OMM606: Operations Management. Quality

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Purpose of this paper: To clarify and examine quality control, its significance in modern world, its effects, pros and cons, and techniques involved it.

I affirm that enclosed work is entirely my own, except where the words or ideas of other writers are specifically acknowledged.
This assignment has not been submitted for any other courses.

Jukka Reinholm

Reinholm 2000-11-03

Quality

In this assignment I first take in-depth look into quality: what we mean by quality, how it has been defined, what are the costs of good or poor quality, and finally how Hiflex Finland Karhula Business Unit should developed quality and quality policy.

Quality

"Quality is primarily a business problem, not a technical problem" (J.M. Juran).

Quality is not "a brand-new idea" to organisations. But what is new to many organisations is that quality represents a competitive weapon, which enables it to improve performance and competitiveness. Furthermore, it is widely accepted that organisations do not have a choice about whether or not to embark on quality improvement programme; in a long run it is necessary for survival. *"The survival of the industrial company depends on its ability to meet the quality needs of society"* (J.M. Juran).
Of course, according to "quality guru" Dr Edward Demming, there is always a choice: "*Survival is not a necessity, you do not have to do it"*

If members of the public are asked what they understand by the term quality, answers might be something like:
- Value for money
- Durability
- Looks good
- Superior
- Reliability
- Functionality etc. etc.

We may agree that products or services of high quality should have those characteristics. But all those definitions have one major drawback; they are very personal statements. What is superior to one person may be inferior to other.
According to "quality guru" Philip Crosby: *"There is no subjective, aesthetic concept of good quality. Quality is conformance to requirements"*.
Some other widely accepted definitions of quality are:
- Fitness for purpose or use (Juran)
- Product and service characteristics as offered by design, marketing, manufacture, maintenance and service that meet customer expectations (Feigenbaum)
- A product or service's nature or features that reflect capacity to satisfy express or implied statements of needs (Deming)

Professor David Garvin has divided all different views into "five approaches' to quality":
1. The transcendent approach, what view quality as synonymous with innate excellence. According this approach, quality is being defined as the best possible, in terms of product or service's specification.
2. The manufacturing-based approach, what is concerned with making error free products or providing error free services, which conform with theirs design specification.

3. The user-based approach is concerned that the product or service is fit for its use or purpose. (I was once forced to take flight with four stopovers between Hong Kong and Paris. After each stopover they served breakfast in the plane, as quality airlines do in the mornings. But for me this "quality specification" was not appropriate. All I wanted was a good sleep.)
4. The product-based approach, which view quality as a measurable set of characteristics that is required to satisfy the customers.
5. The value-based approach. This approach contends that quality should be perceived in relation to price. An inexpensive watch may offer good value by performing quite satisfactorily for a reasonable time, but some people are ready to pay fortunes for the "quality watch" (for example 25 million USD for Chopard's wristwatch!).

To cover all those approaches under the one definition is impossible, but best reconciled all those views by definition:

Quality is consistent conformance to customers' expectations.

Cost of quality

It is estimated that in the average manufacturing company, the total cost of quality may be as high as 35% of turnover, and in the public sector, as high as 50% of the cost of running the business. Where the best "quality-oriented"-organisations' total quality costs are 5-10% of turnover or the cost of running the business.
Finnish professor Eero E. Karjalainen has estimated that an average Finnish manufacturing company spends 15 per cent of its incomes just to fix errors what they have done!

Cost of quality can be allocated to three major categories:
1. Failure costs. The costs if organisation fails to produce to requirements.
- Price of non-conformance: litigation (or payments to avoid litigation), extra storage costs, penalties, repairs, extra transport, extra material, extra labour, extra administration, scrap, re-work, warranties, lost time to breakdowns, loss of reputation, loss of business etc.
2. Appraisal costs. The costs an organisation incurs checking whether or not it is producing to requirements.
- Price of conformance: quality employees' salaries, documentation costs.
- Price of non-conformance: setting costs, extra inspection costs, costs of down time due to failure.
3. Prevention costs. Money spent on trying to avoid quality problems.
- Price of conformance: audits, education and training, suppliers audits, cost of better materials, extra planning, customer liaison costs, piloting, higher salaries of better employee.

Total quality costs = price of conformance (POC) + price of non-conformance (PONC).

Many organisations traditionally have expected to face quality failures, and have seen attempts to prevent all quality problems impossible, or at least as waste of time and money. They have believed that there is an optimum amount of quality effort to be applied in any situation, which minimises the total cost of quality.

(Thank God, maternity hospitals do not agree that. What would be hospitals' "acceptable quality level"? 3 down dropped babies per 1000 childbirth! If Finnish maternity hospitals do accept same quality level what an average Finnish manufacturing company has today, it would mean 67 down dropped babies per 1000 childbirth!!!)
It is common to those "traditional organisations" that they believe quality can be checked or inspected into the products.
In such organisations prevention costs represent only 5-10% of the total quality costs!
Companies witch fail to focus on quality lose market share, decline in reputation and find them to be in unfavourable situation against competitors.

(Here is a very, very simple "quality inspection" test. It clearly shows why quality can not been inspected afterwards.
Consider the typed text below as a batch, each letter being an item. Consider the letter "F" as a defective item
How many "defective items" are there in the batch?

FINISHED FILES ARE THE RE-
SULT OF YEARS OF SCIENTIF-
IC STUDY COMBINED WITH THE
XPERIENCE OF YEARS.

How many you found? Three? Check again!

In that sentence there are 82 letters (items) of which six are "defective Fs". I.e. "production quality level" is 6/82 = 73 defective items per 1000 been produced. After inspection we have 3/82 = 37 defective items per 1000 been inspected!
Did you check the prepositions "of"?
That's great, if you immediately found all six "defective items". People normally do not.)

Good quality cannot be checked or inspected into the products and services. It must be planned and built in to the processes and in to the methods. Direct operators can only correct 15 per cent of quality problems, the rest 85 per cent are built in the system (or lack of it)
Checking and inspection are contributory elements to quality assurance. They provide information to enable the processes and methods of the quality systems to be evaluated.

According to MD Risto Lintula, Center for Excellence – Finland www.laatukeskus.fi, 99% of quality is done in advance by careful planning.

In manufacturing operations an error, what is made in the basic concept of a product, is relatively inexpensive to correct. Maybe some researching and rethinking is required.
But if the error is not discovered, many other decisions will be made based on the original error. Then to fix the original error can be ten times more expensive.
After the prototype been made, the cost of rethinking designs for the product could be hundred times more expensive than cost of original error discovered at concept stage. After pilot production, the price of the original error may be thousand times more expensive (investments in technologies, job designs, delay in the time to market etc.)
The cost of rectifying error discovered in the market can be extreme high! (cf. costs been occurred in auto industry)

Awareness of high total costs of quality (= price of conformance + price of non-conformance), has forced organisations of all types to review their quality strategies.

Quality activities

"For an organisation to be truly effective, every single part of it, each department, each activity, and each person and each level, must work properly together, because every person and every activity affects and in turn is affected by others" (Muhlemann, A., Oakland, J. and Lockyer, K.. 1992. Production and Operations Management. Pitman Publishing).

Quality activities can be divided to two main components:

1. Managerial activities, which are concerned with:

- Setting quality policies
- Establish quality objectives
- Creating plans to meet quality objectives
- Defining responsibilities
- Select, train and motivate people
- Measure and evaluate results
- Taking needed actions to correct deviations

2. Execution of the quality plan, which is dealing with

- Design the quality aspects of materials and products
- Prepare the quality specifications
- Developing test procedures
- Developing measuring instruments
- Testing products against quality characteristics
- Developing and improving machines' and processes' quality aspects
- Fabricate the quality aspects of the product itself
- Determinate the quality performance of the product during use

Quality people's activities are more concerned with "technical questions of quality" where upper management is concerned of managerial issues of quality. It is in interest of top management (or should be) what impacts a good or poor quality has on the business; costs, share of market, customer relations, return on investments, etc.
Whereas many quality people may be fascinated by techniques or methods, by technical charts or newly invented tools used in quality control, they easily forget the economical side of quality control.
Neither a poor quality nor an exaggerated over-quality is in interest of a business organisation!
The full support, commitment and understanding of the top management are the key factors to success of any quality programs. According studies (Binney, G 1992 et al.) over 90 per sent of quality programmes' failures are caused by lack of top management's support!
Therefore it is important for top management to:

- Understand and believe in link between organisation's business performance and quality
- Understand the practicalities of quality
- Be able to get over the principles and techniques to the employees
- Maintain organisations quality orientation.

UniPoly Hiflex Finland Hydraulic Hose Assembly Quality Program

Hiflex Finland Oy (Inc.)

UniPoly Hiflex Ltd. is a manufacturing company, which produces hydraulic hoses; hydraulic hose-end fittings and ferrules, low pressure plastic and rubber hoses and hose assemblies.
Hiflex Finland is a subsidiary of UniPoly Hiflex Ltd.
Hiflex Finland is responsible for marketing and selling of UniPoly Hiflex products in Finland, Estonia and Russia.
Hiflex Finland's head-office is located in Helsinki. It is responsible for main marketing activities in Finland, Estonia and Russia, administration, data processing, import and export activities and main stockpiling.
Within Finland, 13 Sales offices (Business Units) are responsible for their own area's marketing activities, sales, stockpiling for area's needs and manufacturing of hydraulic hose assemblies to local customers.
Hiflex Finland or its Business Units do not have appointed quality manager(s).

Hydraulic hose assembly manufacturing

Hydraulic hoses', ferrules' and fittings' technical specifications; dimensions, minimum burst pressures, maximum working pressures, elasticity etc, are specified in SAE (USA) or in DIN (Europe) standards. DIN standards exceed SAE standards.
Most manufacturers have documented quality management systems for hose, ferrule and fitting production based on ISO/EN/BS9000 (it is good to bear in mind that being accredited for ISO/EN/BS9000 does not automatically prove products or services of high quality. They are just made as specified in the ISO/EN/BS paperwork).
By using only accredited suppliers, we "in the down stream" know the quality level of the "up stream".
Hydraulic hose assembly is made from hydraulic hose (size, type and length varied), from two ferrules (size and type varied) and from two fittings (size and type varied).
First a hose is cut to desired length, and then ferrules and fittings are pushed to hose's both ends and are swaged to predefined diameter (given by ferrule manufacturers).
Karhula depot produces approximately 280 hose assemblies per day

Quality Policy Statement

In any business a clear policy statement is needed. It guides practices and behaviours essential for quality achievement. It must permeate all levels in organisation.
In Hiflex Finland we do not have written Quality Statement(s)

In Hiflex Finland Karhula Branch:

1. Everyone is responsible for high quality and for continuous quality improvements of our products and services.
2. Branch (depot) manager gives complete commitment and allocates necessary resources to the quality improvement programmes what are initiated.
3. We compare our performance and quality against competitors and against market leaders in other sectors. We adapt best practices to use.
4. Quality processes, methods and controls are implemented in a systematic way across the business. We work in closely partnership with our suppliers, internal or external, to enhance quality in supplier chain.

5. Quality roles and systems are clearly defined and reviewed regularly.
6. Our focus is on "getting it right first time, every time".
7. We have to meet, and exceed the quality needs of our internal or external customers.
8. Education, information and communication are main issues in the implementation of the quality policy.

Quality control of hydraulic hose assembly production

In hydraulic hose assembly production, the purpose of the quality planning and control activity is to ensure that products are made to conform to their specifications.
This quality planning and control can be divided into six steps:

1. Define the quality characteristics
2. Decide how to measure quality characteristics
3. Set quality standards for each characteristics
4. Control quality against those standards
5. Find and correct causes of poor quality
6. Continue to make improvements

1. Define the quality characteristics

Much of what defines quality of a product has been specified in its design. But not all what have specified in design ought to be controlled in its production. Rather it is the consequences of the design specification what are controlled.
In hose assembly production important quality characteristics are:

- Functionally. Hydraulic hose assemblies must correspond to the DIN standards.
- Appearance. Assemblies' appearance should be faultless.

2. Decide how to measure quality characteristics

In order to quality is controllable, the quality characteristics must be somehow measurable. If they are not measurable, the organisation cannot measure the quality level or changes in quality levels over time.
There can be some quality characteristics, which are not measurable. For example shop personnel's willingness to help. Then it may be useful to measure customers' perceptions of sales staff.
There are two types of measure used to describe quality characteristics:
Variables, that measures on a continuously variable scale (diameter, weight, length etc), and attributes, which are assessed by judgement (ok or not ok, works or not works, etc).

Functionality:

- Hose ferrules' outside diameter after swaging.

Appearance:

- No visible gashes or faults in hose's outer surface, no ridges in ferrules, and fittings are straight and right assembled (no expulsions)

3. Set quality standards for each characteristics

In this stage we have to decide standards what against we can measure our performance. Total quality management (TMQ) and many others quality management systems give emphasis to "zero defects" i.e. that the organisation must strive for continuous improvements with long term objectives of achieving zero defects. This perfection could be both demoralizing and expensive. Is our service lousy if one dissatisfied customer has been found among ten thousand satisfied customers? Is hose assembly manufacturing process out of control if one assembly is broken after 4 years use?

The quality standard is that level of quality what defines the boundary between acceptable and unacceptable (of course we do not tolerate any "defects". But first we have to agree some quality levels, which then be improved in the long run. Quality is a journey, not a destination). Objectives must be achievable, realistic and measurable.

- Ferrules' diameter after swaging: Acceptable deviation to ferrule's outside diameter after swaging is +/- 0.1 mm (+/- 0.04") of diameter given by hose ferrule manufacturer (based on DIN tests been made to UniPoly Hiflex hydraulic hose assemblies)
- Faultless external surface: Yes

4. Control quality against those standards

Now we have to ensure our products and services really conform to those quality standards. Our processes may not produce products all the time with same quality; tools or machines may wear, ambient temperature may vary, there may be variation in the materials used etc. In service operations there may be variability in staff behaviour, technical problems etc. To ensure we do things right, first time and every time, key decisions are:

A) Where should the checks been carried out?

Here the key task for operations is to identify the critical control points at which the product, service or process need to be checked. It can be performed:
- At the start of the process. For example acceptance inspection when goods receive.
- During the process. For example before particularly costly part of the process, before a "point of no return", immediately after part of the process with high defective rate etc.
- After the process

In hydraulic hose assembly production, the checks should be carried out:
- Ferrules outside diameter and hose assemblies' appearance should be checked after the process (after the swaging machine).

B) Should every item or service be checked?

In spite it might seem ideal to check every product being produced or service being delivered, this might not been sensible. It can be time consuming and costly. Checking every single item from high-volume plastic moulding machine would be extreme expensive compared to item's price. Destroying every product being produced in destructive tests, for example burst pressure tests for hose assemblies, would be inappropriate. Staff may become fatigued when inspecting repetitive items etc. Therefore a continuing series of random samples may offer useful way to evaluate quality of processes. It is usually sufficient to obtain data about a proportion of the population and use this data to draw conclusions about the whole population

To minimize costs and time of inspections in hydraulic hose assembly production, but to ensure that required quality level is achieved, appropriate sample sizes are:
- Four ferrules' outside diameters of 560 (of 280 hose assemblies).
- 70 hose assemblies' appearance is checked of 280 assemblies.

C) How should checks be performed?

Two most common methods for checking the quality of processes through to samples are: Statistical Process Control (SPC) and Acceptance Sampling.

Acceptance Sampling is not in the scope of this assignment. It is argued that by accepting the inevitability of poor quality, the operation will become lazy at trying to eliminate the

cause of bad quality. Acceptance sampling is more involved to measure output and understand the risks involved, than to get to the root causes of poor quality.
SPC is based on the theory that control of the process will lead to control of the products or services coming out of the process. If samples give reason to believe that there is a problem in the process, then process can be stopped and the problem(s) can be identified and rectified. Furthermore, when the results of many samples over a period of time are recorded and plotted to control charts, the trend of the process can be identified. Not only if the process is going out of control and the necessary steps can be taken before there is a problem, but when the trend is steadily improving, it can be identified to what is happening, and this information can be shared with other parts of the organisations.

Process variations are divided in two categories:

A) Random (or natural) variations. For example material variability, temperature variability, vibration variability, human elements, etc. Variations, which derive from these common causes, can never be entirely eliminated.
B) Assignable (or special) variations. For example process setting changes, broken tooling, different materials, etc

When only random causes are present, the process is said to be in statistical control.
But when an assignable cause or causes are in present, it is said to be out of statistical control.
The key issue is to know if the process is in statistical control or not.

Variation in process

Controlling variables

The two main types of charts are where results are recorded and plotted, Mean control chart and the Range control chart. They are used to describe what the process itself is like: how stable is it, at what level is it working, how close is that level to the target and how much control is needed.

If a continuing series of random samples are taken, and the means of each sample are recorded and plotted, they will follow a normal distribution (if only random causes are presents). This allows statistical theories to be applied to the process.
The probability that a plotted measurement falls outside of the range +/-3 standard deviation (3σ) is 0,0027. If such a plot occurs, it is a reasonable safe assumption that an assignable cause has occurred and that the process is out of statistical control.
To aid the process owner to identify when “out of statistical control” situation has arisen, use is made of “action limits” set at:

$$\overline{X} \pm 3\sigma$$

i.e. the probability that a measurement falls within the action limits is 0,9973.

It is known that:

Sample standard deviation = population standard deviation / $\sqrt{}$ (n)

Action limits are $\overline{X} \pm 3\sigma / \sqrt{(n)}$

It is easier to use the mean range of sample (ϖ) than it to calculate σ and further. It is known that a relationship exists between ϖ and σ

i.e. $\varpi = dn\sigma$ where dn is constant for a given sample size

Since for a given sample size (n), dn, 3σ and $\sqrt{(n)}$ are constant, they can be used as one constant that is called A(0.001), which can be read from tables.

Action limits = $\overline{X}$ +/- A(0.001) x ϖ

Warning limits set at X +/- 2σ (0.95 probability that "out of control" has arisen), also are often in use.

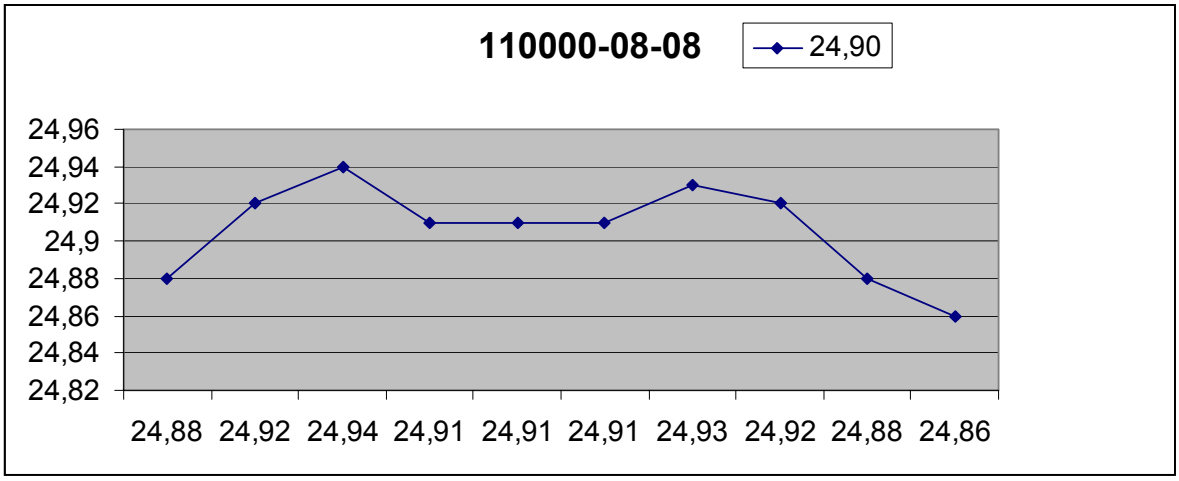
Warning limits $\overline{X}$ +/- A(0.025) x ϖ

A(0.025) can be read from tables (n = 4)

n = 4	A(0.001) = 0.729		Upper	Lower	Upper	Lower	
	A(0.025) = 0.476		action limits	action limits	warning	warning	
			24,94	24,86	24,93	24,88	
	Ferrule's diameter		110000-08-08 (24,90 mm)				
Sample						Sample	Sample
number		1	2	3	4	mean	range
1		24,82	24,87	24,91	24,9	24,88	0,09
2		24,95	24,92	24,87	24,92	24,92	0.08
3		24,97	24,93	24,93	24,91	24,94	0,06
4		24,91	24,93	24,88	24,91	24,91	0,05
5		24,91	24,95	24,9	24,87	24,91	0,08
6		24,89	24,89	24,93	24,91	24,91	0,04
7		24,92	24,95	24,92	24,91	24,93	0,04
8		24,9	24,98	24,89	24,91	24,92	0,09
9		24,92	24,86	24,88	24,84	24,88	0,08
10		24,9	24,83	24,86	24,86	24,86	0,07
					Grande Means	24,90	0,051

Pic 1 Individual diameters of 10 samples of four ferrules

Ten samples of four ferrules are measured and recorded in to sheet (pic1). Red colour indicates sample means hitting or falling out of the control limits. Yellow colour indicates sample means hitting or falling out of warning limits.



Pic2. Control chart for the outside diameter of swaged ferrule

In control chart (pic2) sample means of 10 samples of four ferrules are plotted.
Twice mean hit action limits (24,86 and 24,94) and two times warning limits (24,88).
Control chart indicates that there is a possibility that the process is falling out of statistical control.
Based on this (first ever made in UniPoly Hiflex Finland) Mean Control Chart of hydraulic hose assembly production, I do not recommend the process to be stopped at the moment.
The process is still within its limits.
But I strongly recommend sample sizes to be changed to 2 samples of 100 (of 50 assemblies) to ensure that apparent down going trend is not continuing.
The unstable process may give intimation that swaging machine is worn and probably needed general overhaul (in matter of fact, that machine is over 20 years old, and never been overhauled. Only normal service been given).

Still it might be worth of investigation why

- Several points one side of centre line
- Sudden change in level

Other reasons what might be worth of investigate if they appear in control charts

- Alternating behaviour
- Suspiciously average behaviour
- Two or more points near control limit
- Apparent trend in one direction

But if we use only Mean Charts to describe to quality level of process, we might accept batches, which may not fulfil quality requirements. For example:

Sample number	1	2	3	4	Sample mean	Sample range
1	24,8	24,85	24,95	25	24,9	0,2
2	24,85	24,85	24,95	24,95	24,9	0,1
3	24,9	24,9	24,9	24,9	24,9	0

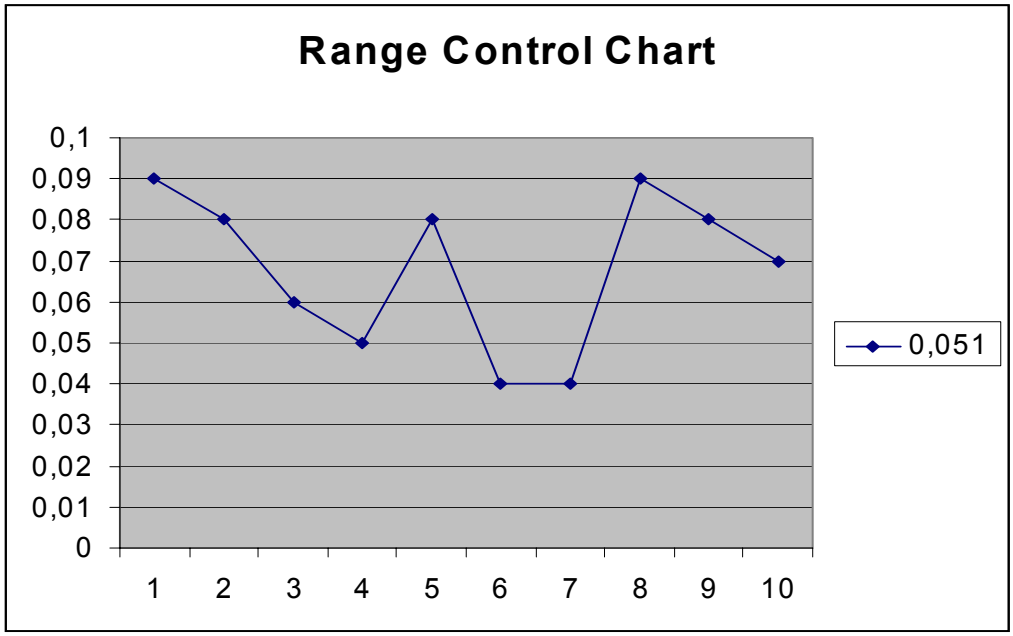
Pic3 Variations within samples

In sheet (Pic3), all samples have identical means (24,90), in spite they are significantly different.
Sample range varies from 0 to 0,2

Therefore monitoring range gives an indication of whether the variability of the process is changing, even when the means remain constant.

In order to control within sample variation, range control charts are constructed in a similar way to Mean Charts with following control limits

Upper Action Limit = D(0.001) x ϖ
Upper Warning Limit = D(0.025) x ϖ
Lower Warning Limit = D(0.0975) x ϖ
Lower Action Limit = D(0.999) x ϖ



Pic4 Range Control Chart

For n = 4,

Upper Action Limit D(0.001)	2,282 x 0,051 = 0,116
Upper Warning Limit D(0.025)	1,93 x 0,051 = 0,098
Lower Warning Limit D(0.975)	0,0 x 0,051 = 0,0
Lower Action Limit D(0.999)	0,0 x 0,051 =0,0

Variations within the samples are in statistical control.

Mean Control Chart and Range Control Chart are the most commonly used control charts in quality control. They are known as *X-R chart.*

Controlling attributes

Hydraulic hose outer surface has only two states, faultless or faulty. So the statistic calculated is the proportion of faulty in the sample.
Over a 10-day period the following faulty were noted
(Sample size n = 70)

DAY	1	2	3	4	5	6	7	8	9	10
Errors	2	1	1	3	0	1	2	1	1	0

p	0,029	0,014	0,014	0,043	0,000	0,014	0,029	0,014	0,014	0

Pic5. "Defective assemblies"

From Pic5 we can calculate:

p(total) = 12

$\bar{p}$ = 12/(10 x 70) = 0,017 (population mean)

Standard deviation can be estimated from (n>30):

σ = square root ((p(mean) x (1 – p(mean))/n)

σ = square root (0,017(1- 0,017)//70 x 10) = 0,0049

The upper and lower control limits are:

Upper control limit p(mean) + 3σ
UCL = 0,017 + 3 (0,0049) = 0,0317

Lower control limit p(mean) - 3σ
LCL = 0,017 – 3 (0,0049) = 0,0023

The warning limits can be set

Upper warning limit = p(mean) + 2σ
UWL = 0,017 + 2(0,0049) = 0,0286

Lower warning limit = p(mean) -2σ
LWL = 0,017 –2(0,0049) = 0,0072

From Pic5 we can see that day 4 (three rejected assemblies) and days 5 and 10 (no rejected) are falling out of action limits.
What has happened in day 4? Are all three assemblies been rejected from same reason?
It might be also worthy to investigate what has happened in days 5 and 10. Had those batches really been faultless? If they had, why, what can we learn from those? Or is it that operators had accepted assemblies, which do not match up with our quality demands?

I have always thought that our assembly production is under control. Single samples what have been taken, have never warned that there might be problems in the process. They have always been within limits. But this first ever made quality control based on SPC and control charts shows that our assembly production could be out of control. Furthermore, it gives us an early warning that in near future we have to:

- overhaul the old swaging machine or
- buy a new one

But now we have time to prepare this decision.

5. Find and correct causes of poor quality

One very simple, but effective technique for helping to understand the root reasons for poor quality is "why-why"- technique. First the problem is stated, and then asked *why* it has occurred. When the major reason or reasons have been identified, each of the reasons is

taken in turn, and again the question is asked *why* those reasons have occurred. This is continued until the cause or causes of poor quality seems sufficiently self-contained.
For example we can ask *why* the swaging process seems to be out statistical control (day 10)? If the reason is that swaging machine is worn-out, *why* it is worn-out? Inadequate maintenance, *why?* Lack of service instructions, *why*? Lack of training, *why?* And so on.

6. Continue to make improvements

Depending on priority and urgency of improvements needed, we can choose between breakthrough and continuous improvement strategies.
For example, if a new, more efficient swaging machine is invented, or new method is developed to joint ferrule, fitting and hydraulic hose together, it will led to major and dramatic change in the way the hydraulic hose assembly operations work. It has profound effects on working methods and processes. Such breakthrough improvements are usually expensive and risks involved are high. Breakthrough improvements have been criticized because such major improvements are difficult to realise quickly and impossible to realise instantly. They are abrupt, volatile and usually focus on technology not on humans. Large improvements can be implemented as and when they see to promise significant improvements or when the organisation's survival depends on it.
In 1991, a profitable Finnish heating, plumbing and air conditioning-wholesale company XXXX made two breakthrough improvements at the same time. They took new computer-controlled warehouse management and logistics systems to use in all 267 warehouses and depots in Finland, and factory-floor automation in production units. 1n 1993, due to confusion and paralyse caused by these "improvements", it was sold to its competitors!
It is more common to organisations to improve performance by small but frequently improvements. We can modify the way a products are fixed to a machine to reduce change-over time. Or we can modify our old machines to be more productive. In continuous improvement it is not the rate of improvement what is important; it is the momentum of improvement.
W.E. Deming's PDCA cycle (or Deming wheel) is the well-known basis of continuous improvement.

P = Plan. Collect and analyse data of current methods or the problem areas so as to formulate a plan of actions what are intended to improve performance.

D = DO. Implement improvement plan. In this stage the action plan is tried out in the operation.

C = Check. Measure and confirm results

A = Act. Standardise and learn lessons. Standardise if it has been successful, if not, learn what you can from trial.

This cycle never stops. When the last stage is over, the new cycle starts again.

Conclusion:

Before we can improve our quality, we need to know how good or poor our quality already is. The urgency, priorities and direction of improvement will be determined partly whether the current performance is good, poor or indifferent.
It is unlikely that a single measure of quality will adequately reflect the whole of a quality objective. Rather, we need "a bundle" of partial measures to make a judgement: level of customer complaints, customer satisfaction scores, warranty claims, mean times between failures, scrap level, actual vs. theoretical throughput time etc.
But the techniques I used in this assignment can be used whether the satisfaction scores or ferrule's outside diameter is the object to be measured and estimated.

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