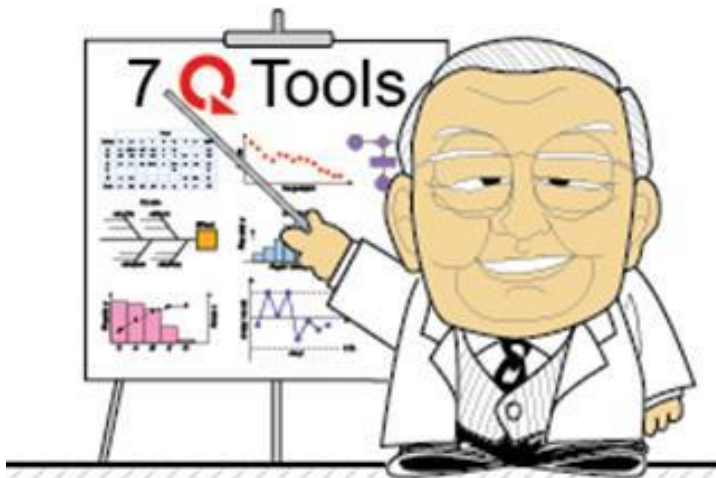


Lecture 7 Improve Phase and 7 New Quality Tools for Management & Planning



Improve Overview

- In the “Improve” phase, the goal is to...

Work through the data gathered at the previous phases and agree changes going forward and associated action items and timelines



Key Steps to Improve

1. Develop Potential Solutions-

- Use the confirmed Cause and Effect relationship (from Analyze) to identify a wide range of potential solutions. This is the one step where being creative is encouraged.
- Documentation on alternative solutions considered e.g. data displays, statistical analysis or other documentation on tools used to develop solutions.
- List of weighted criteria used to evaluate solutions, solution matrix, or other display summarizing the evaluation of results.
- List of concerns raised by process participants and the process owner.

Key Steps to Improve

2. Evaluate, Select, and optimize best solutions.

- Flesh out the solution ideas, develop criteria and evaluate alternatives, and document the results.

3. Develop “future state” value stream map.

- Revise the existing VSM to reflect what the process will look like after changes are made. Include estimates of time savings, improved quality etc.

Key Steps to Improve

4. Develop and implement Pilot Solution.

- Write up the tasks to be performed in the pilot solution. Train participants and document results.
- Documentation (including future state VSM) of the re-designed process with changes in process flow highlighted.
- Documentation on communication with participants
- Data display, statistical analysis showing the results of the pilot test simulation.

Key Steps to Improve

5. Confirm attainment of project goals

- Compare results to baseline.

6. Develop and execute full scale implementation plan

- Document plans for full scale implementation
- Risk Management plans (for avoiding, reducing, or mitigating risks) **e.g. FMEA.**
- Plans for addressing regulatory or business requirements.

7. Prepare for Improve toll-gate review

- Update Project Charter, financial benefits, and schedule



The Seven Old Quality Tools

There are a number of useful problem solving tools in Six Sigma known as **the seven tools**:

- Flowcharts
- Cause-and-effect diagrams
- Pareto charts
- Check sheets
- Scatterplots
- Histograms
- Control charts

The Seven New Quality Tools Management & Planning

- [Affinity diagram](#): organises a large number of ideas into their natural relationships. Can result from a Brainstorming session.
- [Relationship diagram](#): shows cause-and-effect relationships and helps you analyse the natural links between different aspects of a complex situation.
- [Tree diagram](#): breaks down broad categories into finer and finer levels of detail, helping you move your thinking step by step from generalities to specifics.
- [Matrix diagram](#): shows the relationship between two, three or four groups of information and can give information about the relationship, such as its strength, the roles played by various individuals, or measurements.

The Seven New Quality Tools Management & Planning

- [Prioritization Matrix](#): One of the most rigorous, careful and time-consuming of decision-making tools, a prioritization matrix is an [L-shaped matrix](#) that uses pairwise comparisons of a list of options to a set of criteria in order to choose the best option(s). (Pages 285-290)
- [Arrow diagram](#): shows the required order of tasks in a project or process, the best schedule for the entire project, and potential scheduling and resource problems and their solutions.
- [Process decision program chart \(PDPC\)](#): systematically identifies what might go wrong in a plan under development. (Pages 296-297)

Relations to “Old” Tools

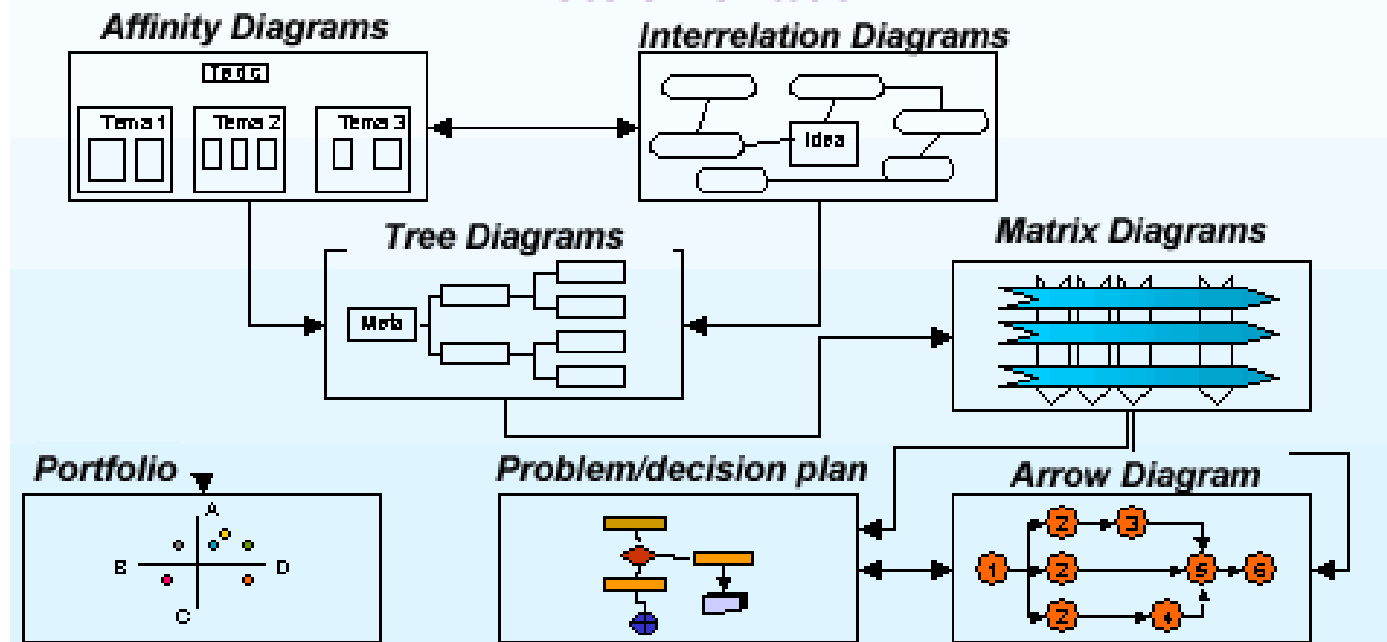
- Similarities:
 - Both are graphics rather than language based
 - Whole first, then elements analysed
 - Universal understanding (pictures)
- Differences:
 - New tools are more relational and network oriented
 - New tools may take more practice to develop proficiency
- They can and should be used together

The Seven New Quality Tools

Quality Management

...the seven new tools for quality control which are linked and thus capable of visualizing the complexity of a total quality system

- The seven new tools -



Total Quality Management

Source: made for this work 2001, adapted from Pfeiffer 1996

Brainstorming



Aim: to generate ideas and find group consensus on their relative importance.

- Can be used as a pre-requisite to **Affinity Diagrams**

Brainstorming Objectives

- Describe the objective(s) of the exercise:
 - New product or service ideas?
 - New feature ideas?
 - Feature/product naming?
 - Promotion ideas?
 - New process for doing something?
- Define top requirements or restrictions.

Brainstorming Rules

There are four rules that participants should follow during a brainstorming session:

1. Postpone the evaluation of ideas until after the session.
2. Any and all ideas are welcome, no matter how silly they may seem – participants should use their imaginations.
3. The more ideas, the better.
4. “Piggybacking” is encouraged – combinations and variations are welcomed and given priority over new unrelated ideas.

Avoid these “Idea Stopping” thoughts

- Don't be ridiculous
- It won't work here
- Our business is different
- It's too expensive
- Management won't like it
- It's good but....
- That's been tried before
- Too much work
- You do not know how things work around here
- That's not my job

Brainstorming Steps

There are **5 steps** to complete in a brainstorming session:

1. **Prepare for the session** – the leader should prepare a clear statement of the problem and give it to team members well before the meeting.
2. **Orient the group** – a team spirit needs to be developed and creative thinking practiced. Often a warm-up or practice run is used.

Brainstorming Steps

3. **Generate ideas** – as many ideas as possible should be the goal (100+ ideas is easily obtainable).
 - Several approaches can be used in this step. One way is to have each member write their ideas on post-it notes and attach these to a large sheet of paper in the middle of the table. Other team members should be able to read these in order for piggybacking to occur.
 - Usually the generation of ideas will begin to slow after a while and the leader can halt the session (30 minutes to an hour is a good time span for this).



Brainstorming Steps

4. **Evaluate ideas** – the ideas can now be classified into categories (about five to ten of these) and those judged the best ideas selected. Plenty of time should be allocated for this step – 30 minutes to an hour may be appropriate.
5. **Follow-up** – the results of the evaluation session should be conveyed to all participants and to the appropriate person(s) for implementation.



The Nominal Group Technique



The Nominal Group Technique

- NGT is another structured problem-solving technique with the same aim as brainstorming – to generate ideas and obtain group consensus on their relative importance.
- Nominal means the participants are a group in name only – they don't interact
- The ideas generated are done so anonymously.
- The approach taken in the nominal group technique means that vocal members of the team do not dominate.

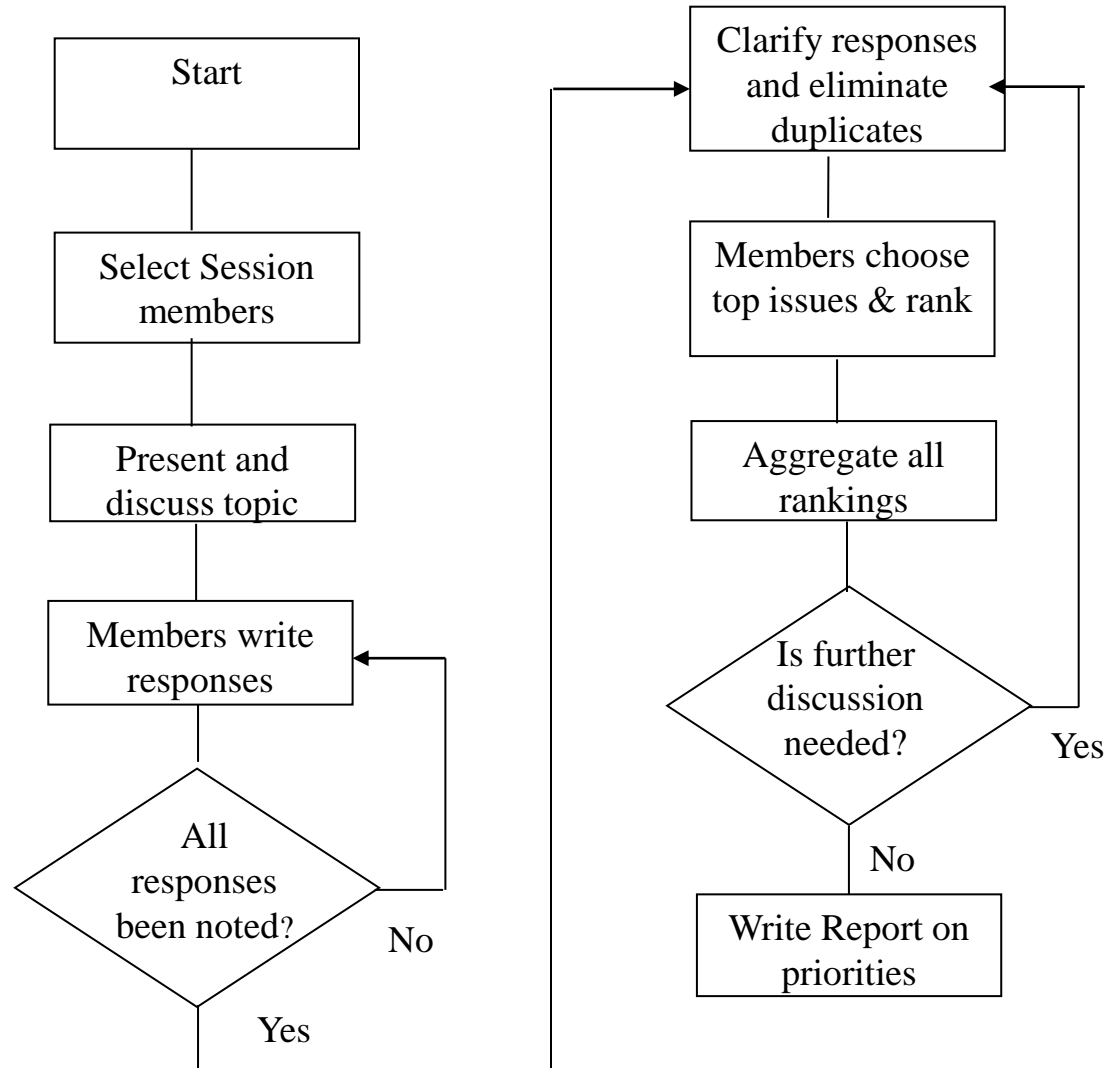
Nominal Group Technique (NGT)

- The approach calls first for the silent generation and priority ranking of ideas by each group member.
- This is followed by a public listing of ideas usually by asking for each person's top-ranked idea and then moving on to second- and third-ranked ideas until everyone's list is exhausted.... Once this is completed, group members are allowed to discuss the ideas....
- After the discussion, a vote is taken in which group members are asked to rank the ideas that have been generated."

Nominal Group Technique - Method

- Presentation of Issue
- Individual Reflection and brainstorming
- Documentation
- Consolidation and Review of Ideas
- Ranking of Ideas
- Compilation of Results

Flowchart of NGT



Nominal Group Technique (NGT)

- Brainstorming is about generation ideas but sometimes it is not enough just to get lots of ideas about something. Usually though you will want to narrow the list down.
- The Nominal Group Technique is a technique to narrow down the list. This means first deciding on criteria, or rules, for picking items from a brainstorm list.
- Brainstorming can be used to come up with plans and projects. It can also help with problem-solving and improvement efforts.
- Whenever you want to generate lots of ideas, brainstorming is the way to go. The nominal group techniques is a way to select from the list of ideas that have been created.

The Nominal Group Technique

- Research reveals that groups that don't discuss and interact generate more ideas than groups that do.
- If the aim of the session includes team building, then brainstorming is a better option.
- If the aim is only to generate ideas, then the nominal group technique is a better option.
- For a nominal group technique session, you need a team leader and five to eight team members.

The Seven New Quality Tools Management & Planning

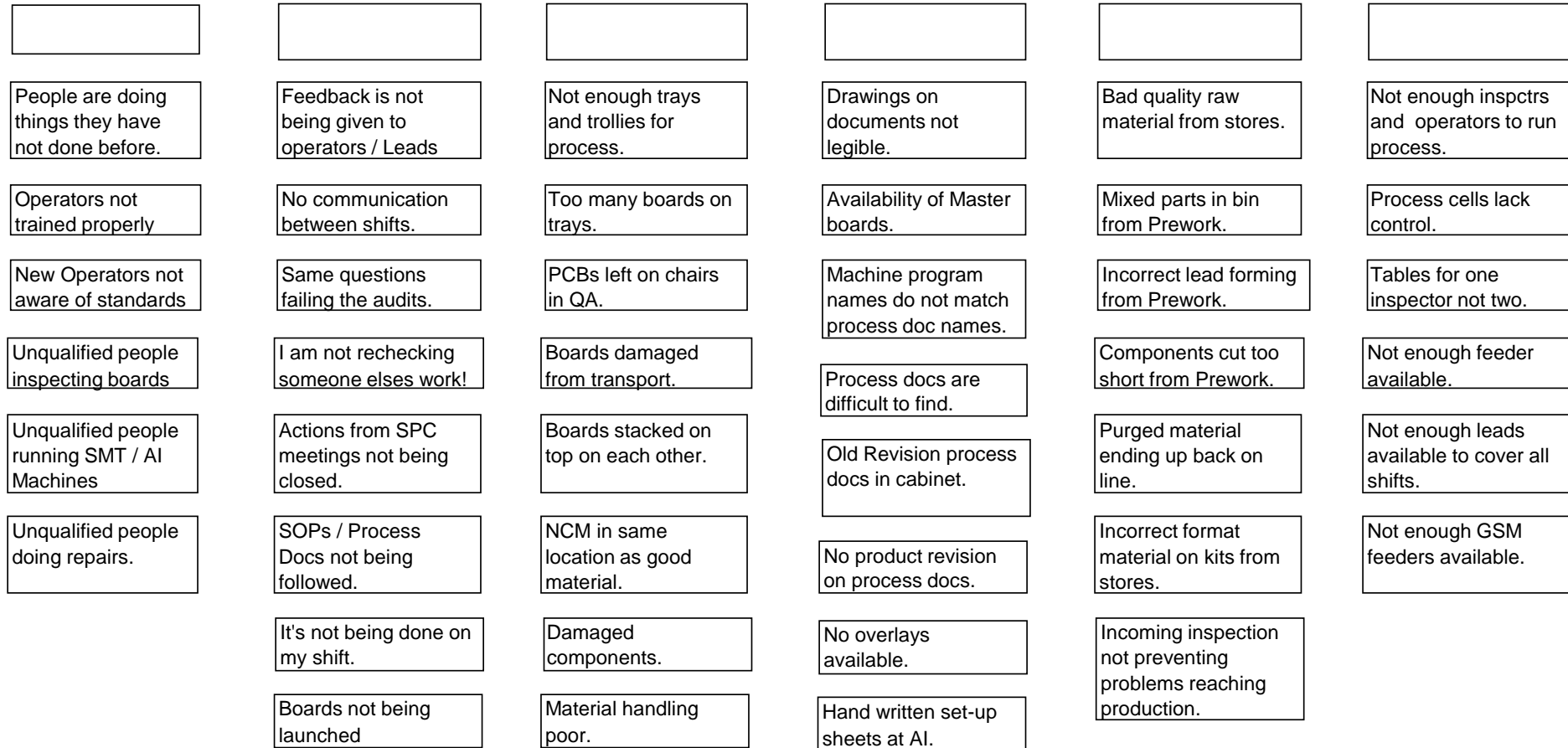
- Affinity Diagrams
- Tree Diagrams
- Process Decision Program Charts (PDPC)
- Matrix Diagrams
- Prioritization Matrix
- Arrow Diagrams
- Interrelationship Diagrams

Affinity Diagrams

- Organizes a large amount of verbal data related to a broad problem or subject
 - Ideas, opinions, facts
- Usage example: Establishing a new QC policy
- Steps:
 1. Gather a large number of ideas
 2. Put individual ideas on cards or sticky notes
 3. As a team, group the ideas according to natural “affinity” or relationship to each other
 4. These natural groups become “strategic factors”

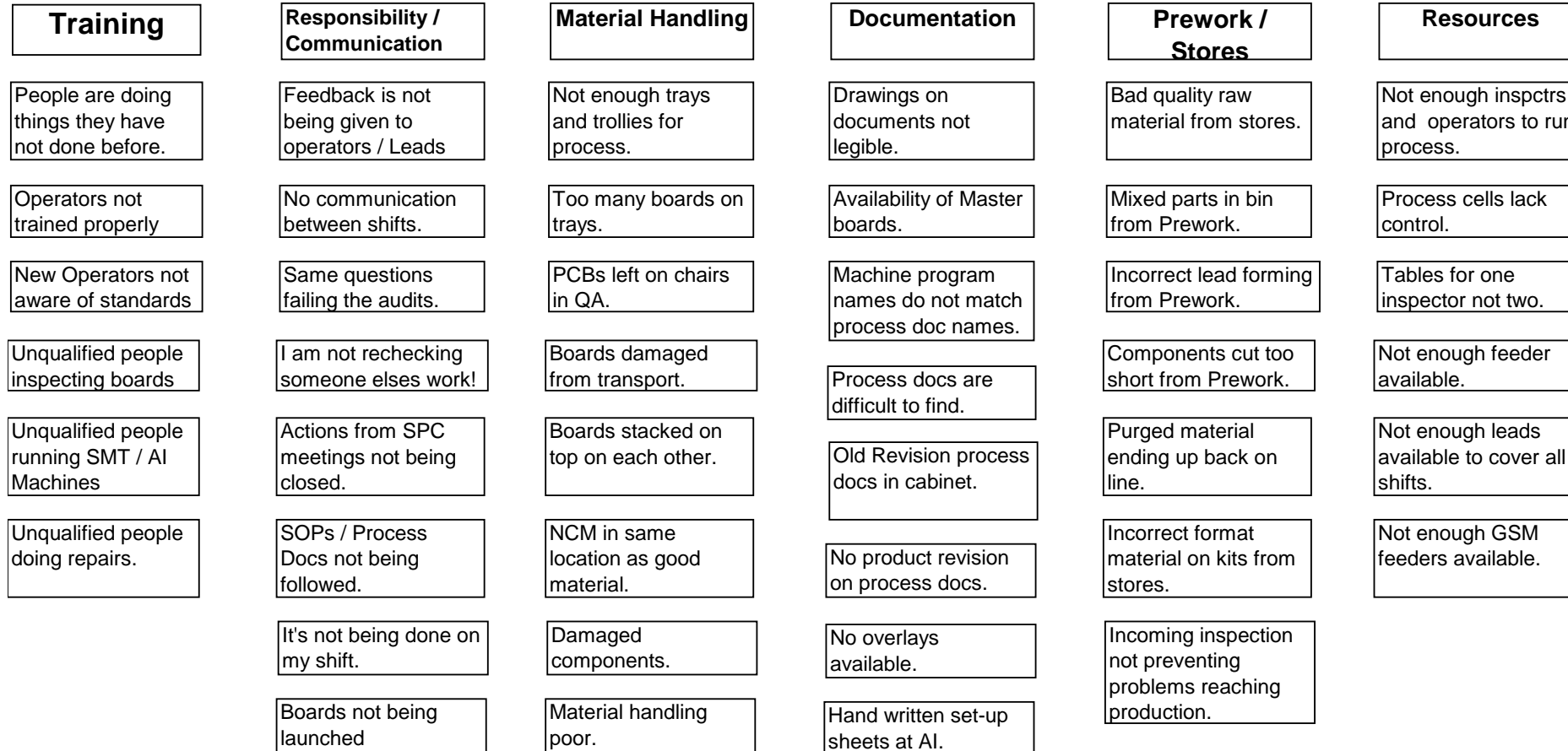
Affinity Diagram Example

What are the Quality problems in this Electronics Manufacturing Site?



Affinity Diagram Example

What are the Quality problems in this Electronics Manufacturing Site?



Affinity Diagrams

- An affinity diagram is a tool used to organise ideas obtained from a brainstorming session.
- The aim is to assemble ideas into groupings based on the natural relationship of these ideas.
- Usually a team of about five people will construct an affinity diagram.
- They should already have access to ideas generated from a brainstorming session (50 to 100 such ideas is usual).

Affinity Diagrams

- Each idea should be written on a post-it note or a card.
- The issue being investigated should be written across the top of a piece of butchers paper.
- In silence, the group should begin to move the post-it notes into 5 to 10 related groupings on the paper.
- As no talking is allowed, an idea may be moved back and forth several times before agreement is reached.

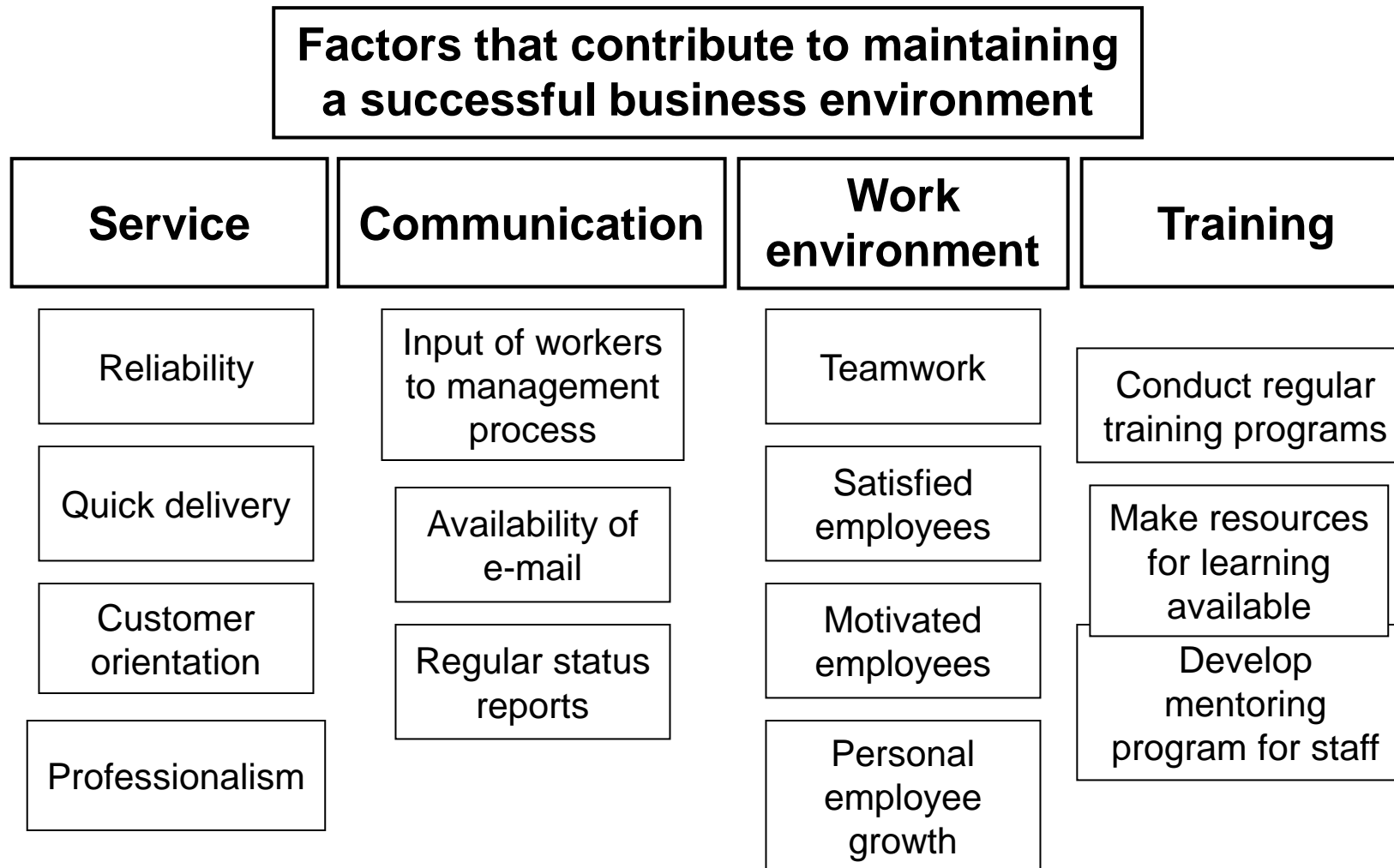


Affinity Diagrams

- After a while, the process will slow and some sort of consensus will be reached.
- The team should then discuss each grouping and decide on an appropriate heading for each grouping.



An example of a simplified affinity diagram



The Seven New Quality Tools Management & Planning

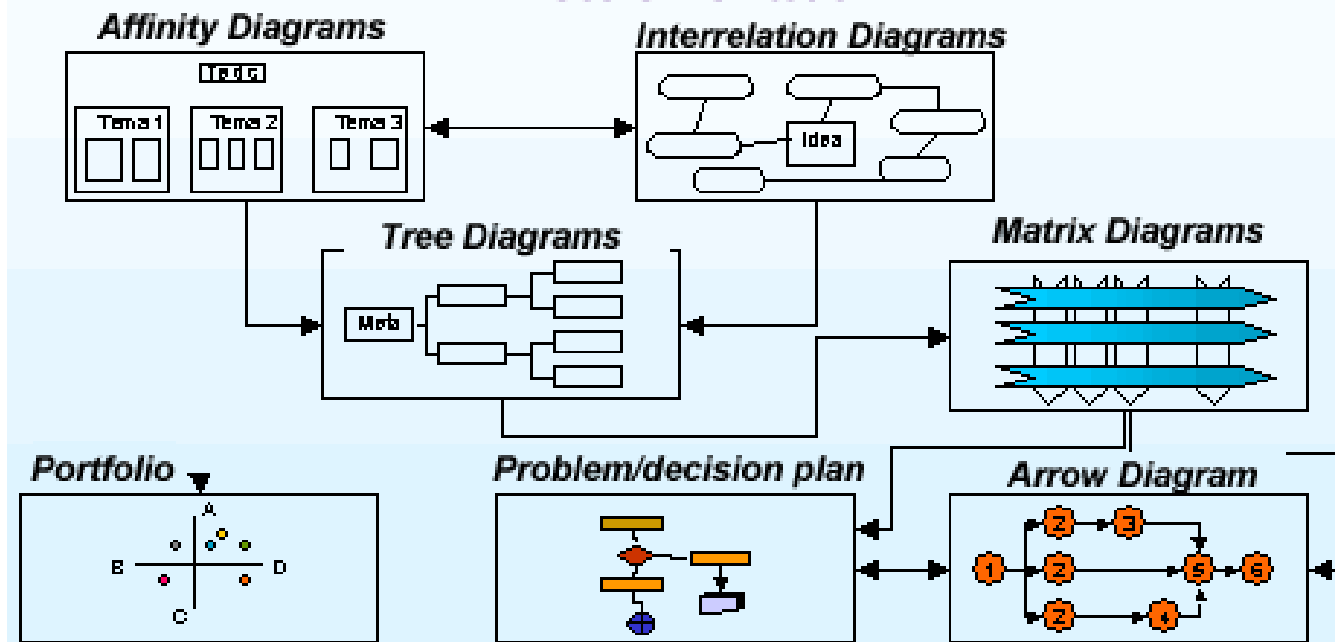
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The Seven New Quality Tools

Quality Management

...the seven new tools for quality control which are linked and thus capable of visualizing the complexity of a total quality system

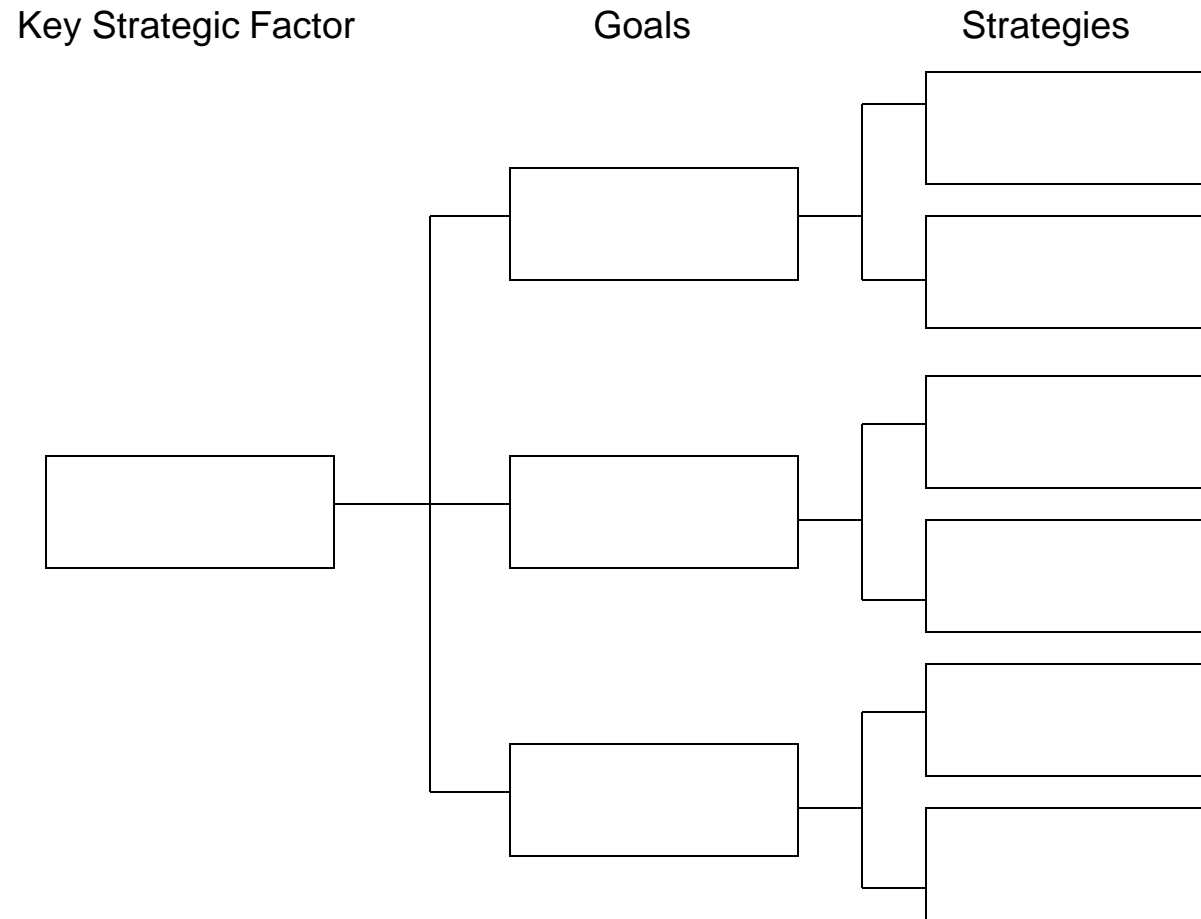
- The seven new tools -



Total Quality Management

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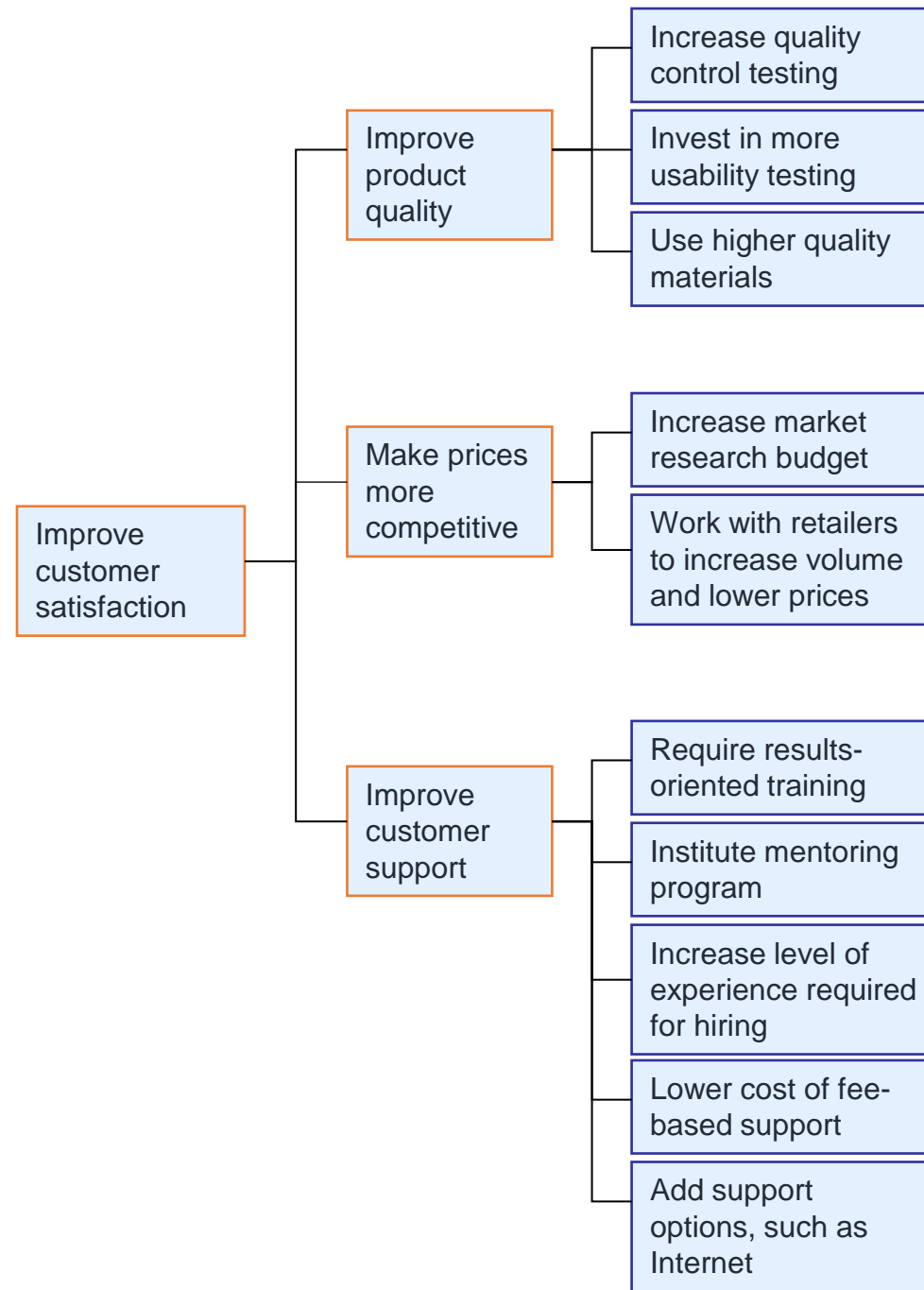
Tree Diagrams



Tree diagrams

- Tree diagrams allow us identify the actions needed to achieve a key goal.
- They allow us to move from more general problems or goals to the specifics needed to solve the problem or attain the goal.
- The process is begun by selecting the problem or goal to be addressed.

Customer Satisfaction Improvement Plan



Tree Diagrams

- Often this issue can have been identified after an interrelationship diagram is constructed.
- The tree is now produced layer by layer by identifying all the sub-issues at each stage.
- Usually no more than about seven layers are required.

When to use a Tree Diagram?

- After an affinity diagram or relations diagram has uncovered key issues.
- When an issue is known or being addressed in broad generalities and you must move to specific details, such as when developing logical steps to achieve an objective.
- When developing actions to carry out a solution or other plan.
- When analyzing processes in detail.
- When probing for the root cause of a problem.
- When evaluating implementation issues for several potential solutions.
- As a communication tool, to explain details to others.

Tree Diagrams (cont.)

- Steps:
 - Work from left to right
 - Start with the purpose to be accomplished
 - Generate the high level targets or goals that must be completed to accomplish the purpose
 - Link each goal to the purpose (these are the first branches of the tree)
 - Expand on each target to identify and define subordinate tasks to accomplish each target
 - Link each to their target
 - Continue expansion process until final level is implementable.
 - Review logic of completed tree (perhaps with larger group)

The Seven New Quality Tools Management & Planning

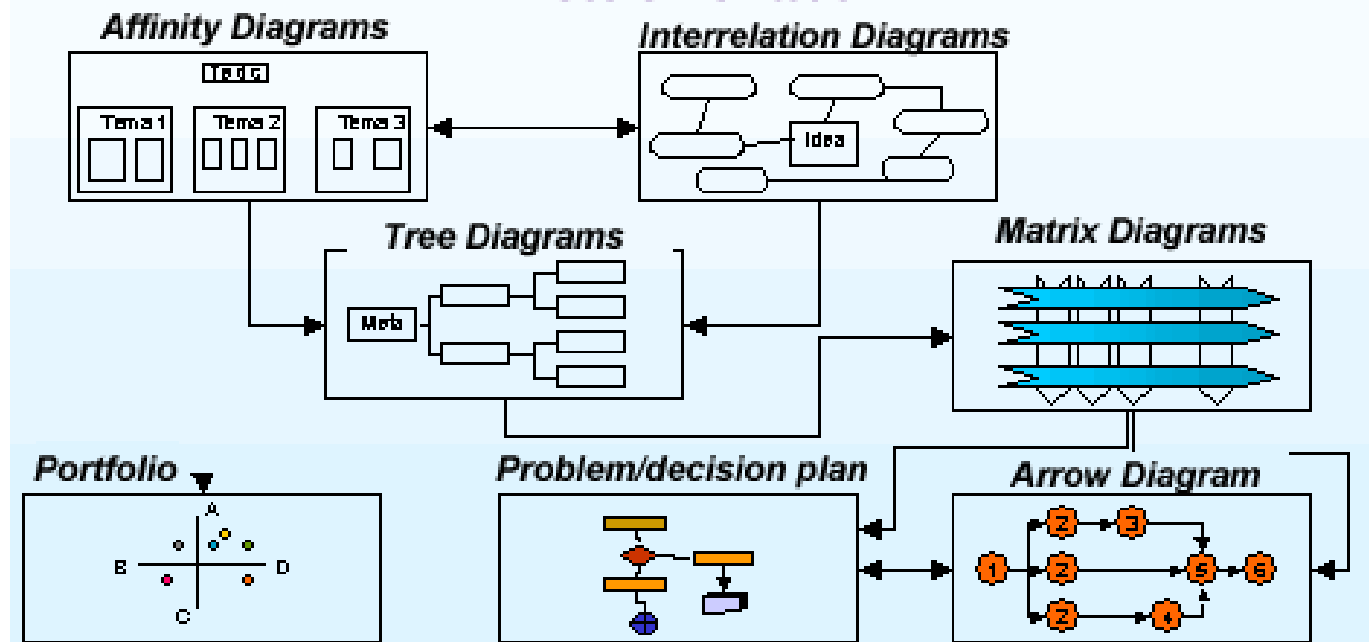
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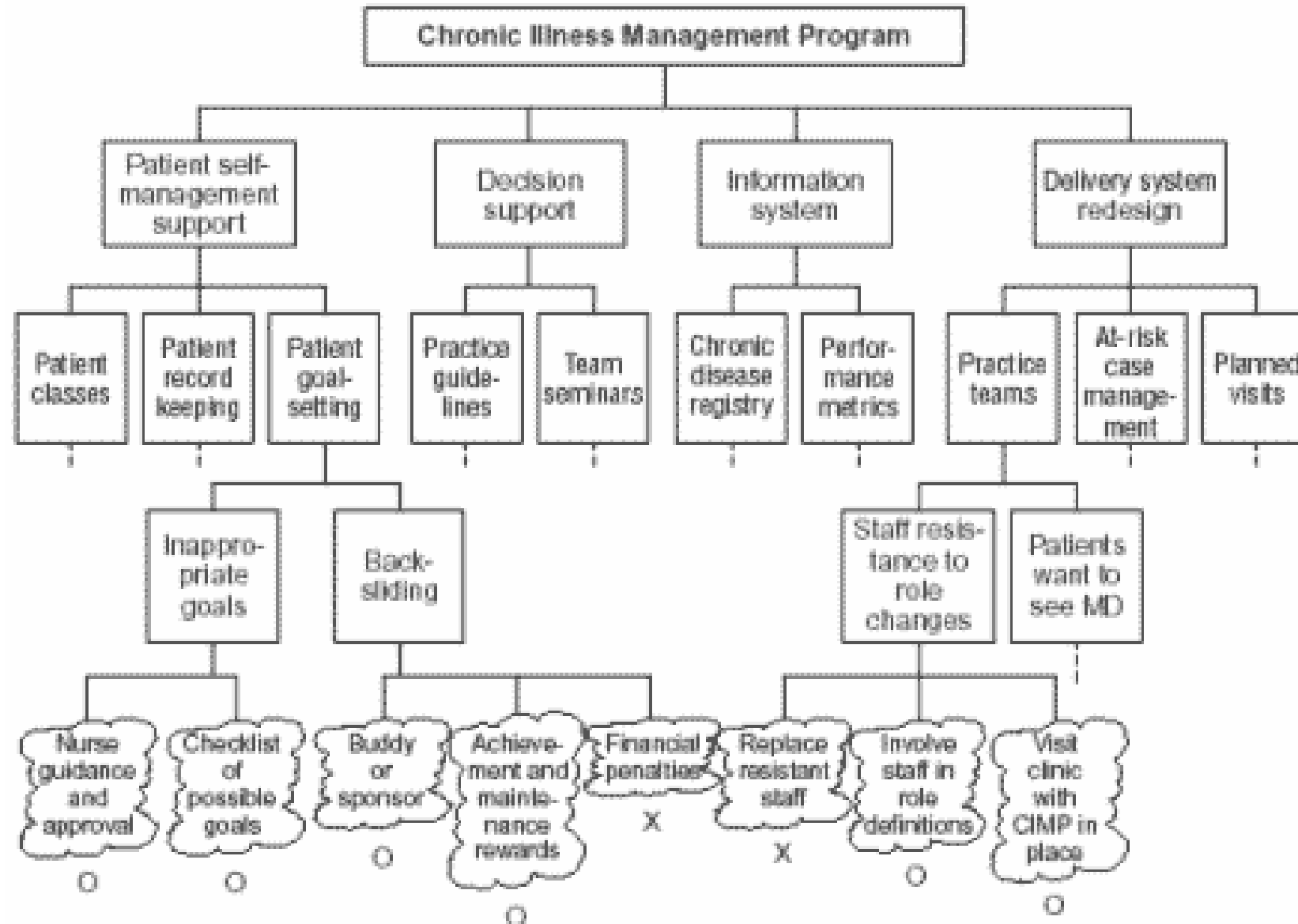
Process Decision Program Charts

- Maps out all contingencies when moving from statement of purpose to its realization
- Usage example: establishing an implementation plan for improvement project
- Steps:
 - Another form of a tree diagram
 - First level: purpose
 - Second level: activities to be undertaken
 - Third level: steps in these activities
 - Fourth level: what ifs? (contingencies)
 - Fifth level: countermeasures (contingency plans)

PDPC Example

- A medical group is planning to improve the care of patients with chronic illnesses such as diabetes and asthma through a new chronic illness management program.
- They have defined four main elements and, for each of these elements, key components. The information is laid out in the process decision program chart on the next slide.

PDPC Example



Process Decision Program Chart Example

- Choose one of the strategies that you came up with in your tree diagram.
- Expand on the actions necessary to implement this strategy.
- Select one action and expand on the necessary steps.
- Continue expanding along a single branch until you can develop at least one contingency and possible countermeasure.

The Seven New Quality Tools Management & Planning

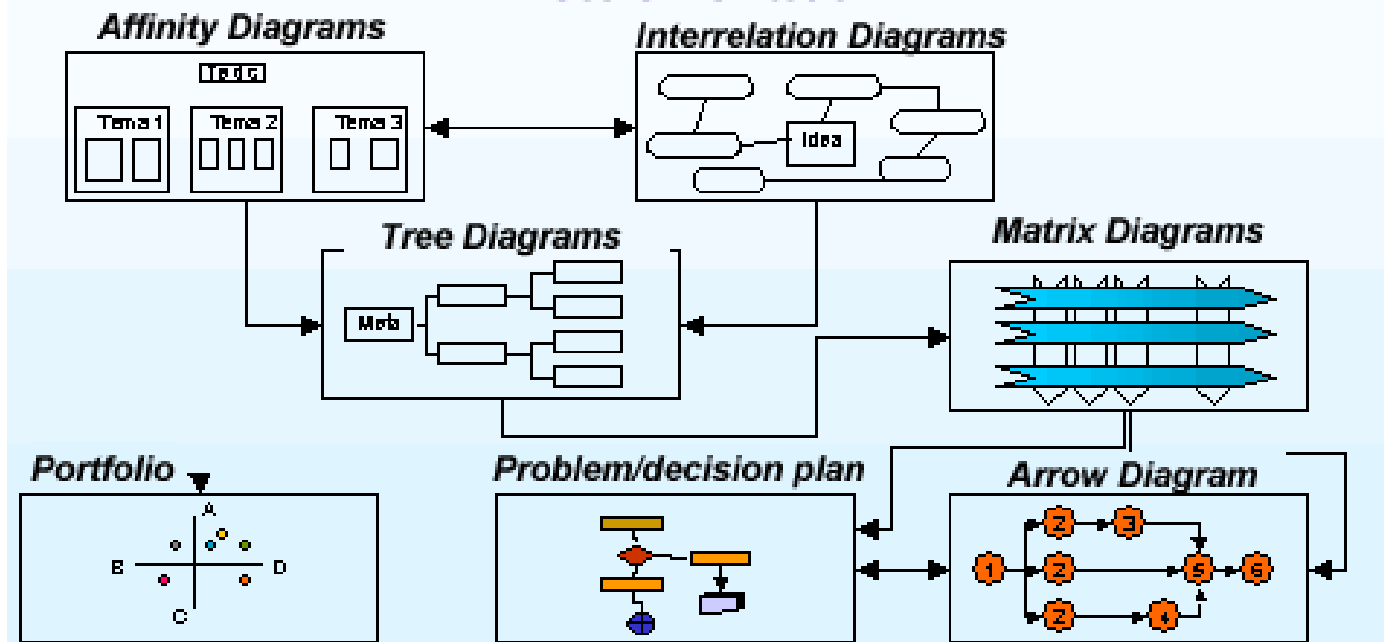
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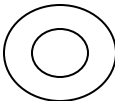
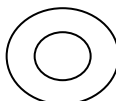
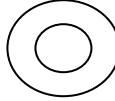
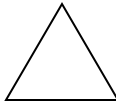
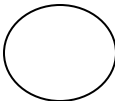

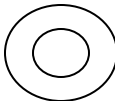
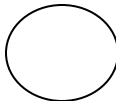
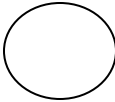

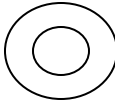
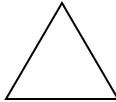
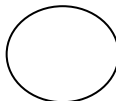
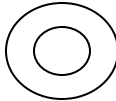
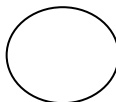
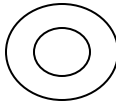
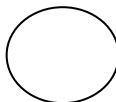
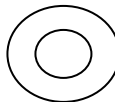
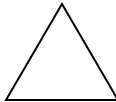
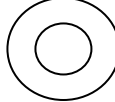
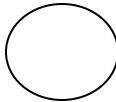
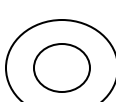
Total Quality Management

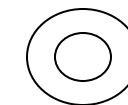
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Matrix diagrams

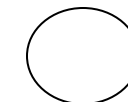
- Matrix diagrams consist of two sets of information such as characteristics, functions or tasks.
- These two sets are compared and the strength or absence of relationships are shown graphically.
- Sometimes the direction of influence is also included.
- A variety of shapes are used to allow for 2 or more dimensions of variables.

A simplified matrix diagram

	John	Mary	Alex	Tom	Donna
Sales representatives					
Software maintenance					
Computer hardware					
Reception					
Payroll administration					
Accounts					
Inventory					
Clerical					



Primary responsibility



Secondary responsibility



Should receive information

Matrix diagrams

Two common possible sets of shapes are:



Strong
correlation



Average
correlation



Weak
correlation

or



Primary
responsibility



Secondary
responsibility



Should receive
information

Matrix diagrams

- Sometimes a points system is used instead of symbols, where, for example, 9 represents strong association, 5 somewhat associated, 2 weak association and 0 no association etc.
- Often the lowest layer of a tree diagram describing a set of tasks is used as one set of variables and departments or personnel in an organisation who have responsibility for these tasks are used as the second set of variables.

Matrix Diagram Example

- Correlation Matrices
 - Shows the relationship between one list of variables and another. Relationships are usually based on experience.
 - Such a matrix forms the body of a “house of quality”

Matrix Diagrams

Correlation Matrix Example

<div> <div>Actions</div> <div>Goals</div> </div>	Improve Work Environment	Improve Manufacturing Technology	Develop New Products
Cost Effectiveness	●	◐	
High Quality	●	●	
Shareholder Value		△	●

● = Strong relationship ◐ = Medium relationship △ = Weak relationship

The Seven New Quality Tools Management & Planning

- Affinity Diagrams
- Tree Diagrams
- Matrix Diagrams
- **Prioritization Matrix**
- Arrow Diagrams
- Process Decision Program Charts (PDPC)
- Interrelationship Diagrams

Prioritization Matrix

- Arranges a large array of numbers so that they may be visualised and comprehended easily
- Usage example: evaluate the desired quality level from the results of a market survey
- Steps:
 - Begin with numerical matrix relating goals or requirements to actions or performance
 - Assign weights to each goal or requirement
 - Subjective
 - Objective (principle component analysis)
 - Calculate weighted importance of actions or performance level

Prioritization Matrix Example

Requirement	Importance Weight	Best Competitor Evaluation	Own Evaluation	Weighted Gap
Price	.2	6	7	
Speed of Delivery	.3	7	6	
Reliability	.4	5	6	
Customization	.1	8	7	

The Seven New Quality Tools Management & Planning

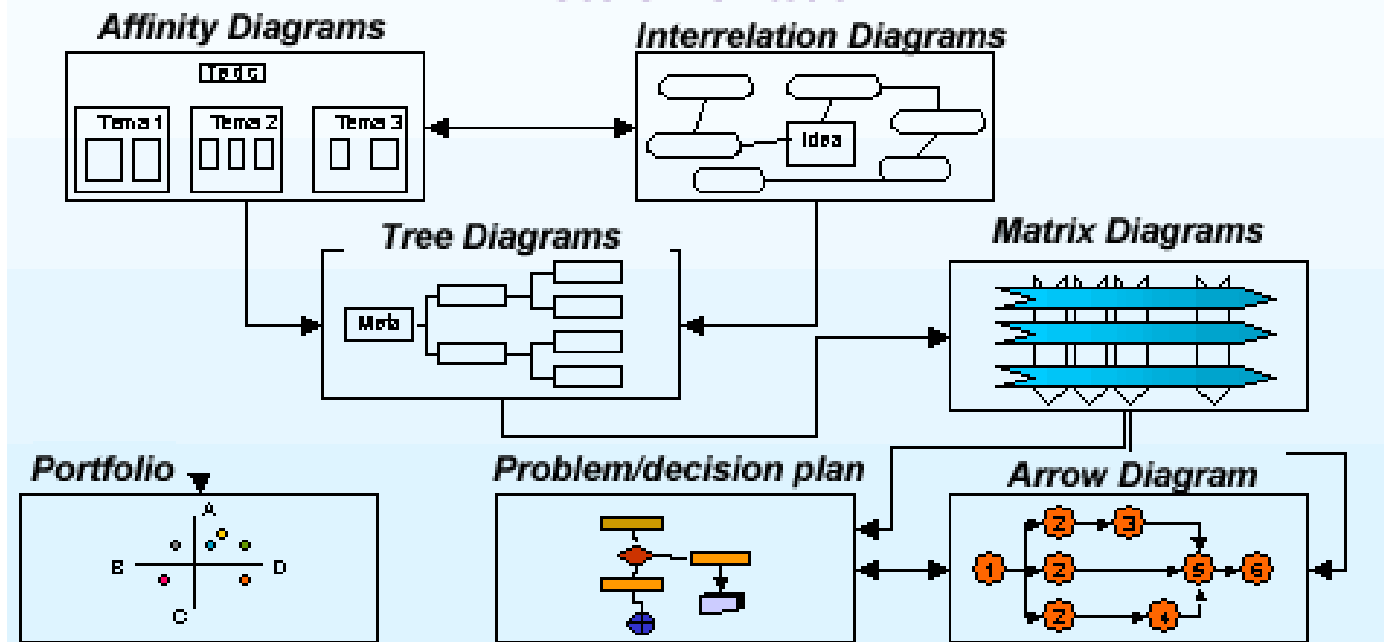
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Total Quality Management

Source: made for this work 2001, adapted from Pfeiffer 1996

Arrow Diagram

- Also called: activity network diagram, network diagram, activity chart, node diagram, CPM (critical path method) chart.

Arrow Diagrams

- It is a network of lines that connects all of the elements related to plan execution.
- Steps: (working on the nodes)
 - All of your activities that have no predecessors can be placed along the left of the page
 - Activities that immediately follow are drawn to the right of the first activities
 - Arrows are drawn from each activity to all those activities that immediately follow that activity
 - Continue adding activities until the process is finished
 - Time estimates can be easily added to schedule and control the project

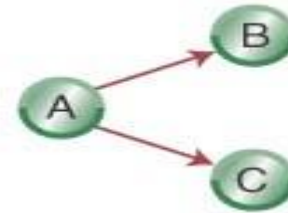
Arrow Diagrams - WBS

Uses nodes to represent the activity

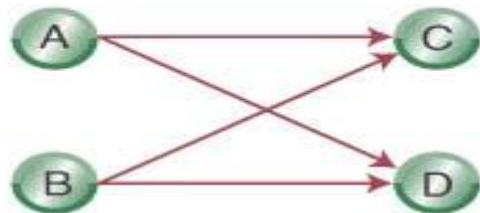
Uses arrows to represent precedence



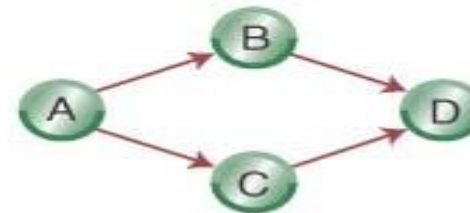
a. Activity A precedes activity B, which precedes activity C



b. Activity A must be completed before activities B and C can begin.



c. Activities A and B must both be completed before activity C or D can begin.

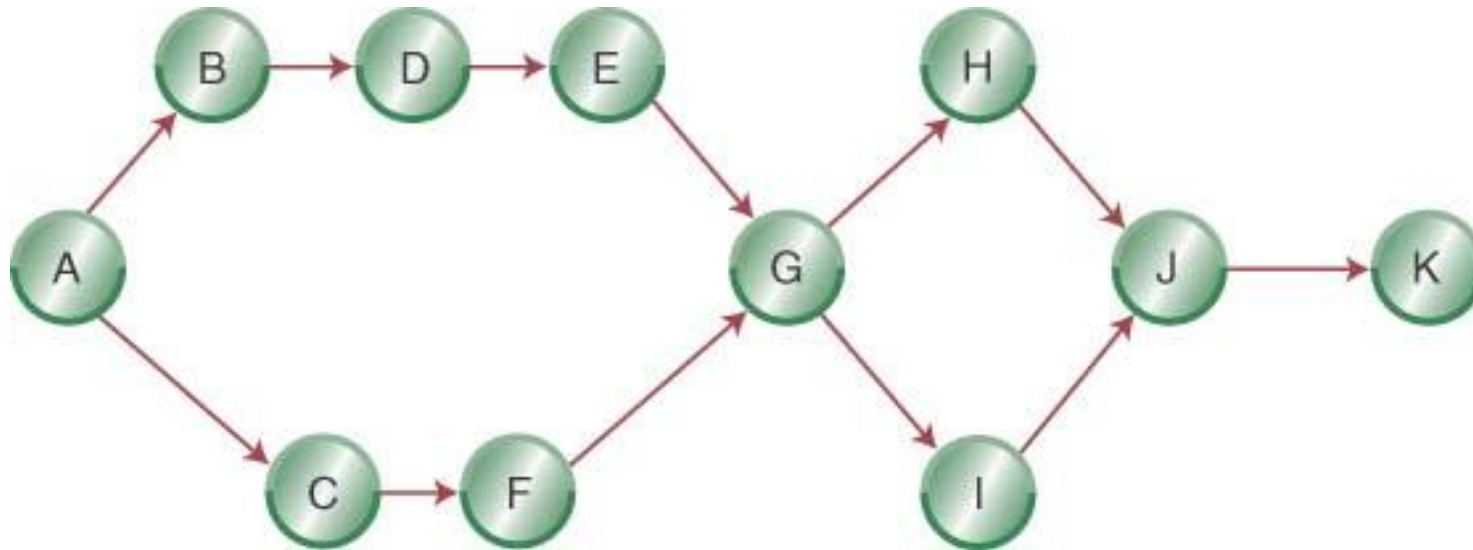


d. Activities B and C can begin once activity A has been completed; activity D cannot begin until both B and C are completed.

Step 1-Define the Project: **Cables Co** is bringing a new product on line to be manufactured in their current facility in some existing space. The owners have identified 11 activities and their precedence relationships..

Activity	Description	Immediate Predecessor	Duration (weeks)
A	Develop product specifications	None	4
B	Design manufacturing process	A	6
C	Source & purchase materials	A	3
D	Source & purchase tooling & equipment	B	6
E	Receive & install tooling & equipment	D	14
F	Receive materials	C	5
G	Pilot production run	E & F	2
H	Evaluate product design	G	2
I	Evaluate process performance	G	3
J	Write documentation report	H & I	4
K	Transition to manufacturing	J	2

Step 2- Diagram the Network for Cables Co

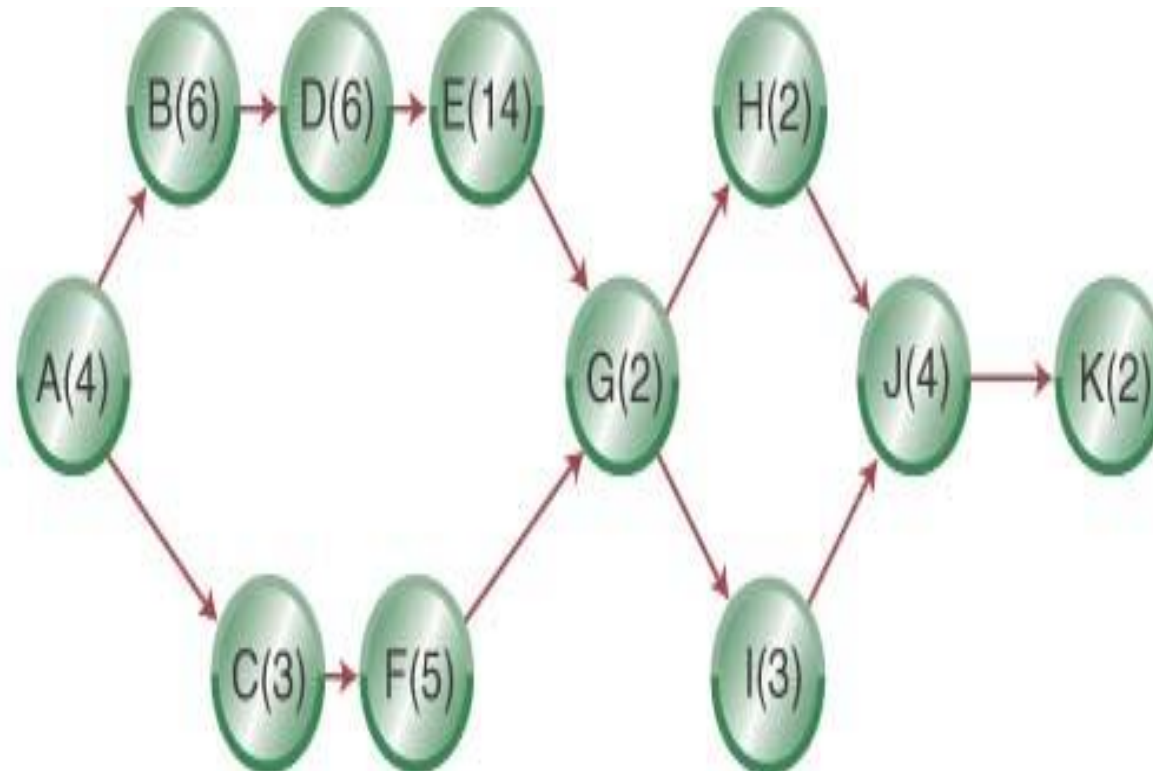


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K	Transition to manufacturing	J	2

Step 3 (a)- Add Time Estimates and Connected Paths

Connected paths

1. A, B, D, E, G, H, J, K
2. A, B, D, E, G, I, J, K
3. A, C, F, G, H, J, K
4. A, C, F, G, I, J, K



Step 3 (a) (Continued): Calculate the Path Completion Times

Paths	Path duration
ABDEGHJK	40
ABDEGIJK	41
ACFGHJK	22
ACFGIJK	23

- The longest path (ABDEGIJK) limits the project's duration (project cannot finish in less time than its longest path)
- ABDEGIJK is the project's **critical path at 41 weeks**

The Seven New Quality Tools Management & Planning

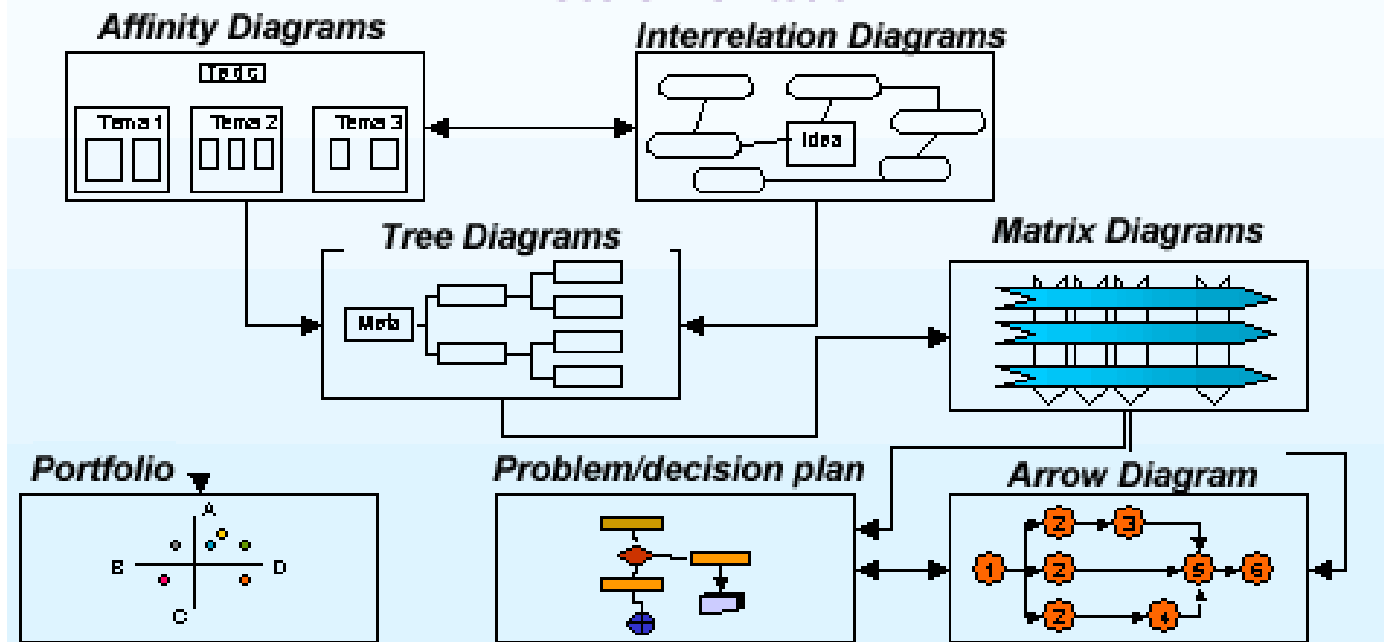
- Affinity Diagrams
- Tree Diagrams
- Process Decision Program Charts (PDPC)
- Matrix Diagrams
- Prioritization Matrix
- Arrow Diagrams
- Interrelationship Diagrams

The Seven New Quality Tools

Quality Management

...the seven new tools for quality control which are linked and thus capable of visualizing the complexity of a total quality system

- The seven new tools -



Total Quality Management

Source: made for this work 2001, adapted from Pfeiffer 1996

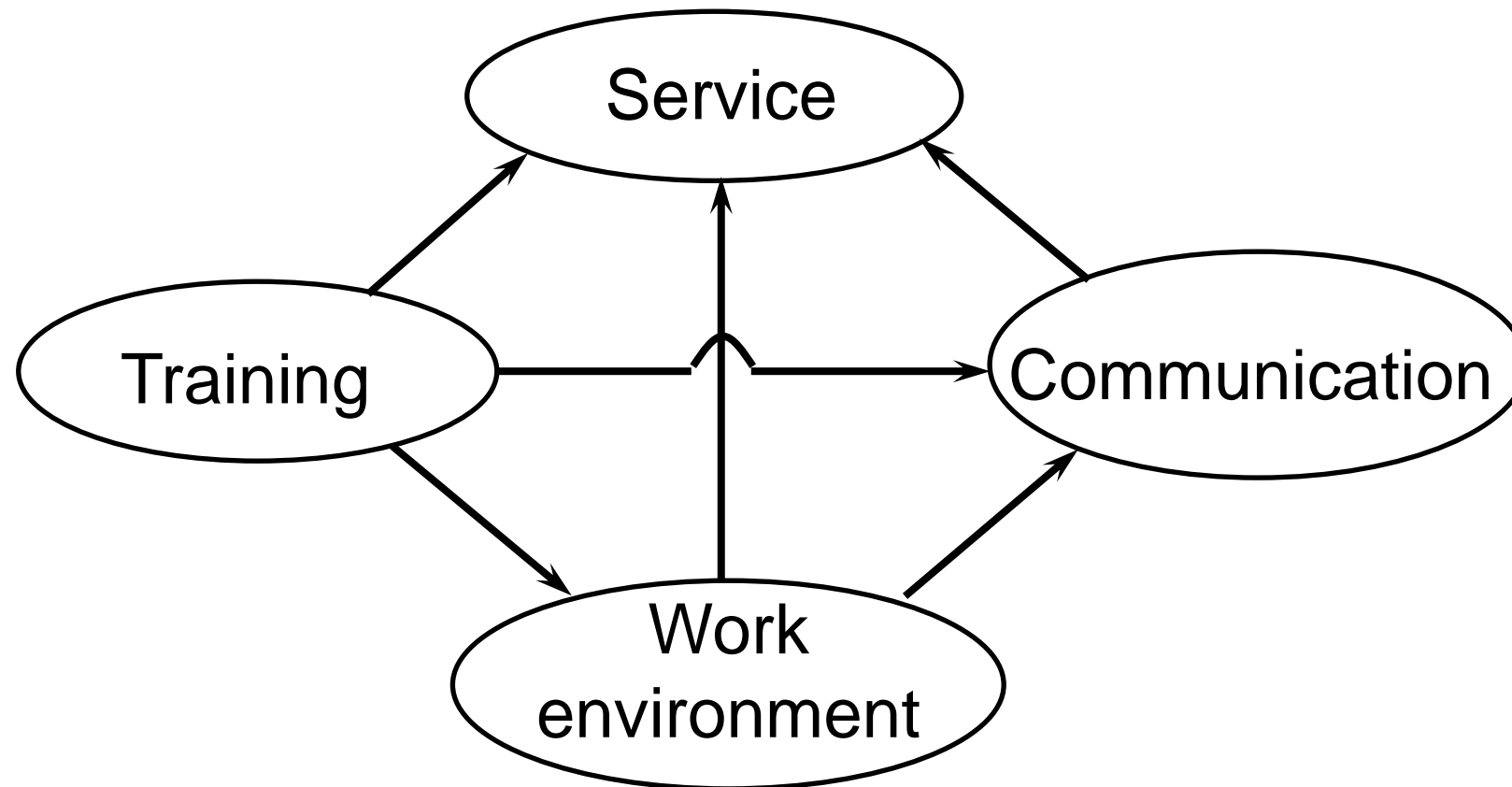
Interrelationship Diagrams

- An interrelationship diagram allows us to display the logical links between categories in a planning process.
- It has the advantage over other tools such as flowcharts, because it allows for multi-directional links rather than just a linear succession.
- Often the major issues (headings) in an affinity diagram are used.

Interrelationship Diagrams

- Arrows are used to link these headings – the direction of the arrows indicates the direction of cause and effect.
- **A driver** is an issue where the majority of arrows are leaving it.
- **An outcome** is an issue where the majority of arrows are entering it.
- In the example that follows, ‘service’ is an outcome and ‘training’ is a driver.

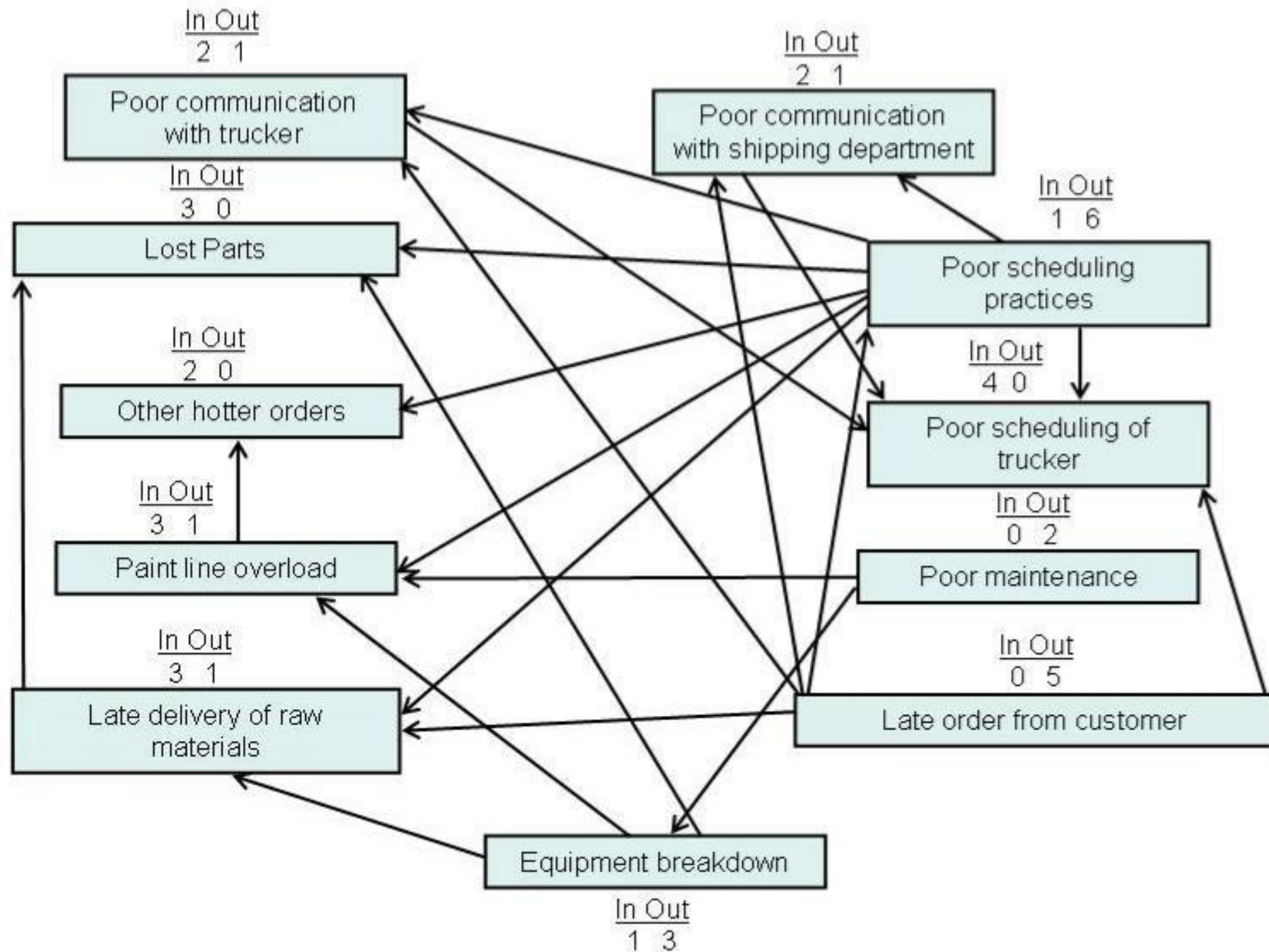
A Simplified Interrelationship Diagram



Interrelationship Diagrams

- Used to identify **Cause and Effect** relationships. Can address problems with a complex network of causes and effects.
 - Identifies key drivers and bottlenecks
- Usage examples: reduce customer complaints, or causes of late deliveries (next slide)
- **Steps:**
 - Write each concern or idea on a piece of paper in a circular pattern (allow room between concepts)
 - Use pairwise comparisons (1-2, 1-3, 1-4...2-3, 2,4...3,4)
 - If there is a relationship draw arrow to one that is most influential on the other.
 - If there is no relationship leave blank
 - There can be no 2-way relationships

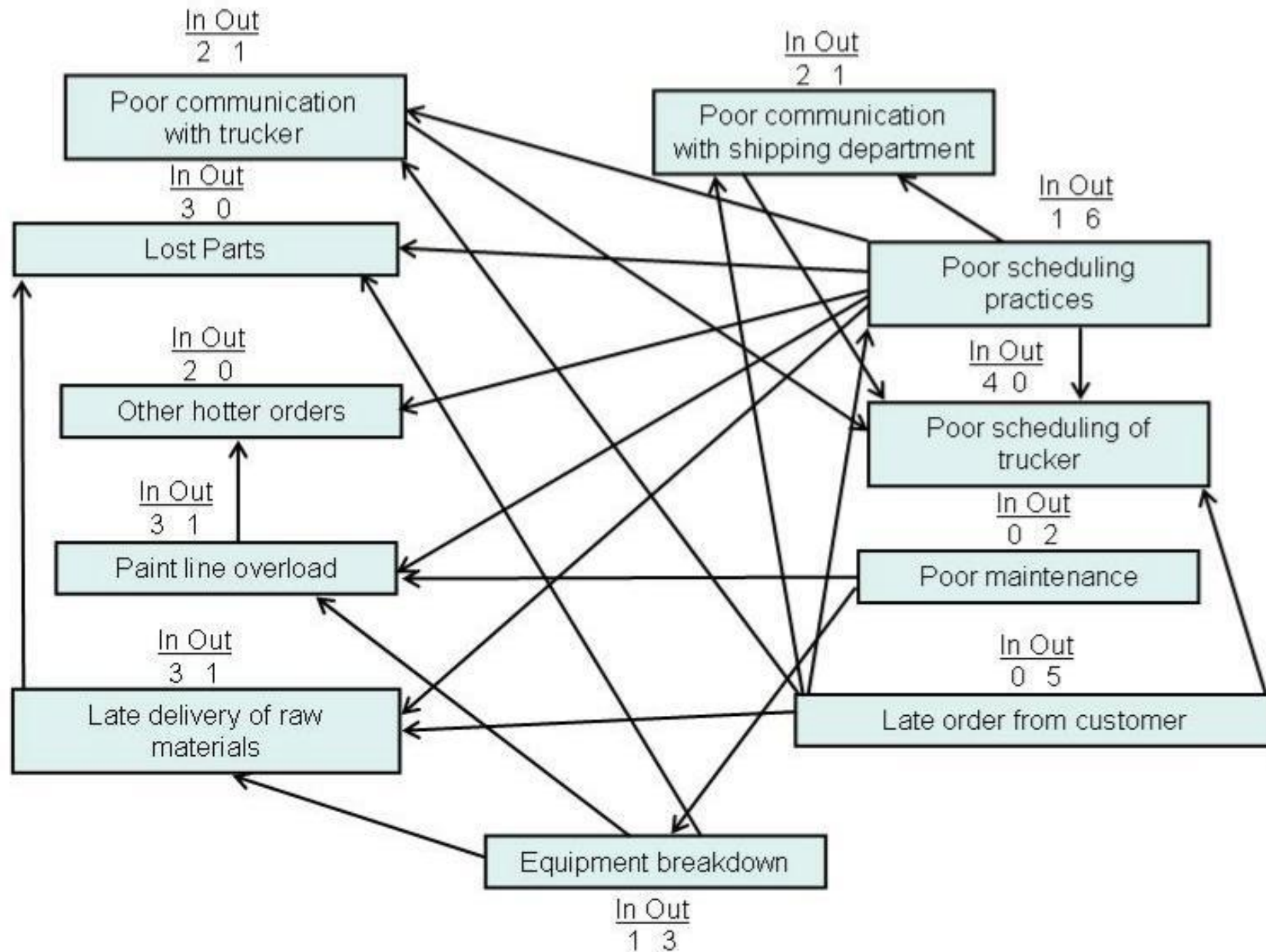
Intro



Interrelationship Diagrams Cont.

- Steps (Cont.)
 - Analyze the diagram
 - Count the arrows (# out - # in)
 - Highest out are primary drivers
 - Resources here can produce pronounced change
 - Lowest are key bottlenecks
 - Affected by many other options
 - May be inhibiting other options from proceeding as required
 - Highlight primary drivers and key bottlenecks
- Note: examine only cause and effect relationships.
Likely will have arrows on only 50% of relationships.

Intro



Interrelationship Diagrams Cont.

- In this example, **Poor Scheduling practices** is the driver **6 out**
- Poor scheduling of trucker is the outcome – largest number of **In arrows (4)**
- Causes or factors contributing to late deliveries
- For each case, ask does A influence B more than B influences A?
- After constructing the interrelationship digraph we want to interpret its meaning. What are the key factors or causes to investigate and improve? Recall that we called the entries in the digraph concerns.
- A concern with a high number of output arrows is a driver or key cause.
- A key cause affects a large number of other items.

Interrelationship Diagrams Cont.

- The diagram shows the following key causes:
 - 'Poor scheduling practices' (6 outgoing arrows),
 - 'Late order from customer' (5 outgoing arrows), and 'Equipment breakdown (3 outgoing arrows).
- A concern with a large number of input arrows is affected by a large number of other concerns. Thus, it could be a source of a quality or performance metric. 'Poor scheduling of the trucker' has 4 input arrows. A measure of poor scheduling performance of the trucker could indicate the magnitude of system problems causing late delivery.

When to Use a Relations Diagram

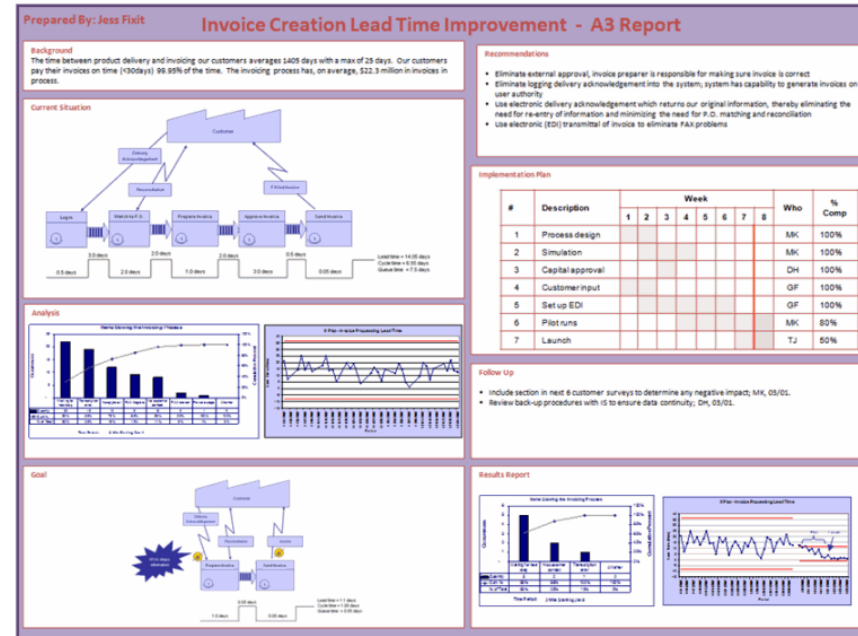
- When trying to understand links between ideas or cause-and-effect relationships, such as when trying to identify an area of greatest impact for improvement.
- When a complex issue is being analyzed for causes.
- When a complex solution is being implemented.
- After generating an affinity diagram, cause-and-effect diagram or tree diagram, to more completely explore the relations of ideas.

Summary

- The Seven New Tools
 - Display information in intuitively helpful ways
 - Structure group work and discussion
 - Promote non-linear thinking
 - Can become quite sophisticated
 - Can be used with the “old” tools

A3 Reporting

- So how do we use these quality tools together?



What is A3 Reporting?

- Toyota Motor Corporation is famed for its ability to relentlessly improve operational performance. Central to this ability is the training of engineers, supervisors and managers in a structured problem-solving approach that uses a tool called the A3 Problem-Solving Report.
- There are **10 steps** to proceed from problem identification to resolution in a fashion that fosters learning, collaboration, and personal development.
- The problem-solver records the results of investigation and planning in a concise, two-page document (the A3 Report, also adapted from Toyota) that facilitates knowledge sharing and collaboration.
- The term "A3" derives from the paper size used for the report, which is the metric equivalent to 11" x 17" (or B-sized) paper.

Why use it?

- Most problems that arise in organizations are addressed in superficial ways, what some call "**first-order problem-solving.**"
- That is, we work around the problem to accomplish our immediate objective, but **do not address the root causes** of the problem so as to prevent its recurrence.
- By not addressing the root cause, we encounter the same problem or same type of problem again and again, and operational performance does not improve.
- The **A3 Process helps people engage** in collaborative, in-depth problem-solving. It drives problem-solvers to address the root causes of problems which surface in day-to-day work routines.
- The A3 Process can be used for almost any situation, and research has found that, when used properly (i.e., all of the steps are followed and completed), **the chances of success improve dramatically.**

10 Steps to A3 Reporting

Step 0: Identify a problem or need

Step 1: Conduct research to understand the current situation

Step 2: Conduct root cause analysis

Step 3: Devise countermeasures to address root causes

Step 4: Develop a target state

Step 5: Create an implementation plan

10 Steps to A3 Reporting

Step 6: Develop a follow-up plan with predicted outcomes

The results of steps 0-6 can be recorded on an A3 report.

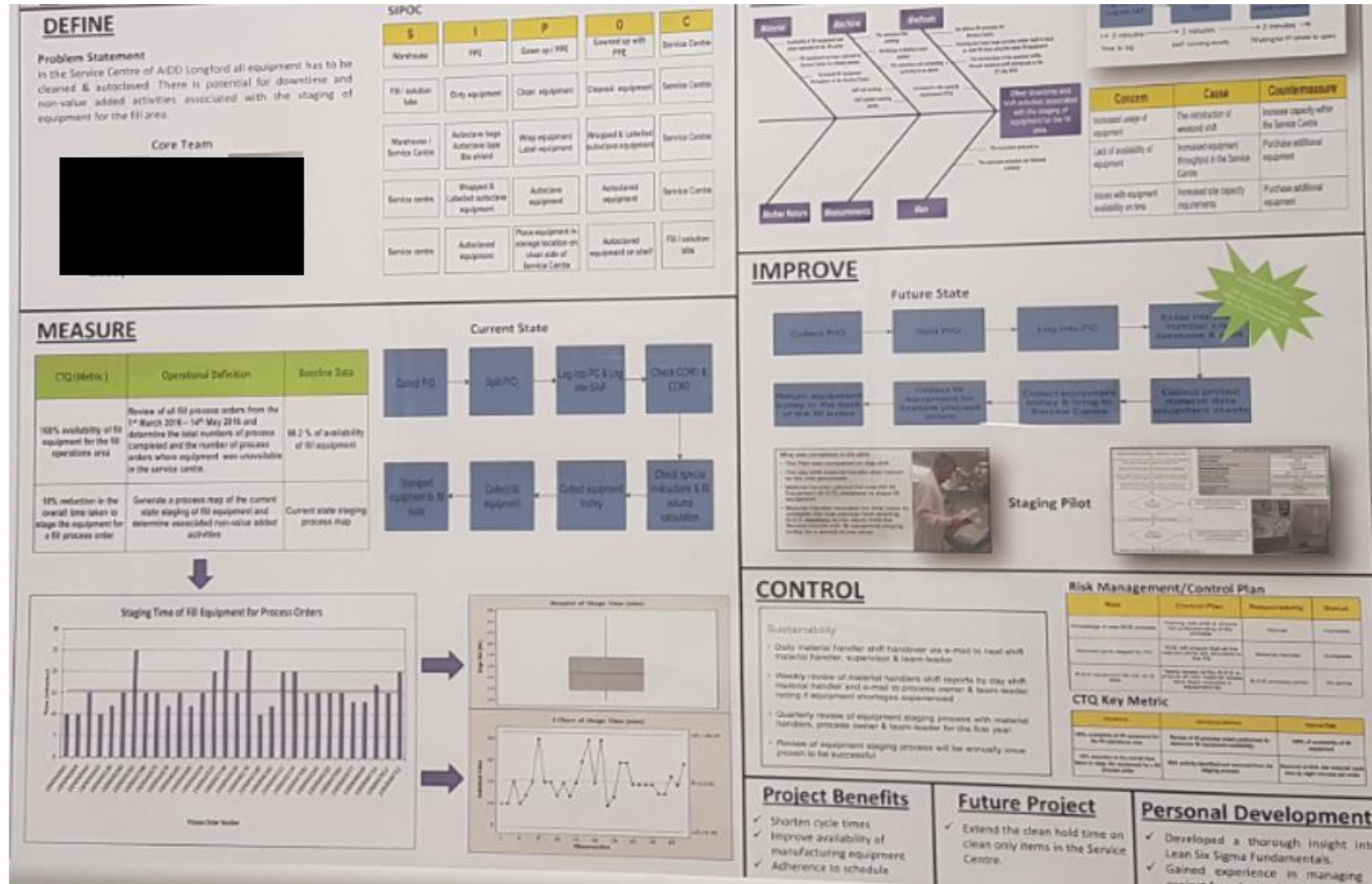
Step 7: Discuss plans with all affected parties

Step 8: Obtain approval for implementation

Step 9: Implement plans

Step 10: Evaluate the results

A3 Report



End of Lecture

