzing their efficiency and effectiveness so that improvements can be developed
- Objectives in operations analysis
  - Increase productivity
  - Reduce time and cost
  - Improve safety and quality
- Same basic objectives as methods engineering

Methods Engineering

Can be divided into two areas:

1. Methods analysis
2. Methods design

Methods Analysis

- Concerned with the study of an existing method or process
- Objectives:
  - Eliminate unnecessary and non-value-adding work elements
  - Combine elements and operations
  - Rearrange elements into more logical sequence
  - Simplify remaining elements and operations

Methods Design

Concerned with either of the following situations:

1. Design of a new method or process
   - Required for new product or service and there is no existing precedent
   - Method must be designed from scratch, using best existing practice for similar operations
2. Redesign of an existing method or process based on a preceding methods analysis

Systematic Approach

1. Define the problem and objectives
2. Analyze the problem
3. Formulate alternatives
4. Evaluate alternatives and select the best solution
5. Implement the best method
6. Audit the study
   - A systematic approach is more likely to yield operational improvements than an undisciplined approach

Techniques of Methods Engineering

- Data gathering and statistical tools
- Charting and diagramming techniques
- Motion study and work design
- Facility layout planning
- Work measurement techniques
- New approaches

Charting & Diagramming Techniques

- Network diagrams
- Traditional industrial engineering charting techniques
  - Operation charts
  - Process charts
  - Flow diagrams
- Block diagrams
- Process maps

Motion Study and Work Design

- Concerned with basic motions of a human worker while performing a given task
- Examples of basic motion elements:
  - Reach
  - Grasp
  - Move
  - Release
- Guidelines for work design include “principles of motion economy”

Facility Layout Planning

- Facility layout refers to:
  - Size and shape of a facility
  - Arrangement of the different departments and equipment within the facility
- Problem area includes:
  - Design of a new facility
  - Installing new equipment, retiring old equipment
  - Expanding (or contracting) an existing facility

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Work Measurement Techniques

- Four basic work measurement techniques:
  1. Direct time study
  2. Predetermined motion time systems (PMTS)
  3. Standard data systems
  4. Work sampling
- PMTS and work sampling can be used in methods engineering to make improvements in the work methods

New Approaches

- Lean production
  - Based on the Toyota production system
  - Embraced by U.S. companies due to its success at Toyota
- Six Sigma and other quality-focused programs
  - Widely adopted in industry for improving quality of work processes

Selecting Among Alternative Proposals

- Need for a systematic procedure to decide among alternative proposals
- To begin, list the technical features and functional specifications for the application
  - Must features
  - Desirable features
- Criteria matrix to evaluate alternatives
  - Drop candidates that do not satisfy “must features”
  - Develop scores for desirable features

Evaluation of Robots for Welding

	Industrial Robot Candidates			
	Model A	Model B	Model C	Model D
Must features:				
Continuous path control	OK	OK	OK	OK
Six-axis robot arm	OK	OK	Not OK	OK
Walkthrough programming	OK	OK	OK	OK
Desirable features:				
Ease of programming (0-9)	6	4		6
Capability to edit program (0-5)	4	2		5
Multi-pass features (0-4)	2	2		2
Work volume (0-9)	5	8		6
Repeatability (0-5)	5	2		4
Lowest price (0-5)	4	5		3
Delivery (0-3)	1	1		3
Evaluation of vendor (0-9)	6	5		8
Totals:	33	29		37

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Basic Data Collection & Analysis Tools

1. Histograms
2. Pareto charts
3. Pie charts
4. Check sheets
5. Defect concentration diagrams
6. Scatter diagrams
7. Cause and effect diagrams

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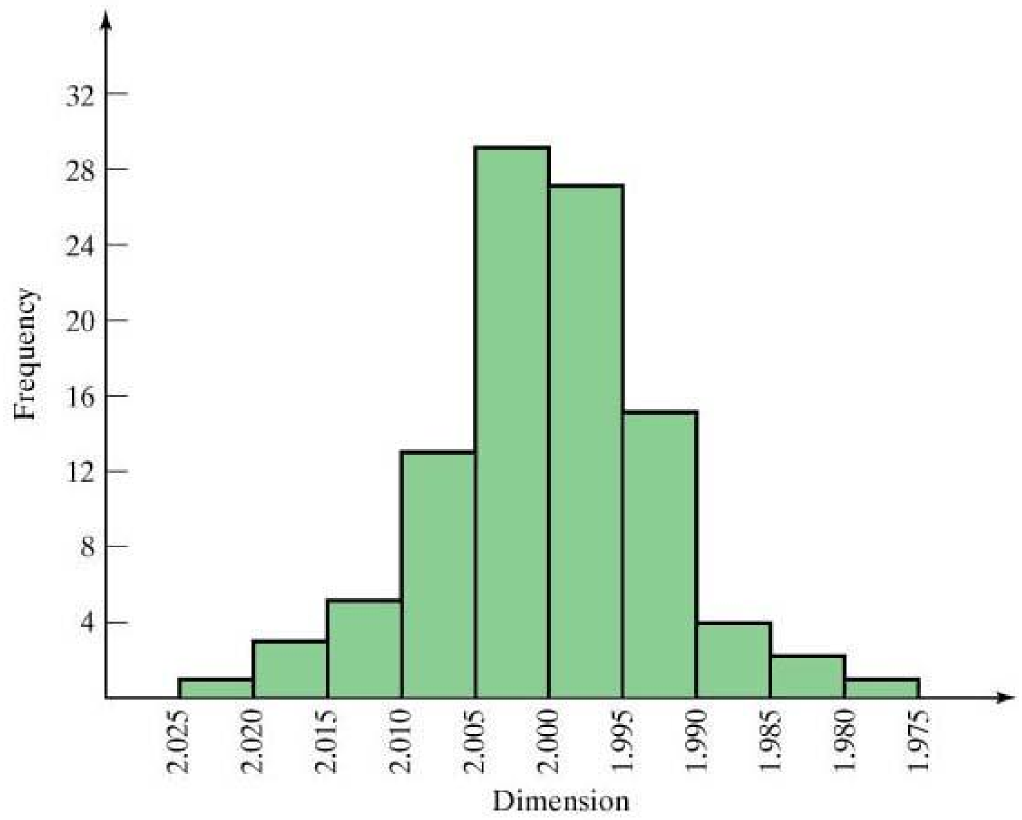
Histogram

A statistical graph consisting of bars representing different members of a population, in which the length of each bar indicates the frequency or relative frequency of each member

- A useful tool because the analyst can quickly visualize the features of the data, such as:
  - Shape of the distribution
  - Any central tendency in the distribution
  - Approximations of the mean and mode
  - Amount of scatter in the data

Histogram for Data Display



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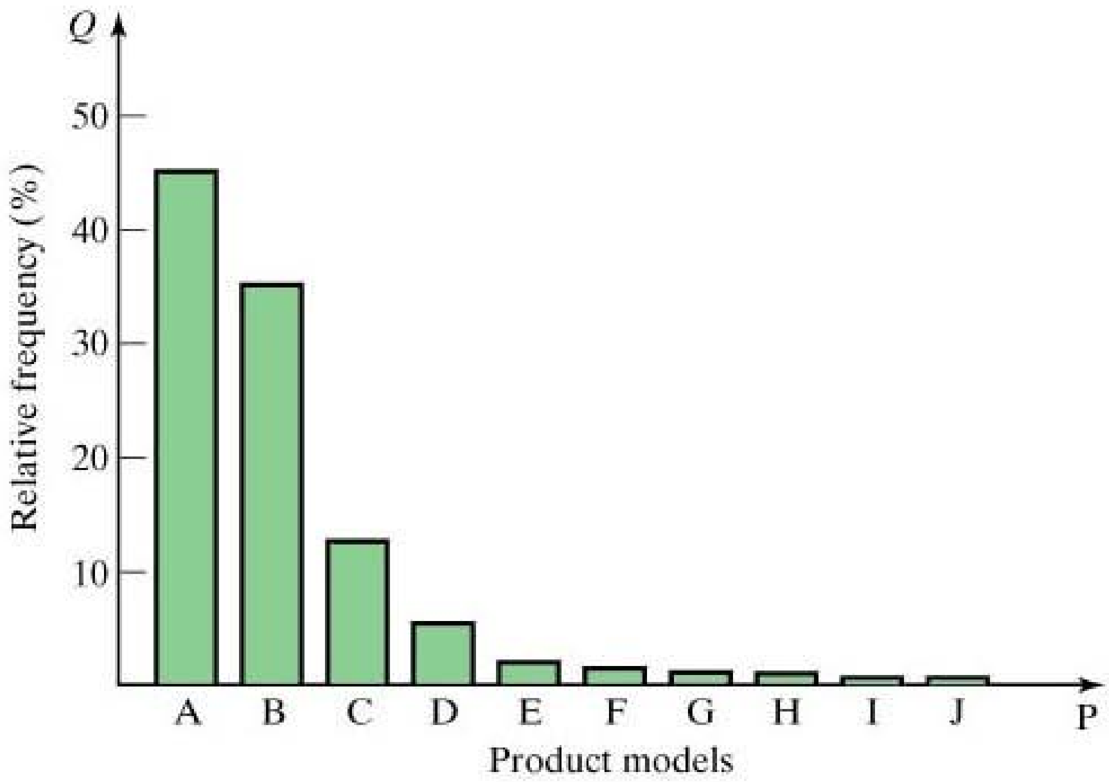
Pareto Chart

Special form of histogram in which attribute data are arranged according to some criterion such as cost or value

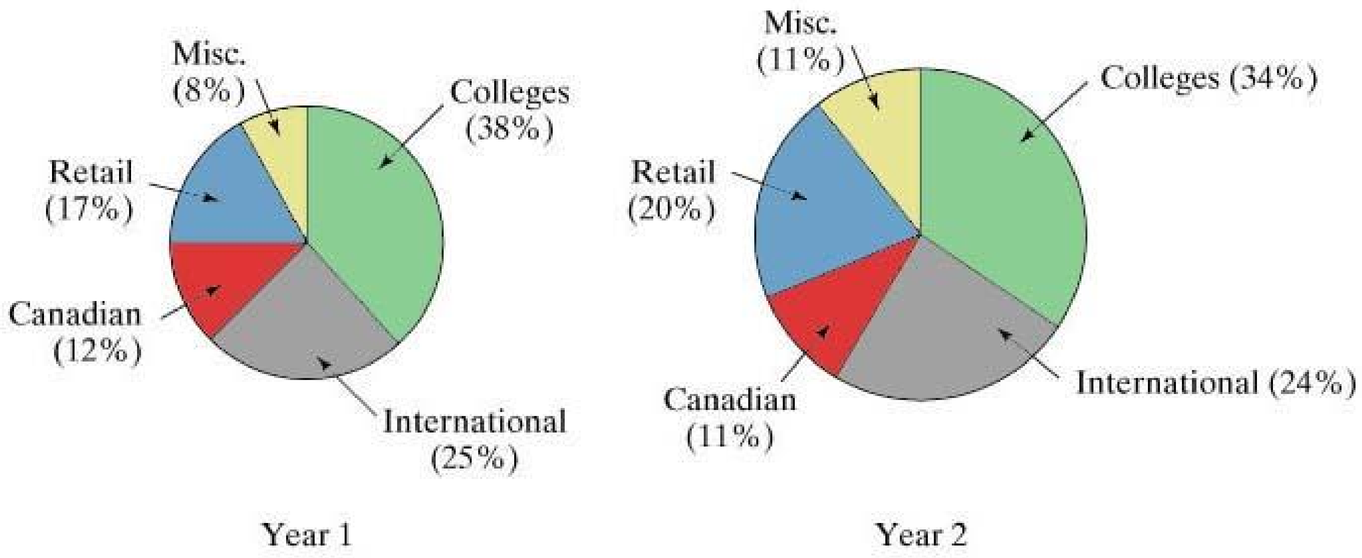
- Based on Pareto's Law: "the vital few and the trivial many"
- Often identified as the 80%-20% rule
  - 80% of a nation's wealth is owned by 20% of the population
  - 80% of sales are accounted for by 20% of the SKUs

Pareto Distribution



Pie Charts

Example: Annual sales revenues and customer distributions for two years



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Check Sheet

Data collection tool generally used in the preliminary stages of a study of a quality problem

- Data often entered by worker as check marks in a given category
- Examples:
  - Process distribution check sheet - data on process variability
  - Defective item check sheet – types and frequencies of defects on the product
  - Defect location check sheet - where defects occur on the product

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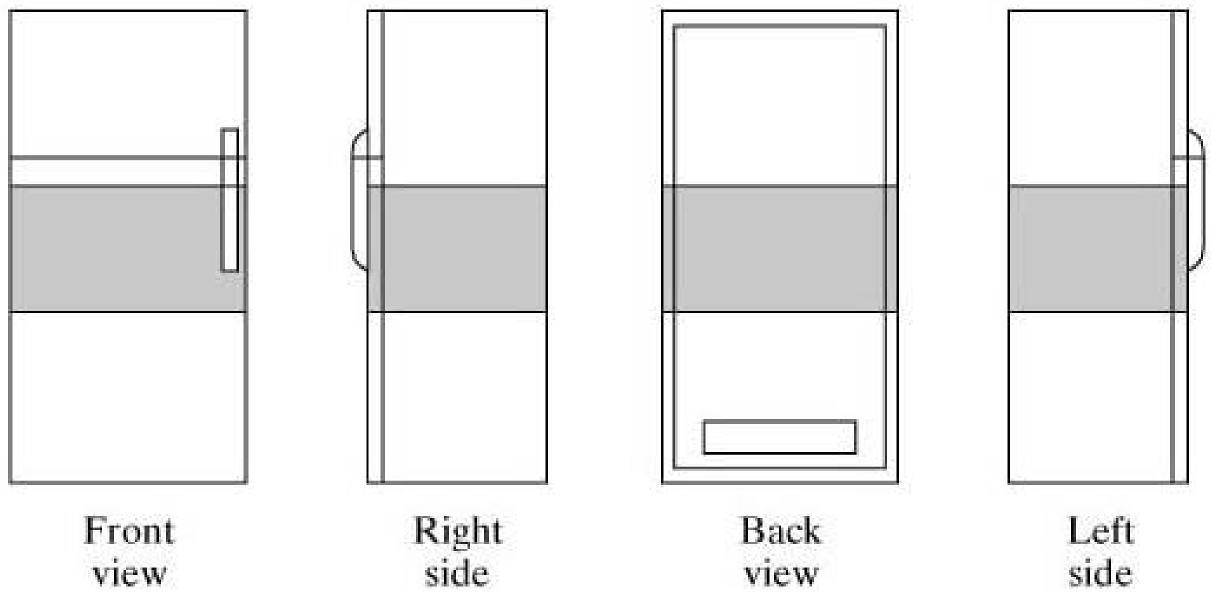
Defect Concentration Diagram

A drawing of the product (all relevant views), onto which the locations and frequencies of various defect types are added

- Useful for analyzing the causes of product or part defects
- By analyzing the defect types and corresponding locations, the underlying causes of the defects can possibly be identified

Defect Concentration Diagram

Four views of refrigerator showing locations of surface defects



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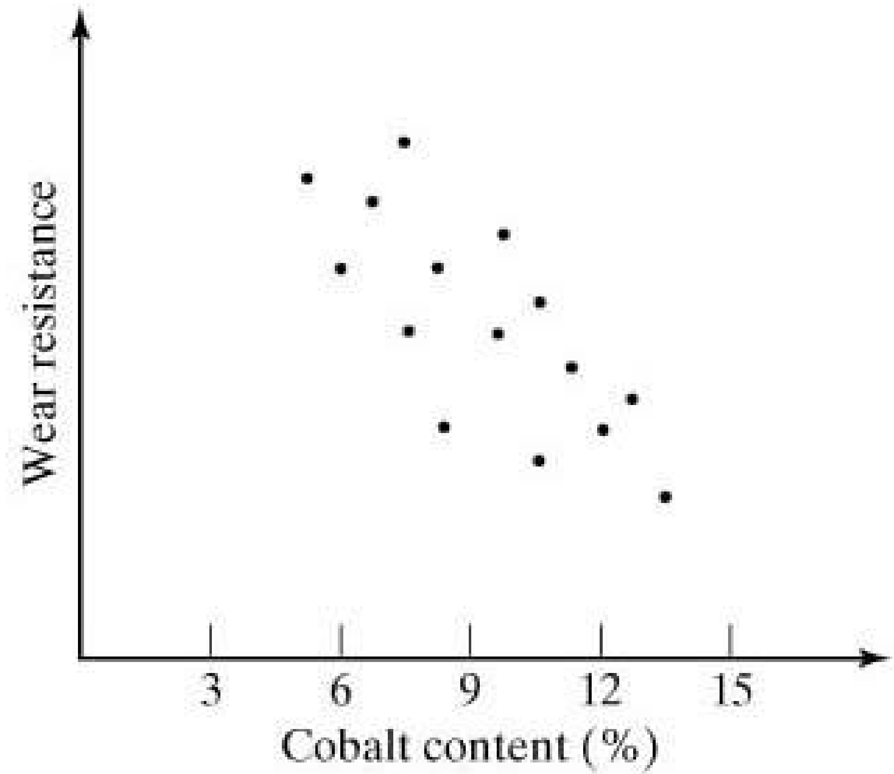
Scatter Diagrams

An x-y plot of data collected on two variables, where a correlation between the variables is suspected

- The data are plotted as pairs; for each x_i value, there is a corresponding y_i value
- The shape of the collection of data points often reveals a pattern or relationship between the two variables

Scatter Diagram

Effect of cobalt content on wear resistance for a cemented carbide cutting tool



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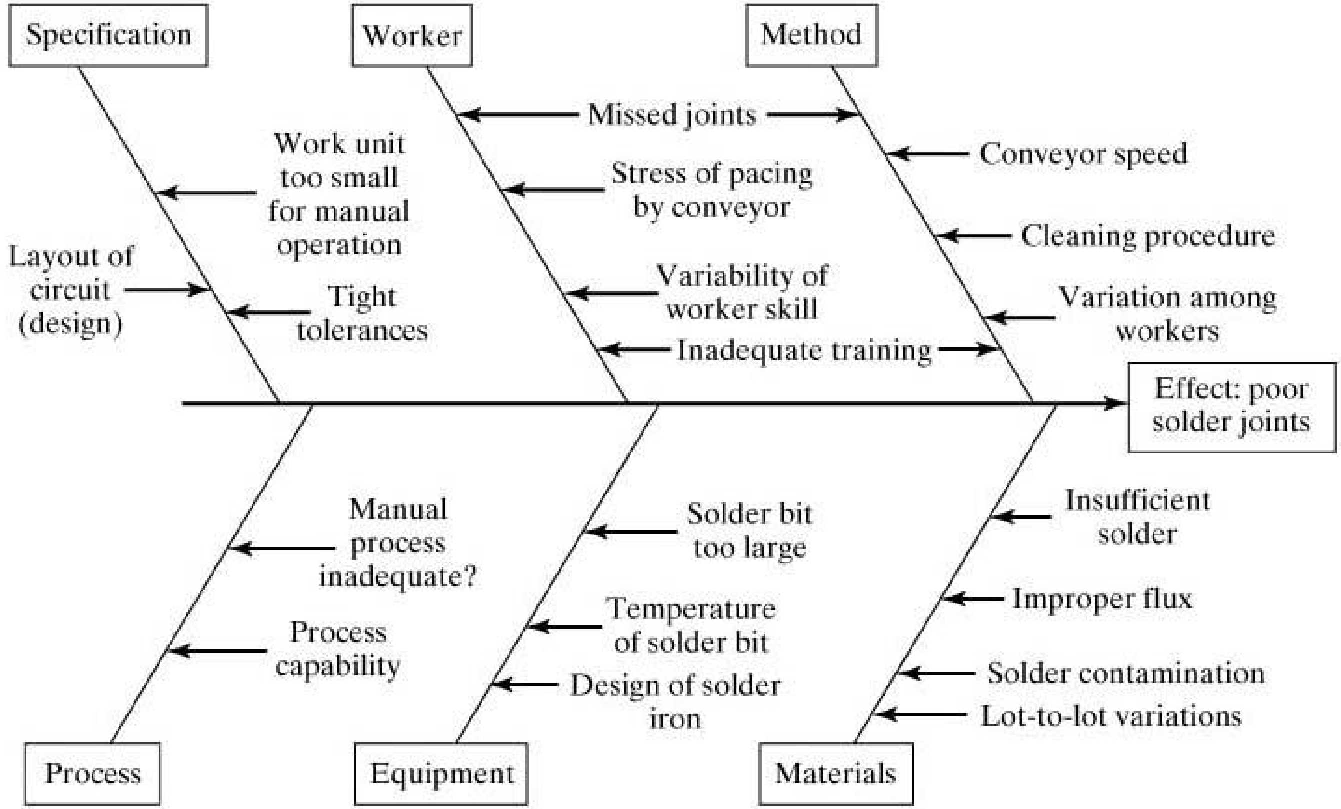
Cause and Effect Diagram

A graphical-tabular chart used to list and analyze the potential causes of a given problem

- Can be used to identify which causes are most consequential and how to take corrective action against them
- Also known as a “fishbone diagram”

Cause and Effect Diagram



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Methods Engineering and Automation

- USA Principle
- Ten Strategies for Automation
- Automation Migration Strategy.

USA Principle

1. Understand the existing process
2. Simplify the process
3. Automate the process

Understand the Existing Process

- What are the inputs?
- What are the outputs?
- Number and placement of inspections
- Number of moves and delays experienced by the work unit
- Time spent in storage

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Mathematical Models

- What are the important output variables?
- How are these output variables affected by inputs to the process?
- Develop mathematical model of the process

Simplify the Process

- What is the purpose of this operation or this transport?
- Can this step be eliminated?
- Is the most appropriate technology being used?
- How can this step be simplified?
- Can steps be combined?
- Can steps be performed simultaneously?
- Can steps be integrated into a manually operated production line?

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Automate the Process

- If simplification is successful, automation may not be necessary
- Ten strategies for automation
- Automation migration strategy

Ten Strategies for Automation

1. Specialization of operations
2. Combined operations
3. Simultaneous operations
4. Integration of operations
5. Increased flexibility
6. Improved material handling and storage
7. On-line inspection
8. Process control and optimization
9. Plant operations control
10. Computer integrated manufacturing (CIM)

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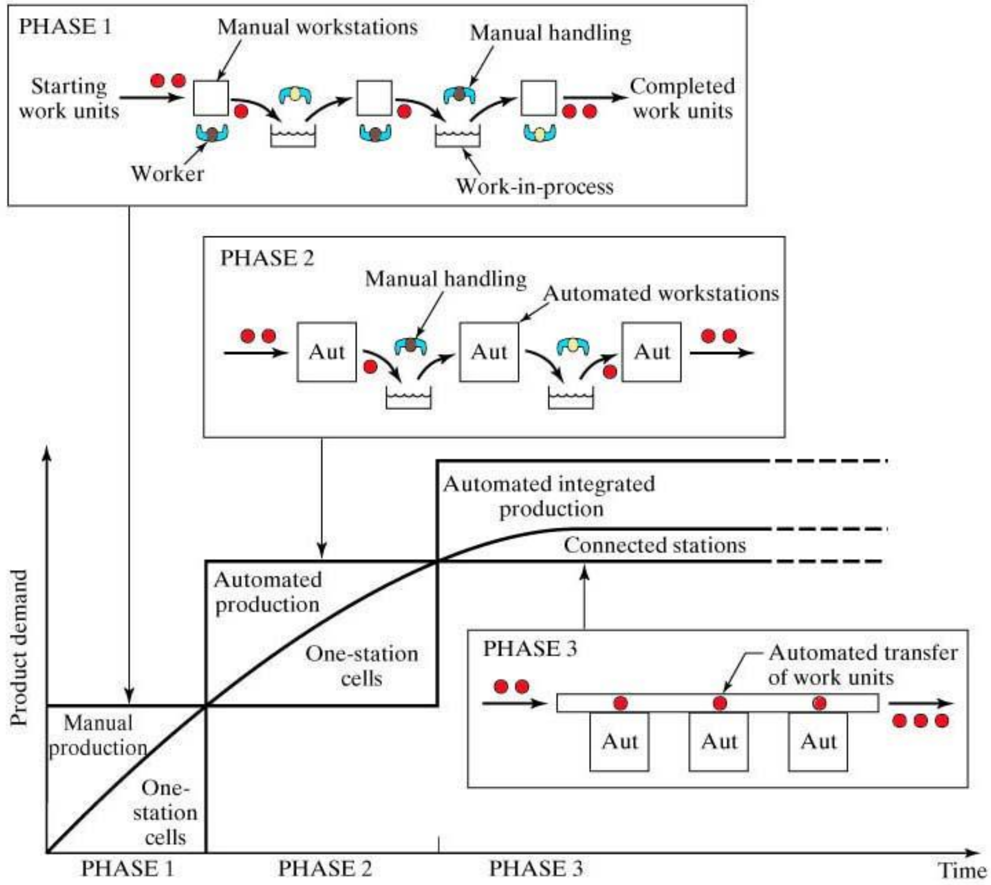
Automation Migration Strategy

- Phase 1: Manual production using single station manned cells operating independently
- Phase 2: Automated production using single station automated cells operating independently.
- Phase 3: Automated integrated production using a multi-station automated system with serial operations and automated transfer of work units between stations.

Automation Migration Strategy



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