Exercise Quality Management

01 Tools of Quality Management

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- Teamwork and quality circle
  Brainstorming, Brainwriting and Osborn-Checklist
- The „Seven K-Tools“
- The „Seven Q-Tools“
- The „Seven M-Tools“
- The „Seven D-Tools“
- The 5 W-Method

Literature:


Theden, P, u.a.: Qualitätstechniken, Werkzeuge zur Problemlösung und ständigen Verbesserung, Pocket Power; Carl Hanser Verlag, München, 1996, ISBN3446186190


DIN: Deutsches Institut für Normung, Sinnbilder und ihre Anwendung; DIN 66001; Beuth Verlag GmbH, Berlin; Dez. 1983, Preisgr. 12


N.N.: http://www.projektmagazin.de/glossar/gl-0727.html?pmSession=; read:
Teamwork

People working together as a team can often accomplish tasks faster than working separately. In certain cases Teamwork is even inevitable. This often makes Teamwork the ultimate goal for many organisations. So called “team building events” are used in attempts to get people to work as a team rather than as individuals.

A further differentiation can be made between Group- and Teamwork. In contrast to Groupwork Teamwork holds common objectives, a strong group coherence, mutual relationship, collective objectives and a strong community spirit within the team. The relation between the members of a group is more lose than by a team.

Group- and Teamwork is an essential part of Quality Management. They are the basis for most methods and tools. A special form of Teamwork is the Quality Circle.

The process of **Teambuilding** is divided into four chronological steps. The specific characteristics of each phase depend on the team members themselves.

The period of time in which the team members get in touch with each other for the first time is called the **Stage of orientation (Forming)**.

During the **Stage of disenchantment** the team members recognize that their prospects concerning work progress and result quality fall below their expectations. The initial team harmony becomes unstable (**Storming**).

In the **Stage of departure** the main topic is to reflect the collaboration and the current situation within the team. Certain rules – the so called **Norms** – are set up and seen as binding for upcoming work (**Norming**).

Positive experiences that were made during the **Norming** are transferred to the **Stage of achievement (Performing)**.
A Quality Circle is a team composed of five to twelve standard employees who meet regularly to discuss improvements for their own workplace. The meetings will be guided and moderated by a colleague or team leader. The meetings will be scheduled weekly for one or two hours. During those meetings weak points or problems, often quality assurance items, specified by team members, will be discussed and systematically investigated. Realisation of solutions and suggestions for improvements will be started after acknowledgement and permission from the management. Realisation and controlling is done by the quality circle.
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Teamwork and quality circle
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  - The „Seven K-Tools“
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  - The „Seven M-Tools“
  - The „Seven D-Tools“
  - The 5 W-Method
Creativity techniques - Tools of Teamwork

**Brainstorming** is a method to generate ideas. Basic rules such as -no idea is a bad idea- are typical. During the first phase (creative phase) new ideas, thoughts and associations will be made by the team members referring to a special question. Any evaluation of the ideas during the process is forbidden. Benefit of brainstorming is the ability of deriving ideas from the ideas of others. In the second phase (evaluation phase) the ideas will be sorted, structured and evaluated.

**Brainwriting** is particularly useful with a group of people who are somewhat incommunicative and would be uncomfortable offering ideas in an open group session such as Brainstorming. It is also useful when everyone has different problems that they want to solve. It also works well with large groups – because there is no real limit to the group size.

The **Osborn-checklist** includes nine standards to work creatively with already known and developed ideas and problem solutions. Standard examples are: Copy (to search for something similar), Scale up (to add something) or Scale down (to leave s.th. out)
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Brainstorming, Brainwriting and Osborn-Checklist

- The „Seven K-Tools“
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Seven K-Tools

Mind-Mapping

A mind map is a generic term used to describe a pictorial representation of a semantic network or cognitive map. The form of the map can involve colour or monochrome images, words and lines and can be arranged intuitively according to the arrangement of concepts in the mind or organized into groups, branches or areas.

Visual Sinectics

The work with pictures activates the right brain hemisphere. After defining the problem, the participants examine certain pictures to find solutions for the problem.

Sinectics-meeting

The problem will be solved by transferring external structures to the problem. The origin of external structures can lie in the personal experience of the participants or in the nature.

Morphologic box

The problem will be divided into smaller problems. Afterwards possible solutions for those smaller problems are searched. By combining them, the overall problem can be solved.

Progressive abstraction

The definition of the problem is checked with the question: „What is really essential?“. This way every possible upcoming solution is checked again to enhance new thoughts.

Controversial term analysis

After the definition of the problem, words are found, which do not refer to the problem. By building a relation between these words and the problem, solutions...
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Teamwork and quality circle
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The „Seven D-Tools“
The 5 W-Method
Seven Q-Tools

The Seven Q-Tools are a set of basic quality tools to support processes of problem solving. They are used for the registration and the analysis of failures.

In the phase of failure registration, tools like the tally sheet, the histogram and the control chart are used to get information about types, location and frequency of failures and to visualize them.

In the phase of failure analysis the Pareto Analysis, cause-effect diagram, correlation diagram and process diagram are used. They allow statements about the importance, the cause and the interdependency between failure effects and the order of complex process flows.
# The „Seven Q-Tools“ - Tally Sheet

<table>
<thead>
<tr>
<th>Failure</th>
<th>Frequency</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

**Product:**

**Date:**

**Tester:**

Tally Sheet

With the aid of tally sheets frequent reappearing failures can be recognized easily and the character and frequency can be represented in a clear form. In that way a preparation of an explicit failure catalogue is possible.

Besides failure types also classes for measured values can be documented in a clearly arranged way. Later on those classes can be used to visualize the distribution of the measured values in a histogram (see next page).

**Procedure:**

First the problem, which will be analyzed, has to be determined. Afterwards the possible types of errors are listed one below the other – sorted by specified criteria. It is advisable to leave some lines open for unpredictable failures. Now failures concerning the analyzed object can be listed and tallied in the according line.
Histogram

With a histogram, collected data can be displayed graphically sorted by classes. Types of classes are failure types or a range of measured values. The classes are displayed as columns, whereas the height of the column corresponds to the classes’ value. Frequency allocations and thereby derived legalities can be visualized easily that way.

Procedure:

A list of determined single dates is the basis for the histogram. The amount of displayed classes is $k$ can be derived from $n$, it has to be rounded up. The difference $R$ of the highest value $x_{\text{max}}$ and the lowest value $x_{\text{min}}$ of the total number of determined dates $n$ is determined. The class width is calculated by $H=\frac{R}{k}$.
In the following list values of sprayed lacquer portion for an assembly are displayed. First create a tally sheet, as it can be used for a histogram. Then draw the histogram based on the tally sheet.

<table>
<thead>
<tr>
<th>Lacquer: X5Z-Y8</th>
<th>colour: silver</th>
<th>number: 20</th>
<th>employee: Le Grand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo</td>
<td>1.25</td>
<td>1.42</td>
<td>1.27</td>
</tr>
<tr>
<td>Tu</td>
<td>1.44</td>
<td>1.35</td>
<td>1.31</td>
</tr>
<tr>
<td>We</td>
<td>1.32</td>
<td>1.30</td>
<td>1.45</td>
</tr>
<tr>
<td>Th</td>
<td>1.18</td>
<td>1.19</td>
<td>1.33</td>
</tr>
<tr>
<td>Fr</td>
<td>1.33</td>
<td>1.29</td>
<td>1.43</td>
</tr>
</tbody>
</table>

**Product:** Fender W124  
**date:** 2004/06/01
The „Seven Q-Tools“ - Histogram
The „Seven Q-Tools“ – Tally Sheet/ Histogram – Model Solution

<table>
<thead>
<tr>
<th>Product: Fender W124</th>
<th>date: 2004/06/01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lacquer: X5Z-Y8</td>
<td>colour: silver</td>
</tr>
<tr>
<td>number: 20</td>
<td>employee: Le Grand</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>9:00 a.m.</th>
<th>11:00 a.m.</th>
<th>2:00 p.m.</th>
<th>4:00 p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo</td>
<td>1.25</td>
<td>1.42</td>
<td>1.27</td>
<td>1.30</td>
</tr>
<tr>
<td>Tu</td>
<td>1.44</td>
<td>1.35</td>
<td>1.31</td>
<td>1.25</td>
</tr>
<tr>
<td>We</td>
<td>1.32</td>
<td>1.30</td>
<td>1.45</td>
<td>1.39</td>
</tr>
<tr>
<td>Th</td>
<td>1.18</td>
<td>1.19</td>
<td>1.33</td>
<td>1.31</td>
</tr>
<tr>
<td>Fr</td>
<td>1.33</td>
<td>1.29</td>
<td>1.43</td>
<td>1.26</td>
</tr>
</tbody>
</table>

\[ R = x_{\text{max}} - x_{\text{min}} \]
\[ R = 1.45 - 1.18 \]
\[ R = 0.27 \]
\[ k = \sqrt{n} \]
\[ k = \sqrt{20} \]
\[ k = 4.47 \]
\[ \Rightarrow k = 5 \]
\[ H = \frac{R}{k} \]
\[ H = \frac{0.27}{5} \]
\[ H = 0.054 \]

Range | Quantity | Class
--- | --- | ---
1.18 – 1.234 | 2 | A
1.234 – 1.288 | 4 | B
1.288 – 1.342 | 8 | C
1.342 – 1.396 | 2 | D
1.396 – 1.45 | 4 | E
The „Seven Q-Tools“ - Tally Sheet/ Histogram – Model Solution

\[ n = 20 \]
\[ x_{\text{min}} = 1,18 \]
\[ x_{\text{max}} = 1,45 \]
\[ R = 0,27 \]
\[ k = \sqrt{20} = 4,47 = 5 \]
\[ H = \frac{0,27}{5} = 0,054 \]

<table>
<thead>
<tr>
<th>Range</th>
<th>Quantity</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,18 – 1,234</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>1,235 – 1,288</td>
<td>4</td>
<td>B</td>
</tr>
<tr>
<td>1,289 – 1,342</td>
<td>8</td>
<td>C</td>
</tr>
<tr>
<td>1,343 – 1,396</td>
<td>2</td>
<td>D</td>
</tr>
<tr>
<td>1,397 – 1,45</td>
<td>4</td>
<td>E</td>
</tr>
</tbody>
</table>
After creating a histogram the trend can be interpreted. For this several types of allocation can be used (see diagram) so that problems within the process can be identified. If a mixed allocation occurs two single processes might overlay each other. The reason for this can be e.g. a shift change or the use of a new tool according to abrasion after a certain period of time. If abnormalities are discovered in a histogram a time analysis has to be done to point out the reasons for data layering. Further problems can be:

1. Bell shaped:
   - Symmetric, data appears to be distributed normally
   - Analysis of the time course necessary → is a systematic deflection recognizable?

2. Two peaks / rectangle distribution:
   - Trend process or measuring with different operating conditions
   - Analysis of the time course necessary → search for factors concerning data layering

3. Two or more runaways:
   - Special cause or measuring fault
   - Identify cause → if measuring fault: exclude result
4. One-sided steep:
   - Attribute is not normally distributed
   - Search for a suitable distribution and use of data transformation
   - No usage of methods that demand a normal distribution

5. Large frequency of one top value
   - Measuring device cannot collect the whole range or data was not collected regularly above a certain border
   - Optimize measuring system, overcome “timidity” concerning “bad data“ recording

6. Large frequency of a certain value
   - Damaged measuring device, hard to read or inspector tends to certain values
   - Optimize measuring system
Pareto-Analysis

The Pareto-Analysis is used to display failures weighted by their frequency. The principle of the Pareto-Analysis shows that the most eminent effects of a problem can be reduced to a small number of causes. The Pareto-Analysis is displayed by columns, which sort the importance of a call for action for problem-solving.

**Procedure:**

After listing possible production failures and their frequencies, the number of occurring failures and their percentaged frequencies are listed in a chart. Then the possible failures are stated in a diagram, sorted by their frequencies – beginning with the most often occurring failure. Optionally a sum-curve, that accumulates – beginning on the left side – the percentage frequencies of occurring failures can be added for clarification.
The „Seven Q-Tools“ - Exercise to Pareto-Analysis

<table>
<thead>
<tr>
<th>Failure</th>
<th>Mo</th>
<th>Tue</th>
<th>We</th>
<th>Thu</th>
<th>Fr</th>
<th>Sum</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above upper tolerance</td>
<td>A</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Below under tolerance</td>
<td>B</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Missing screw</td>
<td>C</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Edges not completely trimmed</td>
<td>D</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Lacquer failure on the surface</td>
<td>E</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Exercise to Pareto-Analysis

Above a list of failures from a housing cover bracket is shown, that has been created within a week. Please create a Pareto diagram that refers to this chart.
The „Seven Q-Tools“ - Pareto-Diagram

- Quantity
  - 50
  - 40
  - 30
  - 20
  - 10
- Failure type (class)
  - 100
  - 80
  - 60
  - 40
  - 20

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The chart shown above and the faults that occurred in a production during one week are given. Only the frequency of failures is taken into consideration, but not the costs resulting from them.

**Procedure:**

A Pareto-Analysis can be done by hand. Failures and their sums are plotted into a prepared diagram (see next page). It starts with the highest value. The single percent share of each failure of the total failure sum is calculated. The accumulated shares are also calculated and plotted into the diagram by using a sum-curve.
The „Seven Q-Tools“ - Pareto-Analysis – Model Solution

<table>
<thead>
<tr>
<th>Failure Types (Class)</th>
<th>Quantity</th>
<th>Percent, added up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above upper tolerance</td>
<td>32</td>
<td>36,0 %</td>
</tr>
<tr>
<td>Below under tolerance</td>
<td>22</td>
<td>20,0 %</td>
</tr>
<tr>
<td>Missing screw</td>
<td>14</td>
<td>17,0 %</td>
</tr>
<tr>
<td>Edges not completely trimmed</td>
<td>13</td>
<td>16,0 %</td>
</tr>
<tr>
<td>Lacquer failure on the surface</td>
<td>8</td>
<td>9,0 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Day</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sum</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>13.0</td>
<td>14.8</td>
</tr>
<tr>
<td>Tu</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>8.0</td>
<td>9.0</td>
</tr>
<tr>
<td>We</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>32.0</td>
<td>36.0</td>
</tr>
<tr>
<td>Th</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>22.0</td>
<td>24.7</td>
</tr>
<tr>
<td>Fr</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>14.0</td>
<td>15.7</td>
</tr>
<tr>
<td>Sum</td>
<td>32</td>
<td>22</td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>146</td>
<td>100.0</td>
</tr>
</tbody>
</table>

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Another possibility to create a Pareto-Analysis is to use certain software tools. The figure above shows the procedure with the help of Minitab®. The Analysis indicates that missing screws form the largest failure class. Accordingly those faults should be eliminated first.

Annotation:
A Pareto-Analysis has to be evaluated carefully. It only provides an approach of rating faults. In this example the most frequent faults are observed without looking at the costs. If faults and costs are multiplied with each other a new Pareto-chart is generated and again it has to be evaluated carefully.
If the analysis creates some sort of flat chart, which means that one bar does not exceed above the other one significantly, an appropriate sequence of types of failures can't be created. So another possibility of categorizing the collected data has to be found. Therefore the category with the highest difference in fault frequency is taken.
The „Seven Q-Tools“ - Cause-Effect-Diagram

The Cause-Effect diagram – also known as Ishikawa-diagram – fractionises a problem into its possible causes. Doing this a cause can be fractionised in main and auxiliary causes. Finally all causes merge together and result in an effect.

Procedure:
First of all categories for the possible causes have to be defined. Usually these causes can be allocated to the “7M” (not necessarily). These causes are being applied above arrows, which show to the problem via a main arrow. Afterwards causes are collected e.g. by brainstorming and assigned to the categories. Each cause is applied to one new arrow. For solving the problem it is important to choose an adequate branching factor.
The „Seven Q-Tools“ - Exercise to the Cause-Effect Diagram

A laser printer provides a poor printing quality. Possible reasons could be:
- wrong printer settings at the printer
- low toner status
- defect heating element
- dirty transport rolls
- poor paper quality
- machine is overloaded
- wrong toner type
- printer options are wrong at the pc
- fixer is too old

Create the Ishikawa diagram and sort these reasons by the categories man, material, method and machine.
The „Seven Q-Tools“ - Cause-Effect-Diagram – Model Solution

Bad print results

- Poor paper quality
- Wrong toner type
- Fixer is too old
- Dirty rolls
- Defect heating element

Man

- Wrong settings at printer
- Wrong print options at the pc

Material

- Machine is overloaded
- Low toner status

Method

- Machine

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Correlation Diagram

The correlation diagram is used to display data pairs. In a diagram they are displayed as dots. A statistical correlation can be made from the pattern of these dots.

Procedure:

After having determined at least 30 data pairs (better 50 – 100) they are registered in a X-Y-coordinate system. The X-axis refers to attribute 1, the Y-axis refers to attribute 2. If data pairs appear repeatedly, they are assigned with numbers of circles according to their frequencies. Then a straight line has to be drawn through the dot accumulation. If a dot is positioned near to the straight line we talk about a strong correlation, otherwise of a weak correlation. If the drawn dots appear as scatter plot there is no correlation at all. If the value of attribute 2 grows as while increasing attribute 1 we talk about a positive correlation, otherwise about a negative correlation.

To calculate the connection between the correlation the Pearson’s correlation coefficient can be used. An approximate value can be calculated by drawing a eclipse over the plot and then calculate the axes ratio (r).
The „Seven Q-Tools“ – Correlation Diagram - Examples

Example **positive Correlation** \((r>0)\):
- The more food, the fatter the cow

Example **negative Correlation** \((r<0)\):
- increasing sales of umbrellas, decreasing sales of sun cream

The value of the correlation coefficient is between -1 and 1:
\[-1 \leq r \leq 1\]
The value of \(r\) can be:
\(|r| = 1\): Complete explanation, so a complete correlation is given.
The „Seven Q-Tools“ – Correlation Diagram - Anmerkungen

In contrast to the proportionality, the correlation is only a stochastic connection.

Example no Correlation (r=0)

But: Be careful with „fake-correlationen“

The results have to be evaluated carefully!

r=0: No existing correlation, the two characteristics have no linear interdependency.

Beware of „fake-correlation“:

There can be a mathematic correlation between the decline of the number of the storks in the Burgenland and the decline of newborns.

Of course, logically speaking, these incidents are not linked.

In contrast to proportionality the correlation is just a random combination. It is only possible to predict an approximate increase or decline:

A 200% increase of the cattle feed amount may cause a weight gain of about 10% or 20%.

With a constant acceleration a duplication of the hammer weight always causes a doubling of the force. Here a proportional context is given.
A table with collected data from Switzerland, covering the years from 1993-2003, is given:
- Diesel price in SFr.
- GDP in billion SFr.

The interdependency of these characteristics shall be determined with the help of a correlation diagram.

**Procedure:**
1. Calculate the mean value
2. Calculate covariances
3. Calculate variance
4. Calculate standard deviation
5. Calculate correlation \( r \)
6. Verification of the statistical statement

**Interpretation:**
An increase of the GDP correlates with an increase of diesel price.
A larger sample would probably lead to a more definite result.
The correlation diagram shows that a GDP increase is associated with an increase of the diesel price.
The diagram is especially useful for displaying possible non-linear correlations.
Types of Control Charts - Variable Attributes

<table>
<thead>
<tr>
<th>Variable Attributes</th>
<th>Small Control Sample Size with Median, normally 3 or 5 pieces</th>
<th>Great Control Sample Size, normally more than 10 pieces</th>
<th>Small Control Sample Size, normally 3 or 5 pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median/range</td>
<td>X/R-card</td>
<td>X/s-card</td>
<td>X/R-card</td>
</tr>
<tr>
<td>Mean Value/Standard-Div</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Control Chart

The control chart is a graphical tool to clarify possible existing variations of quality characteristics. The quality characteristics are listed in a variable mode (e.g. length) or as attributive characteristics (good/bad) – depending upon the type of control chart – against the time. To detect non-coincidental occurrences there is a certain number of test criteria. Three of them are described exemplarily.
Attributive attributes

Qualitative attributes are considered if it is too expensive to consider variable attributes. The controlled samples will therefore be divided into "incorrect" and "correct".
Quality Control Charts

- Mean value: $\bar{X}$

- Range (variance): S

- Median: $\tilde{X}$

- Range: R

- Median / Original value: $\tilde{X}, X_1$
Procedure:
The upper and lower tolerance limit and action control limit are plotted against the
Y-axis. The action control limit value is calculated by a formula depending on the
control chart type. Then the measured quality characteristics are listed against the
time and connected by lines. If some values exceed the action control limit there
are systematic failures in the production line. Measures have to be taken to
eliminate them.
Process Diagram

Process diagrams originally come from the information processing and serve the clear, graphical description of tasks. Their function is to display complex actions in a simple and logical way. Thus a complicated description can be spared.

The DIN 66001 gives information about notations of data flow plans etc.

Procedure:

To draw a process, information given by the preceding to the subsequent processes is necessary. In columns left and right to the process drawing the responsible employees, the necessary instruments and used methods, the exhibits and process results as well as information about the work implementations are associated. Depending on the range of the needed information it can be referred to a work instruction.
Content

Teamwork and quality circle
Brainstorming, Brainwriting and Osborn-Checklist
The „Seven K-Tools“
The „Seven Q-Tools“
■ The „Seven M-Tools“
The „Seven D-Tools“
The 5 W-Method
Seven M-Tools

The Seven Management Tools, also called the Seven New Management and Planning Tools are a branch of methods to illustrate a problem solving process through the breakdown of information.

In contrast to the „Seven Q-Tools“ their aim is to sort a huge amount of (most likely verbal) information.

These Tools can be used in the planning and research phase.

The Seven M-Tools support the problem recognition, the finding and evaluation of solutions as well as their realisation.
Affinity Diagram

The Affinity Diagram organizes a large number of ideas under certain topics and titles. It is possible to find unknown and unrealised ideas and interdependencies within a topic and to identify and work out new approaches to solve a problem.

When to Use:
- When you are confronted with many facts or ideas in an apparent chaos
- When issues seem too large and complex to grasp
- When group consensus is necessary

Procedure:
The theme is being described in an understandable sentence.

Randomly spread notes on a large work surface so all notes are visible to everyone. Look for ideas that seem to be related in some way. Place them side by side. Repeat this until all notes are grouped. It's okay to have “loners” that don’t seem to fit in a group. Combine groups into “super groups” if appropriate.
The „Seven M-Tools“ – Exercise to Affinity Diagram

A bicycle courier is very successful.

Reasons are amongst others:

- carefulness with sending
- simple payment
- appropriate price
- small queue time
- transport insured
- fast order acceptance
- telephonic availability
- fair billing
- adequate amount of drivers
- small transport time
- long trading hours
- no loss of sending

Arrange the reasons and name the categories.
The „Seven M-Tools“ – Affinity Diagram – Model Solution

What represents a successful bicycle courier?

- Fast transport
- Fast order acceptance
- Small transport time
- Small queue time
- Pricing
- Appropriate price
- Simple payment
- Fair billing

- Absolute reliability
- No loss of sending
- Transport insured
- Carefulness with sending
- High availability
- Adequate amount of drivers
- Long trading hours
- Telephonic availability

- Fast transport
- Fast order acceptance
- Small transport time
- Small queue time
- Pricing
- Appropriate price
- Simple payment
- Fair billing

- Absolute reliability
- No loss of sending
- Transport insured
- Carefulness with sending
- High availability
- Adequate amount of drivers
- Long trading hours
- Telephonic availability

- Fast transport
- Fast order acceptance
- Small transport time
- Small queue time
- Pricing
- Appropriate price
- Simple payment
- Fair billing

- Absolute reliability
- No loss of sending
- Transport insured
- Carefulness with sending
- High availability
- Adequate amount of drivers
- Long trading hours
- Telephonic availability

- Fast transport
- Fast order acceptance
- Small transport time
- Small queue time
- Pricing
- Appropriate price
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- Fair billing

- Absolute reliability
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- Fast order acceptance
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- Absolute reliability
- No loss of sending
- Transport insured
- Carefulness with sending
- High availability
- Adequate amount of drivers
- Long trading hours
- Telephonic availability
The Relations Diagram shows cause-and-effect relationships. Just as importantly, the process of creating a relations diagram helps a group analyze the natural links between different aspects of a complex situation.

**Procedure:**

Write a statement defining the issue that the relations diagram will explore. Write it on a card or sticky note and place it at the top of the work surface.

Brainstorm ideas about the issue and write them on cards or notes.

For each idea, ask, “Does this idea cause or influence any other idea?”

Draw arrows from each idea to the ones it causes or influences. Repeat the question for every idea.

Analyze the diagram:

Count the arrows in and out for each idea. Write the counts at the bottom of each box. The ones with the most arrows are the key ideas.

Note which ideas have primarily outgoing (from) arrows. These are basic causes.

Note which ideas have primarily incoming (to) arrows. These are final effects that also may be critical to address.

Draw bold lines around the key ideas.
The „Seven M-Tools“ – Relations Diagram - Example

Define goals

Successful use of M7

Building an launch team

Support by upper management

Further education

main cause

Information material

Increase knowledge of employees

Take away employees fear

main effect

Define goals

Successful use of M7

Building an launch team

Support by upper management

Further education

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The "Seven M-Tools" – Relations Diagram – Exemplary Solution

- Support by upper management
  - Main cause
  - Main effect

- Define goals
  - Individual aspect
  - Hin / Weg

- Successful use of M7
  - Further education
  - Information material
  - Increase knowledge of employees

- Building an launch team
  - Take away employees fear

- 0/3
- 3/3
- 6/0
- 1/3
- 3/1
- 0/3
- 2/1
- 2/1

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The „Seven M-Tools“ - Portfolio

Portfolio
In a Portfolio many objects are being contrasted. The objects are evaluated in two dimensions. Through this illustration possible developments and objectives can be derived.

Procedure:
Firstly all objectives which should be compared have to be defined.
After this choice two criteria have to be defined which evaluate the objectives. For those the units as well as the way of calculation have to be specified.
There is the possibility to draw a third criterion into the Portfolio with the help of differing the symbol size in the portfolio.
The „Seven M-Tools“ - Portfolio - Example

A-G: competitors
1: status of own company
2: aspired status of own company

The size of the circle shows the sales volume of each company.
Matrix Diagram

The Matrix Diagram shows the relationship between two, three or four groups of information. It also can give information about the relationship, such as its strength, the roles played by various individuals or measurements.

**Procedure:**

At first it has to be defined which dimensions of a theme should be compared. Up to 4 dimensions can be chosen.

Each dimension is described through individual attributes. These can be gathered with the help of Brainstorming or Tree Diagrams.

Each cell shows a possible relationship between two attributes. For each it has to be checked, if a relation exists.
### The „Seven M-Tools“ – Matrix Diagram in T-Form - Example

<table>
<thead>
<tr>
<th>Aims</th>
<th>Functional Area</th>
<th>Quality-Techniques</th>
<th>QFD</th>
<th>FMEA</th>
<th>SPC</th>
<th>DOE</th>
<th>Q7</th>
<th>M7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fulfillment of customer requirements</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of possible failures in the forefront</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled procedure to abolish failures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement of documentation</td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality Control</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Quality Function Deployment (QFD)**

**Failure Mode and Effects Analysis (FMEA)**

**Statistical Process Control (SPC)**

**Design of Experiments (DOE)**

**Q7: seven quality tools**

**M7: seven management tools**

- **Weak**
- **Middle**
- **Strong**

- **Cooperation**
- **Information**
- **Implementation**
- **Responsibility**

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The „Seven M-Tools“ – Tree Diagram

Tree Diagram

The Tree Diagram starts with one item that branches into two or more, each of which branches into two or more, and so on. Afterwards it looks like a tree, with trunk and multiple branches.

It is used to break down broad categories into finer and finer levels of detail. Developing the tree diagram helps to move the thinking step by step from generalities to specifics.

Procedure:

Develop a statement of the goal, project, plan, problem or whatever is being studied. Write it at the top (for a vertical tree) or far left (for a horizontal tree) of your work surface.

Ask a question that will lead you to the next level of detail.

Brainstorm all possible answers.

Show links between the tiers with arrows.
The „Seven M-Tools“ – Tree Diagram - Example

Possible oppositions against introduction of group work

- motivation barrier
  - lack of social competence
  - comfort
  - lost of image
  - for of loosing the workplace
  - lack of professional competence

- skill barrier
**The „Seven M-Tools“ – Network Diagram**

The Network 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. The network diagram lets you calculate the “critical path” of the project. This is the flow of critical steps where delays will affect the timing of the entire project and where addition of resources can speed up the project.

**Procedure:**

List all the necessary tasks in the project or process.

In the first step all tasks which can happen at the beginning of the project, without finishing another task, are identified. These are placed one below the other next to the project start.

In the following step all tasks are detected which can start when the previous and already pinned tasks are finished.

This step is repeated until all tasks are placed.

In the next step two tasks are linked, when one task can only start when the other one has ended.

**Calculation:**

\[ ES = EF - \text{length} \]
\[ LS = LF - \text{length} \]
The „Seven M-Tools“ – Exercise to Network Diagram

Develop a Networking Plan with the help of the information given in the table!
Which activities are on the critical path?

<table>
<thead>
<tr>
<th>activity</th>
<th>description</th>
<th>length</th>
<th>predecessor</th>
<th>successor</th>
</tr>
</thead>
<tbody>
<tr>
<td>turn a shaft</td>
<td>turning</td>
<td>5</td>
<td>-</td>
<td>S-harden</td>
</tr>
<tr>
<td>Milling a gear-wheel</td>
<td>milling</td>
<td>7</td>
<td>-</td>
<td>Z-Härten</td>
</tr>
<tr>
<td>found the housing</td>
<td>founding</td>
<td>3</td>
<td>-</td>
<td>grinding</td>
</tr>
<tr>
<td>harden the shaft</td>
<td>S-harden</td>
<td>10</td>
<td>turning</td>
<td>sub assembly</td>
</tr>
<tr>
<td>harden the gear wheel</td>
<td>C-harden</td>
<td>11</td>
<td>milling</td>
<td>sub assembly</td>
</tr>
<tr>
<td>grinding the housing</td>
<td>grinding</td>
<td>5</td>
<td>founding</td>
<td>final assembly</td>
</tr>
<tr>
<td>install shaft and</td>
<td>sub assembly</td>
<td>8</td>
<td>S-harden,</td>
<td>final assembly</td>
</tr>
<tr>
<td>gear-wheel</td>
<td></td>
<td></td>
<td>C-harden</td>
<td></td>
</tr>
<tr>
<td>Final housing</td>
<td>Final assembly</td>
<td>5</td>
<td>grinding,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sub assembly</td>
<td></td>
</tr>
</tbody>
</table>

Calculate the earliest times each task can start and finish, based on how long preceding tasks last. These are called earliest start (ES) and earliest finish (EF). Start with the first task, where ES = 0, and work forward.

For each task:

Earliest start (ES) = the largest EF of the tasks leading into this one

Earliest finish (EF) = ES + task time for this task

Calculate the latest times each task can start and finish without upsetting the project schedule, based on how long later tasks will last. These are called latest start (LS) and latest finish (LF). Start from the last task, where the latest finish is the project deadline, and work backwards.

Latest finish (LF) = the smallest LS of all tasks immediately following this one

Latest start (LS) = LF – task time for this task

With the help of the critical path analysis shortages can be avoided.
The „Seven M-Tools“ – Network Diagram
The „Seven M-Tools“ – Network Diagram – Model Solution

Start

- Turning: 5 (0, 5, 3, 8)
- Milling: 7 (0, 7)
- Founding: 3 (0, 3, 18, 21)

S-Harden: 10 (5, 15, 8, 18)
- C-Harden: 11 (7, 18)
- Grinding: 5 (3, 8, 21, 26)
- Final Assembly: 5 (26, 31)
- Sub Assembly: 8 (18, 18, 26)

Ende

Critical path.
The „Seven M-Tools“ – PDPC - Process Decision Program Chart

The Process Decision Program chart systematically identifies what might go wrong in a plan under development. Counter measures are developed to prevent or offset those problems. By using PDPC, you can either revise the plan to avoid the problems or be ready with the best response when a problem occurs.

**Procedure:**

Obtain or develop a tree diagram of the proposed plan. This should be a high-level diagram showing the objective, a second level of resources and a third level of broadly defined tasks to accomplish the resources.

For each task on the third level, brainstorm what could go wrong.

Review all the potential problems and eliminate any that are improbable or whose consequences would be insignificant. Show the problems as a fourth level linked to the tasks.

For each potential problem, brainstorm possible counter measures. These might be actions or changes to the plan that would prevent the problem, or actions that would remedy it once it occurred. Show the countermeasures as a fifth level, outlined in clouds or jagged lines.

Decide how practical each counter measure is. Use criteria such as cost, time required, ease of implementation and effectiveness.
The „Seven M-Tools“ – Problem Decision Diagram - Example

- **shipment process**
  - shipment request received
  - shipment request is processed
  - Compile goods for shipping

  + wrong product chosen
    - automatic combination
  + wrong amount of products
    - double count
  + defect products chosen
    - clear mark of defect products
    - separate storage of defect products

- Compile goods for shipping
- wrong product chosen
- wrong amount of products
- defect products chosen
Content

Teamwork and quality circle
Brainstorming, Brainwriting and Osborn-Checklist
The „Seven K-Tools“
The „Seven Q-Tools“
The „Seven M-Tools“

The „Seven D-Tools“
The 5 W-Method
Seven D-Tools

Services feature themselves by a number of specific characteristics. They are immaterial (not sizable), integrative (the customer is always connected to a service), indivisible (production and consumption happen simultaneously) and fading (not superposable). To create more efficient and customer-oriented services a list of quality techniques is provided. They are summarized by the so-called „Seven D-Tools“.
### The „Seven D-Tools“ – Vignette technique

Vignette-Technique

Scenarios (Vignettes) of new services are created systematically and introduced to a certain customer group. With them the actual customer requirements can be determined and checked.

**Procedure:**

After setting up an idea and a target group, several criteria are determined and evaluated by the help of a preliminary interview. Afterwards the single parameter values are displayed in a Morphological Box, from which different Vignettes can be combined. The Vignettes are presented pair wise to the target group for rating them. The favoured one receives two, the other Vignette zero points. In case of a draw each Vignette receives one point. After several interviews some trends can be anticipated.
Service Blueprinting

Being some kind of workflow diagram the blueprint is used for visualizing the sequence of a certain service.

Procedure:
With the help of a Brainstorming certain activities referring to the customer are focused. After that the sequence of those activities is plotted.
Sequential Approach

The Sequential Approach focuses the spots of contact, that were created during the Blueprinting, from a qualitative point of view. This works in a sequential way which means along the process of the service delivery.

Procedure:
The customer has got the opportunity to express positive or negative experiences concerning the single contact spots. The information is classified along a single path and compared to further customer information. During an evaluation the single statements are displayed below the sequence of services to visualize problems.
### The „Seven D-Tools“ – ServQual

<table>
<thead>
<tr>
<th>Dimension</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>reliability</td>
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<td></td>
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<td>2</td>
<td>2.55</td>
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<td>2</td>
<td>6</td>
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<td>8</td>
<td>7</td>
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<td>2.66</td>
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<td>interest to satisfy requirements</td>
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<td>13</td>
<td>11</td>
<td>3</td>
<td>2</td>
<td>2.7</td>
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<tr>
<td>cooperation</td>
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<td></td>
<td></td>
<td></td>
<td>4</td>
<td>3.03</td>
<td></td>
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<tr>
<td>explanation of admission procedure</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>13</td>
<td>3</td>
<td>3.13</td>
<td></td>
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<tr>
<td>employees were not to busy</td>
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<td>5</td>
<td>11</td>
<td>9</td>
<td>1</td>
<td>2.93</td>
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<td>sovereignty</td>
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<td></td>
<td>7</td>
<td>2.28</td>
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<td>4</td>
<td>0</td>
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<td></td>
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<tr>
<td>safe transactions</td>
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<td>4</td>
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<td>0</td>
<td>2.93</td>
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<td>5</td>
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<td>individual attention</td>
<td>5</td>
<td>10</td>
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<td>7</td>
<td>1</td>
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<td>material environment</td>
<td></td>
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<td>ZPA attracts attention</td>
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<td>0</td>
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<td>16</td>
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<td>judgement</td>
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<td>10</td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>2.55</td>
<td></td>
</tr>
</tbody>
</table>

**ServQual**

ServQual is put together by the words „service“ and „quality“. With the help of a questionnaire the strengths and failings of a company are collected.

**Procedure:**

The 22 questions have to be modified for each single company. The customer has to rate those questions by following a given pattern.
Service FMEA

The Service FMEA includes an Analysis of potential failures, a risk evaluation, measures, suggested solutions as well as an evaluation.
Frequency-Relevance-Analysis

The *Frequency-Relevance-Analysis* displays the frequency and the relevance of problems that were determined e.g. during ServQual.

*Procedure:*

The detected problems are rated by the customer with the help of a questionnaire. Afterwards the results are illustrated in a portfolio. The further a problem occurs to the upper left, the more immediately it has to be solved.
The „Seven D-Tools“ – Complaint Blueprint

Complaint Blueprint

The complaint management offers the opportunity to learn and grow from criticism.
Content

Teamwork and quality circle
Brainstorming, Brainwriting and Osborn-Checklist
The „Seven K-Tools“
The „Seven Q-Tools“
The „Seven M-Tools“
The „Seven D-Tools“

• The 5 W-Method
The 5W-Method: How can it be used?

The 5W-Method

Applications are at any situation, where it's necessary to understand the failure's origin e.g. during the design of new processes and to optimise existing processes.

Purpose:
- CIP (continuous improvement process) in production and administration
- Planning of new processes
- Problems and issues of any kind
5W-Method- Example – montage of a frame

First W:
Why had there been difficulties during the assembly of the shelf-unit?

Second W:
Why was the wheelhouse at the wrong position?

Third W:
Why was the distance in the appliance faulty adjusted?

Fourth W:
Why did the sub-assembly use the wrong appliance?

Fifth W:
Why are similar devices not well-defined in the sub-assembly?

Answer:
The wheelhouse was at the wrong position!

Answer:
Because the distance in the assembly appliance had been adjusted incorrectly!

Answer:
Because the sub-assembly used the wrong appliance!

Answer:
The sub-assembly can hardly distinguish similar looking appliances!

Answer:
There have been no numbers given by the fixture construction.

Identifying the causal problem – clearing faults!

*Situation:*
During the equipment of a truck, a shelf-unit could not be mounted. The foreman now uses the 5W-Method during a CIP-meeting:

*Problem:*
No possibility to identify fixtures

*Solution:*
Fixture construction assigns fixture numbers to be placed with the work instructions
Anmerkungen zum Format

Small cause – big effect!

Thanks for your attention!