METHODS ENGINEERING AND OPERATIONS ANALYSIS

- Methods engineering is the 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

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 relative to specified objectives.

Objectives in operations analysis

- Increase productivity
- Reduce time and cost
- Improve safety and quality

- Methods engineering and operations analysis are very similar, except that methods engineering places more emphasis on design.

Methods Engineering

Can be divided into two areas:

Methods analysis and Methods design.

Methods analysis is 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 is 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 standard
   - Method must be designed from scratch, using best existing practice for similar operations

2. Redesign of an existing method or process based on a previous methods analysis.

HOW TO APPLY METHODS ENGINEERING

Systematic Approach in Methods Engineering

- has its basis in the *scientific method* used in science, research and development, engineering design, and other problem areas.
- The systematic approach in methods engineering consists of the steps described below.

Step 1: Define the Problem and Objectives. The problem in methods engineering study may be low productivity, high cost, inefficient methods, or the need for a new method or a new operation. The objective is the desired improvement or new methods design. Possible objectives are to increase productivity, reduce labor content and cost, improve safety, or develop a new method or new operation.

Step 2: Analyze the Problem. Data collection and analysis activities for the type of problem being studied.

- Activities often used in this step include the following:
  - Identify the basic function of the operation.
  - Gather background information.
  - Observe the existing process or observe similar processes if the problem involves a new work design.
  - Collect data on the existing operation and document the details in a format that provides itself to examination.
  - Conduct experiments on the process.
  - Develop a mathematical model of the process or utilize an existing mathematical model
  - Perform a computer simulation of the process.
  - Use charting techniques.

Step 3: Formulate Alternatives. There are always multiple ways to perform a task or accomplish a process, some of which are more efficient and effective than others.

- The purpose of this step in the problem-solving approach that is not to identify the best alternative but to formulate all of the alternatives that are feasible.

Step 4: Evaluate Alternatives and Select the Best. This step consists of a systematic assessment of the alternatives and the selection of the best solution among them, based on the original definition of the problem and objectives.

Step 5: Implement the Best Method. Implementation means installing the selected solution: introducing the changes proposed in the existing method or operation, or installing the new method or process.

- This may involve pilot studies or trials of the new or revised
- Implementation also includes complete documentation of the new or revised method and replacement of the previous documentation

Step 6: Audit the Study. Perform an audit or follow-up on the methods engineering project.

- How successful was the project in terms of the original problem definition and objectives?
- What were the implementation issues?
- What should be done differently in the next methods engineering study?

For an organization committed to continuous improvement, answers to these kinds of questions help to fine-tune its problem-solving and decision-making skills.

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 These are used for analyzing work flow, assembly line balancing, and project scheduling.
- Traditional industrial engineering charting techniques These are used to symbolize and summarize the details of an existing operation or sequence of operations. The traditional charting techniques can be used to analyze the activities of one human worker, groups of workers, worker-machine systems, materials, parts, and products.
    - Operation charts
    - Process charts
    - Flow diagrams
- Block diagrams These diagrams represent alternative ways of illustrating processes.

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” that is guidelines for work design in three categories: (1) use of the human body in developing the standard method, (2) workplace layout, and (3) design of the tooling and equipment used in the task.

Facility Layout Planning

What is Facility Layout?

- Refers to the size and shape of a facility, the arrangement of the different functions and/or departments in it, and the way the equipment is positioned.
- Plays a significant role in determining the overall efficiency of the operations accomplished in the facility.
- Objectives are to maximize
  - Customer satisfaction
  - Utilization of space, equipment, & people
  - Efficient flow of information, material, & people
  - Employee morale & safety
- Problem area includes:
  - Design of a new facility
  - Installing new equipment, retiring old equipment
  - Expanding (or contracting) an existing facility

How do you conduct a plant layout project?

1. Define or redefine the goals of the facility.
2. Specify the activities to be performed in accomplishing the goals
3. Determine the interrelationships among all activities
4. Determine the space requirements for all activities
5. Generate alternative facility layouts
6. Evaluate alternative facility layouts
7. Select a facility layout
8. Implement facility layouts
9. Maintain and adapt the facility layout

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 often used in methods engineering to make improvements in the work methods

- **Predetermined motion time system (PMTS)** is a database of basic motion elements and their associated normal time values, and it includes procedures for applying the database to analyze manual tasks and establish standard times for the tasks.

- The principal application of a PMTS is to determine standard times.

- **Work sampling** is a statistical technique for determining the proportions of time spent by workers or machines in various categories of activity.
- It can be applied to determine machine utilization, worker utilization, and the average time spent performing various types of activities. As such it can be a useful tool in methods engineering for identifying areas that need attention.
- For example, if a work sampling study finds that workers in a facility spend large amounts of their time waiting for work, then this is a management problem that should be addressed.

Basic Data Collection & Analysis Tools

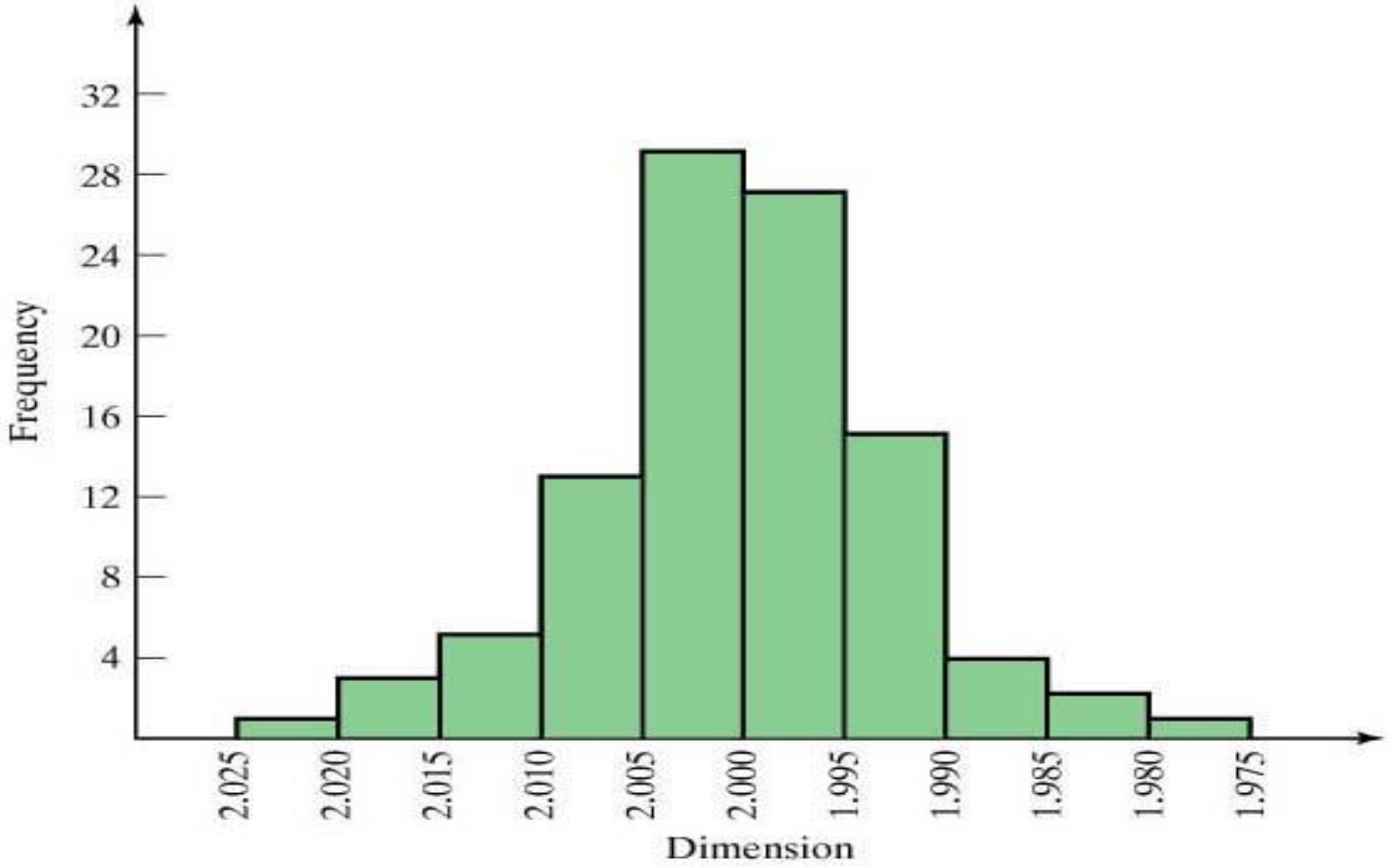
1. Histograms
2. Pareto charts
3. Pie charts
4. Check sheets
5. Defect concentration diagrams
6. Scatter diagrams
7. Cause and effect diagrams

Histogram

- A histogram is a statistical graph consisting of bars representing different values or ranges of values, in which the length of each bar is proportional to the frequency or relative frequency of the value.
- A useful tool because the analyst can quickly visualize the features of the data, such as:

  (1) the shape of the distribution,
  (2) any central trend exhibited by the distribution,
  (3) approximations of the mean and mode of the distribution,
  (4) the amount of scatter or spread in the data.

Histogram for Data Display

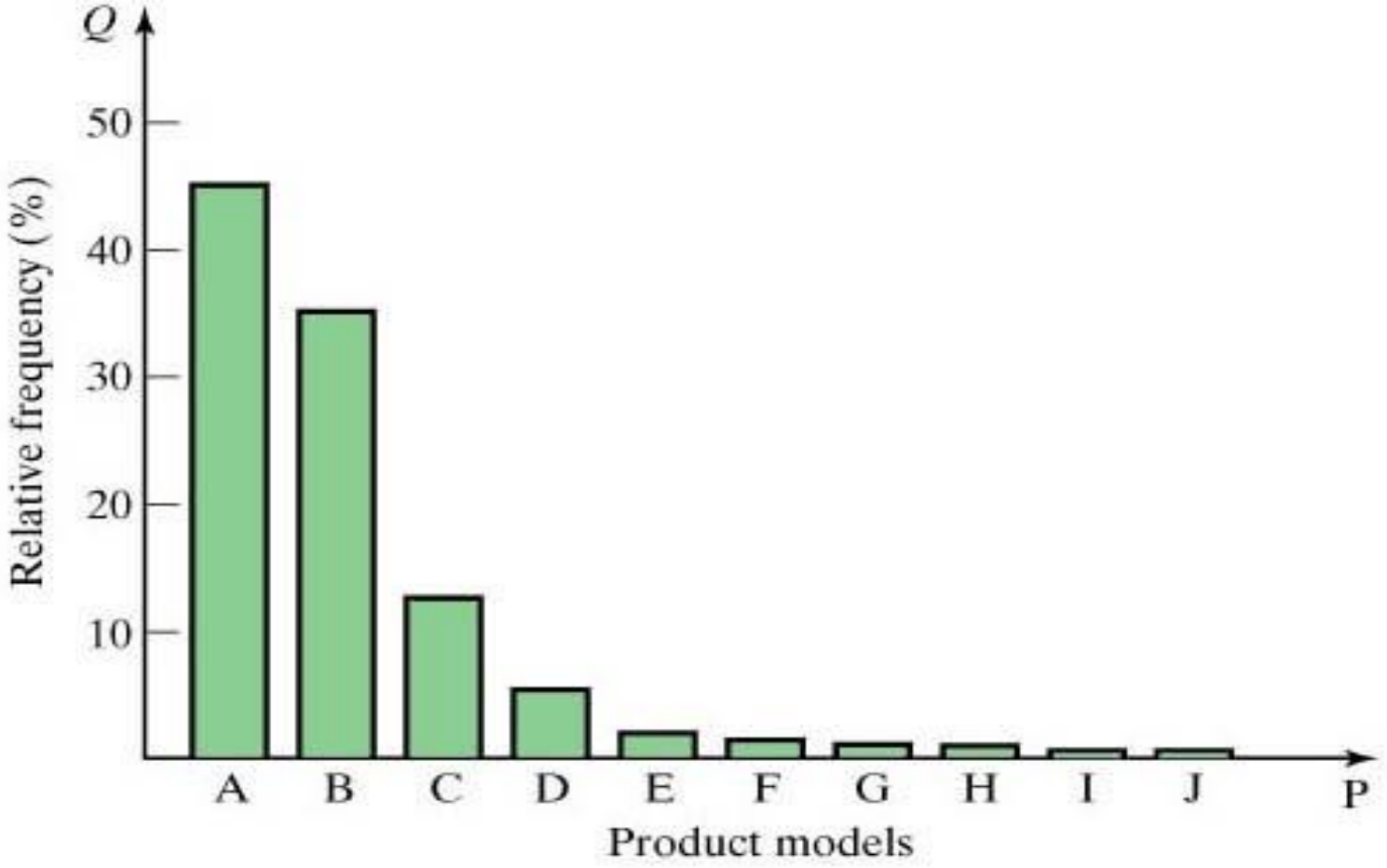


Pareto Chart

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

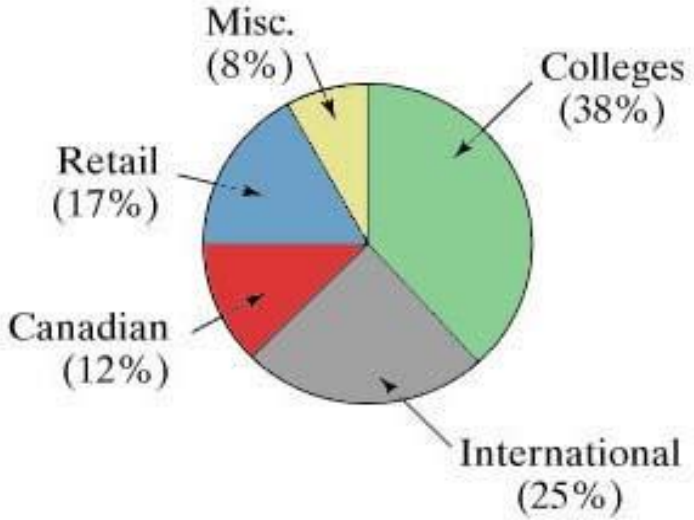
- Based on Pareto's Law: "the very important few and the unimportant many"
- Often identified as the 80%-20% rule
  - 80% of a nation's wealth is owned by 20% of the population
  - 80% of sales are accounted for by 20% of the Stock Keeping Units
  - 80% of a factory's production output is concentrated in only 20% of its product models.

Pareto Distribution

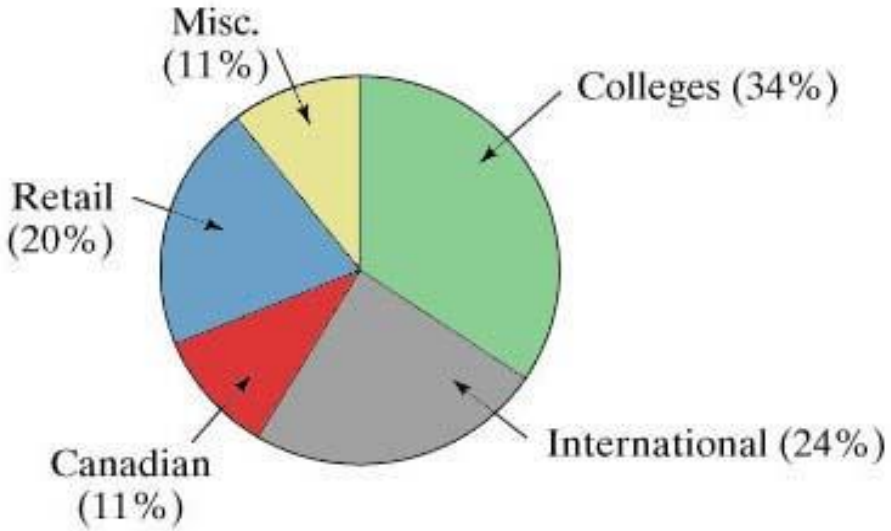


Pie Charts

Example: Annual sales revenues and customer distributions for two years



Year 1



Year 2

Cause and Effect Diagram

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

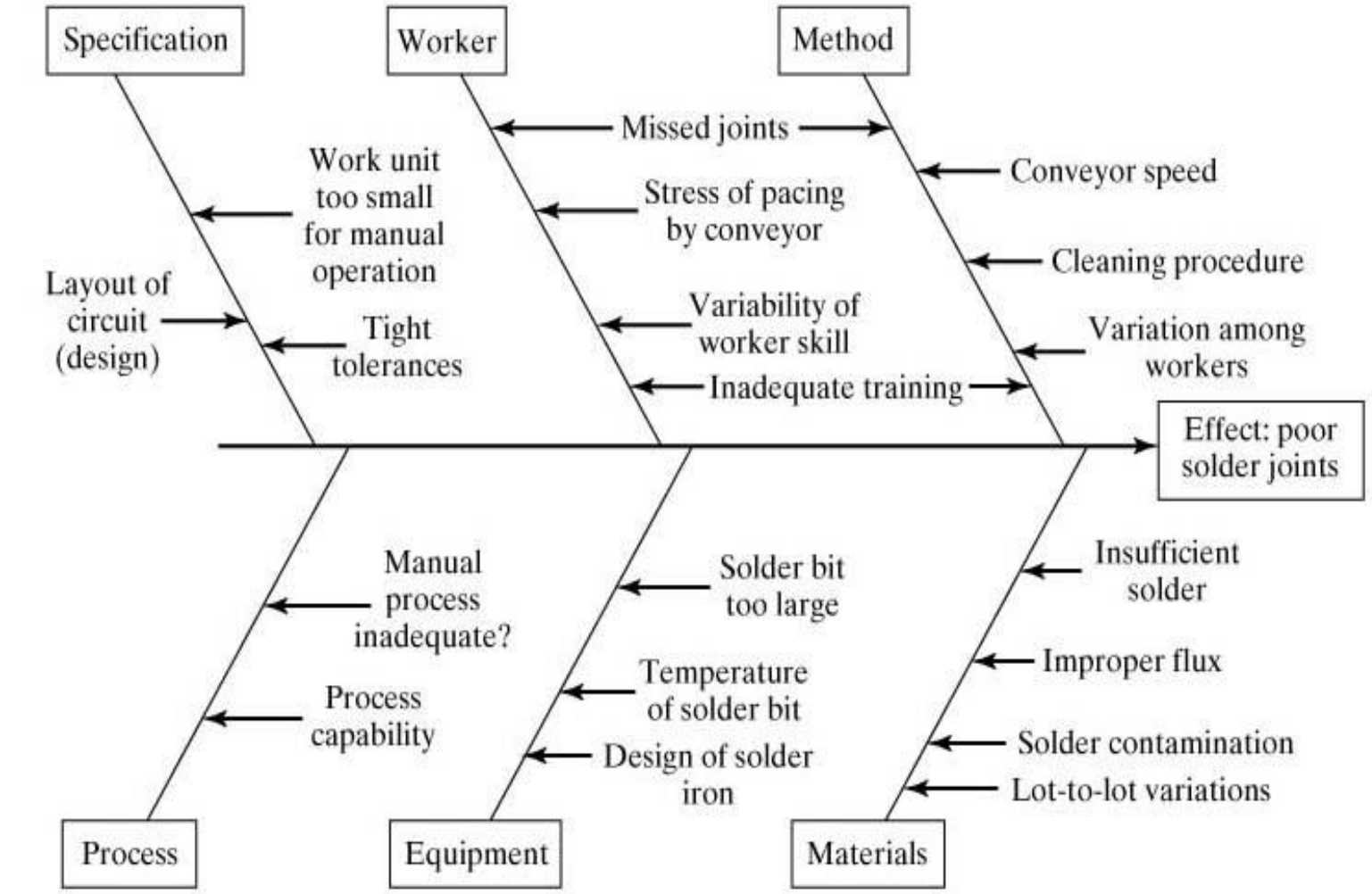
- Can be used to identify which causes are most significant and how to take corrective action against them
- Also known as a “fishbone diagram”
- In application, cause and effect diagrams are often developed by worker teams who study operational problems.
- The diagram provides a graphical means for discussing and analyzing a problem and listing its possible causes in an organized and understandable way.

- As a starting point in identifying the causes of the problem, six general categories of causes are often used because they are the factors that affect performance of most production and service processes. They are called the 5Ms and 1P

- ***Machines.*** This refers to the equipment and tooling used in the process.
- ***Materials.*** These are the starting materials in the process.
- ***Methods***. This refers to the procedures, sequence of activities, motions, and other aspects of the method used in the process.
- ***Mother Nature***. This is for environmental factors such as temperature and humidity that might affect the process.
- ***Measurement***. This relates to the validity and accuracy of the data collection procedures.
- ***People.*** This is the human factor.

Does the worker bring the necessary skills to the process?

Cause and Effect Diagram



Methods Engineering and Automation

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

- The USA principle is a common sense approach to automation projects. USA stands for three steps in the analysis and design procedure:
  - ***U**nderstand* the existing process.
  - ***S**implify* the process.
  - ***A**utomate* the process.

Understand the Existing Process

- What are the inputs?
- What are the outputs?
- What exactly happens to the work unit between input and output?
- What is the function of the process?
- How does it add value to the product?

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?

Automate the Process

The USA Principle is a good first step in any automation evaluation project.

- If automation seems a feasible solution to improve productivity, quality, or another measure of performance, then the following ten strategies provide a road map to search for these improvements.

- The ten strategies constitute a checklist of the possibilities for improving the work system though automation or simplification.

- For many situations, multiple strategies can be implemented in one improvement project.

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)