INF5180: Software Product- and Process Improvement in Systems Development

Part 01:

Introduction into Concepts and History of SPI

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Spring 2010

Contents

- Process Improvement history
- Why Software Process Improvement (SPI)?
- What is the relationship between structure, process and product?
- What does it mean to plan SPI?

Process Improvement History

- Process improvement through division of work, specialization, training, team work, etc. has always taken place during history of mankind.
  - Some might even consider the physical differences between man and woman as a metaphor for evolution's "specialization" regarding tasks.
- The principle of division of work is mentioned in **Plato's work "The State".**
- One of the first systematic and "modern" process improvements was accomplished by **Fredrik The Great** of Prussia who wanted to turn criminals, the poor, foreign mercenaries and forced recruits, into soldiers.
  - Fredrik ruled from 1740 to 1786 and was among other things inspired by the organization of the legions of the Roman Empire.
  - The goal was to make the soldiers "war machines" regardless of their previous profession. He introduced military reforms such as formalization of ranks, standardized equipment, a genuine military command jargon, rule-based training through drilling, "you shall fear your superiors more than your enemy", etc.

The Process Improvement History

- **Adam Smith** focused much on streamlining work processes (among other things through division of work) in his famous book "Wealth of Nations" (1776).
- **Max Weber** (German sociologist) analyzed the relationship between "bureaucratizing" of work (specialization, monitoring, rule enforcing) and social aspects (political, human vision, spontaneity and more).
  - Weber saw the rationalization process itself as a form of "domination" – i.e., the processes and the requirement for efficiency (process improvement) become our masters.

Florence Nightingale (1820-1910)

- Probably the first process improver in the health sector. (→ see her book: *Notes on Nursing*, 1860)
- Introduced, among other things, visualizing the ”quality” in hospitals. This lead to enormous improvements – death rates decreased from 42% to 2% (according to Jens Dahlgaard)
- BTW: Recently, it was estimated that there are approximately 98,000 deaths per year in the United States resulting from medical errors. (Kohn, L.T., Corrigan, J.M., Donaldson, M.S., (eds.): To Err is Human: Building a Safer Health System. National Academy Press, Washington DC (1999)

Scientific Management

- In Frederick Winslow Taylor’s book «Principles of scientific management» (1911) the following principles were highlighted:
  1. Replace rule-of-thumb work methods with methods based on a scientific study of the tasks
  2. Scientifically select, train, and develop each worker rather than passively leaving them to train themselves
  3. Cooperate with the workers to ensure that the scientifically developed methods are being followed
  4. Divide work appropriately between managers and workers:
     - Managers apply scientific principles to plan the work tasks
     - Workers perform the work tasks

[See URL: http://www.netmba.com/mgmt/scientific/]

Scientific Management (cont'd)

- One of the methods he frequently used in the improvement work was:
  - Find 10 to 15 men (preferably from different groups) who have shown particularly good performance in the work at hand.
  - Study the sequence of the elementary operations and also how the operations are carried out.
  - Measure the time which is required to carry out the elementary operations and choose the fastest methods to do operations.
  - Eliminate all erroneous movements, slower movements and unnecessary movements.
  - Arrange in a sequence only the fastest (efficient) and best (effective) movements.

- Taylor claims to have achieved with his principles that in the steel industry productivity increased from 12.5 tons per worker per day, to 47.5 tons per worker per day.
  - The conveyor belt (or assembly line → Ford) re-confirmed the idea of scientific management.


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Scientific Management – Today

Good examples on using scientific management is the work within call-centers or fast-food chains (example from a checklist is provided below):

Contact the customer	Yes	No
1. Smile	_	_
2. Genuine greetings	_	_
3. Eye contact	_	_

.....

Say thank you to the customer and welcome her/him back		
1. Always say «thank you»	_	_
2. The "thank you" must appear as "real"	_	_
3. Eye contact	_	_
4. The customer is welcomed back	_	_


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Frederick Taylor

- What do you think?

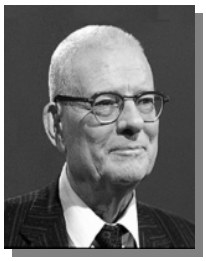
  Do Taylor's methods work in the software industry, too?

  – Pros?
  – Cons?

Scientific Management and "Modern" Process Improvement

- There are certain similarities between scientific management and today's product and process improvement framework with regard to
  – Principle of systematic approach to improvement
  – Focus on people
  – Description of processes
  – Division of work
- We will look at this closer, but it is apparent that parts of today's product and process improvement have their roots in scientific management.
- Thus it's worthwhile to study the successes of scientific management – but also their disadvantages (in order to learn from both).

W. E. Deming

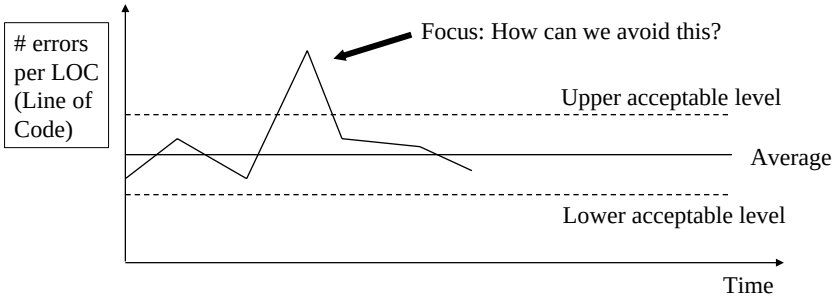


- William Edwards Deming. Born October 14, 1900 in the US.
- Played an important role in Japan's development to become a leading industrial nation after the second world war.
- Strong instigator for the use of statistics and measurement in product processes - "Statistical leadership".
- Doctorate in "mathematical physics" from Yale. Taught mathematics and statistics from 1930 to 1946, head of department from 1933.
  - Invited Dr. Walter Shewhart (who is regarded as "father" of the main principles behind statistical processes control – and who also was the inventor of "Plan – Do – Check – Act" cycle) to give lectures in his department.

"In God we trust, all others bring data."

W. E. Deming (1900-1993) "The Father of Modern Quality"

Statistical Process Control



Assumption: Variation of values between the dashed lines are due to many small single occurrences ("normal variation"), while deviation beyond this is due to single occurrences with a big effect. It is these single occurrences that process improvers want to understand (NB: Deviations can be positive or negative).

Statistical Process Control

- Main principles:
  - Measurements are done at the end and during the production process.
  - A process is under "statistical control" if variations in the measurement values are within the process's "normal" variations.
  - Deviation from normal variations should be analyzed (→ what are the causes?) and measures to avoid these should be implemented.
  - A process should be under statistical process control so that effects of changes in design, training, tools etc can be evaluated.
- Deming puts much stress on management and leadership. While workers might only be able to improve (individually) by a certain percentage (say 15%), there rests much responsibility on management to design the processes right and to pick the right processes for monitoring.

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Deming's 14 Principles

1. **Constancy of purpose:** Create constancy of purpose for continual improvement of products and service to society, allocating resources to provide for long range needs rather than only short term profitability, with a plan to become competitive, to stay in business, and to provide jobs.
2. **The new philosophy:** Adopt the new philosophy. We are in a new economic age, created in Japan. We can no longer live with commonly accepted levels of delays, mistakes, defective materials and defective workmanship. Transformation of Western management style is necessary to halt the continued decline of business and industry.
3. **Cease dependence on mass inspection:** Eliminate the need for mass inspection as the way of life to achieve quality by building quality into the product in the first place. Require statistical evidence of built in quality in both manufacturing and purchasing functions.
4. **End lowest tender contracts:** End the practice of awarding business solely on the basis of price tag. Instead require meaningful measures of quality along with price. Reduce the number of suppliers for the same item by eliminating those that do not qualify with statistical and other evidence of quality. The aim is to minimize total cost, not merely initial cost, by minimizing variation. This may be achieved by moving toward a single supplier for any one item, on a long term relationship of loyalty and trust. Purchasing managers have a new job, and must learn it.
5. **Improve every process:** Improve constantly and forever every process for planning, production, and service. Search continually for problems in order to improve every activity in the company, to improve quality and productivity, and thus to constantly decrease costs. Institute innovation and constant improvement of product, service, and process. It is management's job to work continually on the system (design, incoming materials, maintenance, improvement of machines, supervision, training, retraining).
6. **Institute training on the job:** Institute modern methods of training on the job for all, including management, to make better use of every employee. New skills are required to keep up with changes in materials, methods, product and service design, machinery, techniques, and service.

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Deming's 14 Principles (cont'd)

8. **Drive out fear:** Encourage effective two-way communication and other means to drive out fear throughout the organization so that everybody may work effectively and more productively for the company.
9. **Break down barriers:** Break down barriers between departments and staff areas. People in different areas, such as Leasing, Maintenance, Administration, must work in teams to tackle problems that may be encountered with products or service.
10. **Eliminate exhortations:** Eliminate the use of slogans, posters and exhortations for the work force, demanding Zero Defects and new levels of productivity, without providing methods. Such exhortations only create adversarial relationships; the bulk of the causes of low quality and low productivity belong to the system, and thus lie beyond the power of the work force.
11. **Eliminate arbitrary numerical targets:** Eliminate work standards that prescribe quotas for the work force and numerical goals for people in management. Substitute aids and helpful leadership in order to achieve continual improvement of quality and productivity.
12. **Permit pride of workmanship:** Remove the barriers that rob hourly workers, and people in management, of their right to pride of workmanship. This implies, among other things, abolition of the annual merit rating (appraisal of performance) and of Management by Objective. Again, the responsibility of managers, supervisors, foremen must be changed from sheer numbers to quality.
13. **Encourage education:** Institute a vigorous program of education, and encourage self improvement for everyone. What an organization needs is not just good people; it needs people that are improving with education. Advances in competitive position will have their roots in knowledge.
14. **Top management commitment and action:** Clearly define top management's permanent commitment to ever improving quality and productivity, and their obligation to implement all of these principles. Indeed, it is not enough that top management commit themselves for life to quality and productivity. They must know what it is that they are committed to-that is, what they must do. Create a structure in top management that will push every day on the preceding 13 Points, and take action in order to accomplish the transformation. Support is not enough: action is required!

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Software Project Disaster

Automated baggage system at Denver International Airport

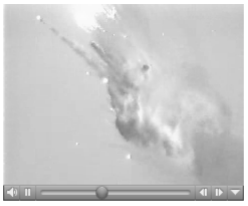
The airport's computerized baggage system, which was supposed to reduce flight delays, shorten waiting times at luggage carousels, and save airlines in labor costs, turned into an unmitigated failure, and is widely given as a textbook example of a software engineering disaster.
An opening originally scheduled for October 31, 1993 with a single system for all three concourses turned into a February 28, 1995 opening with separate systems for each concourse, with varying degrees of automation.
The system's $186 million in original construction costs grew by $1 million per day during months of modifications and repairs. Incoming flights never made use of the system, and only United, DIA's dominant airline, used it for outgoing flights. The 40-year-old company responsible for the design of the automated system, BAE Automated Systems of Carrollton, Texas, at one time responsible for 90% of the baggage systems in the U.S., was acquired in 2002 by G&T Conveyor Company, Inc.
The automated baggage system never worked well, and in August 2005, it became public knowledge that United would abandon the system, a decision that would save them $1 million in monthly maintenance costs.

(Source: Wikipedia http://en.wikipedia.org/wiki/Denver_International_Airport)

Software Quality Risks/Problems

- Boeing 747 (1969)
  - 8.000.000 lines of software
  - Equals about 250.000 pages

- One defect can be fatal!
  - Ariane missile: € 0.5 Billion loss
  - Lockheed's F-22 Raptor: systems switched off when crossing the date line!
  - UK air traffic centre: 6 years delay due to bugs
  - German Telecom: € 50 million in wrong bills
  - Postbank (NL): 55.000 double withdrawals
  - ... many other examples exist!!!



The first quartet of Cluster satellites is destroyed when Europe's Ariane 5 explodes soon after launch on June 4, 1996. Source video: ESA (216k, 18sec QuickTime file).

4th June1996, Kourou / Guyana, ESA

"Chaos Report" by The Standish Group (1994):

Cost ($)	Succeeded	Challenged	Failed
< 750K	55%	31%	14%
750K-1.5M	33%	45%	22%
1.5M-3M	25%	47%	28%
3M - 6M	15%	52%	33%
6M-10M	8%	51%	41%
> 10M	0%	51%	49%

Why Software Process Improvement (SPI)?

- The society's dependence on software is dramatically increasing.
- The numbers of safety critical and enterprise-wide systems are dramatically increasing.
- The software industry gets constantly – and rightly so – media focus.
  - Cf. examples on previous slides.
- The software products we use every day often have bad quality. (→ Question: what is "quality"?)

Software Characteristics

- Intangible / not physical (no weight, volume, force, ...)
- No production, only development (design)
- Flexible, 'easy' to change
- Difficult to verify & validate (complete? / consistent? / correct?)
- Little scientific basis and relatively young engineering discipline
- Lack of commonly agreed models / lack of discipline and professionalism

→ That's why software often contains (too many) defects

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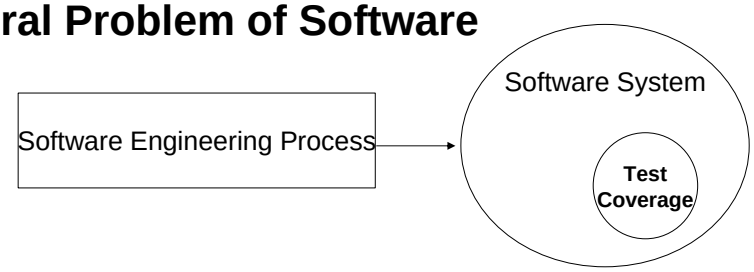
The General Problem of Software



- Quality cannot be tested into the software; it must be built into it from the very beginning.
- The higher the demand for product quality, the greater the demands on the process(es).
- The process cannot yield predictable results (→ reliability of process) unless there exists a solid process culture.

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What Triggers SPI Initiatives?

- Internal reasons
  - Key persons are fed up having to do more and more “fire-fighting"
  - The most competent workers slip gradually over to maintenance tasks rather than being assigned to new development projects
  - Too much overtime
  - Fed up having to repeatedly explain delays
  - Too many errors in the product → lack of professional pride
  - Etc...

- **SPI initiatives often result from an acknowledged crisis (pressure/discomfort level gets too high)**

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What Triggers SPI Initiatives?

- Sales problems
  - Customers experience that contracts are breached (delays, excesses, quality problems)
  - Competitors deliver faster - show improvements
- Market changes
  - More demanding customers
  - Gradually more critical about use of software
  - Gradual transition from electronics to software
  - The market demands more frequent delivery and faster response time.
- Organizational changes
  - More distributed organization
  - Strong growth
  - Mergers
- Desire to strengthen the market position through evaluation
  - ISO 9000 certification
  - Maturity evaluations (CMMI, SPICE etc)
  - Six Sigma, EFQM etc

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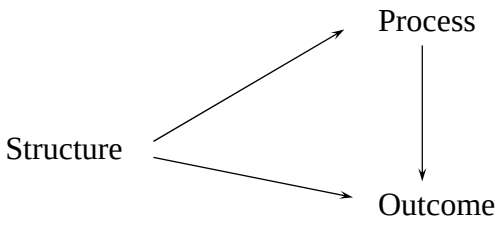
The SPO-Model



Process – Product – Structure

Process

- A set of activities or operations for obtaining something.
- A set of changes, especially changes which are happening ”naturally”.
- A method (= a way of doing something in order to achieve a goal)
- “The mental and physical activities we use to produce outcomes”.
- “A controlled set of activities that uses input products to produce output products by relying on a set of process resources”.

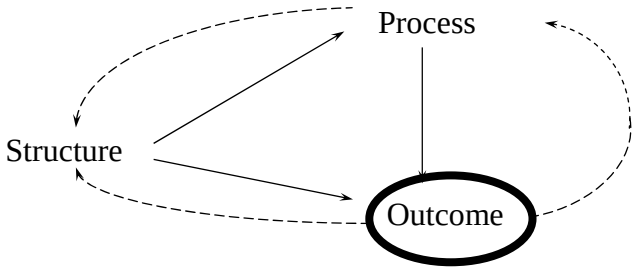
Product (“Outcome”)

- A thing or substance produced naturally or by a production-oriented process.
- “Things produced through mental or physical processes”.

Structure

- “The definition of the form and content of outcomes; the prescription and support of the processes needed to create outcomes”.

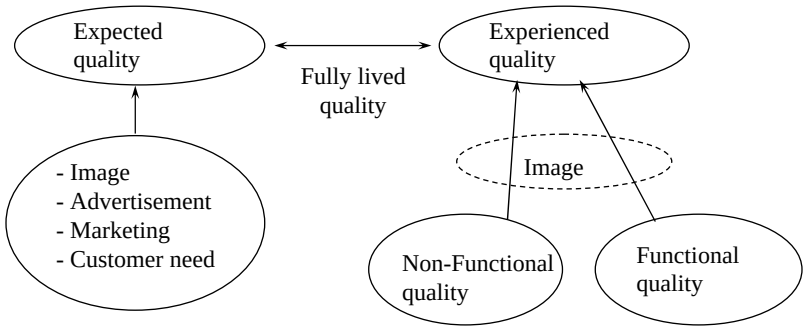
The SPO-Model with “feedback”



This model is will be used to structure the contents of this course.

What is Quality? (cont'd)

- Quality has to do with expectations...



What is Quality? – A Pioneer's View

"There are two common aspects of quality:

Objective

- *One of them has to do with the consideration of the quality of a thing as an objective reality independent of the existence of man.*

Subjective

- *The other has to do with what we think, feel or sense as a result of the objective reality. In other words, there is a subjective side of quality."*

Walter A. Shewhart: *Economic control of quality of manufactured product*, Van Nostrand, 1931.

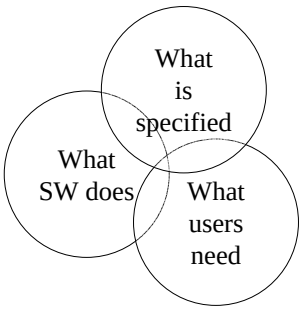
(1891 – 1967)

What is Quality? – Popular vs. Professional View

- **Quality – popular views:**
  - Something "good" but not quantifiable
  - Something luxury and classy

- **Quality – professional views:**
  - Conformance to requirements (Crosby, 1979)
  - Fitness for use (Juran, 1970)

What is Software Quality?



- **Conformance to requirements**
  - The requirements are clearly stated and the product must conform to it.
  - Any deviation from the requirements is regarded as a defect.
  - A good quality product contains fewer defects.
- **Fitness for use**
  - Fit to user expectations: meet user's needs.
  - A good quality product provides better user satisfaction.

Definition: Quality

ISO 8402:

"The totality of features and characteristics of a product or a service that bear on its ability to satisfy stated or implied needs."

Software Quality

ISO 9126:

"The totality of features and characteristics of a software product that bear on its ability to satisfy stated or implied needs."

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What is Quality?

- **Different perspectives on quality:**
  - **End-users**: User friendliness, reliability, simplifies task execution...
  - **End-user organization/employer**: Profitability, benefit in order to reach the organization's strategic goals, risk, ...
  - **Software developers**: Low error frequency, maintainability, ...
  - **Project manager:** Process control, deadlines are met, ...
  - **Development organization**: Profitability, user satisfaction, ...
  - **Service organization**: Stability, comprehensibility, maintainability, testability, ...
  - … many more …

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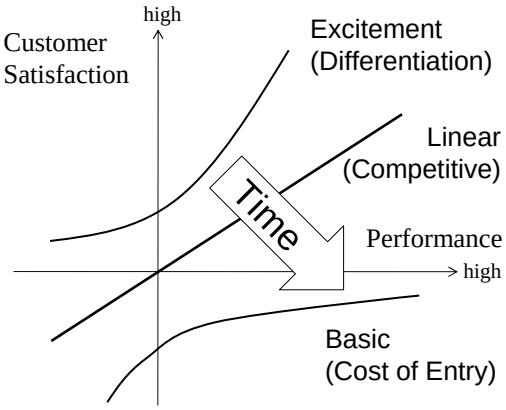
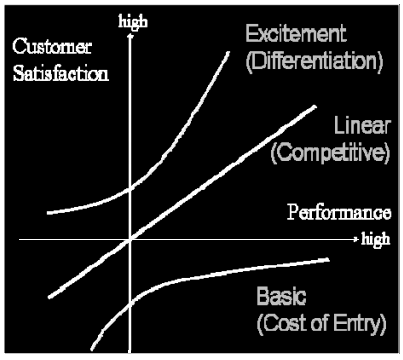
The Kano-Model



Five dimensions of quality:

- ”Basic quality” – satisfies basic “must-have” needs which probably do not even need to be specified .
- ”Competitive quality” - satisfies expressed needs (usually in requirement specification).
- ”Excitement quality” - satisfies latent needs, needs which are there but which the user hasn’t expressed and/or is himself/herself aware of
- ”Indifference quality” - needs which are covered but which user is indifferent to
- ”Reverse quality” - qualities which the customer do not want

The Kano-Model – Surveying Users



- To assess whether a feature is basic, linear, or exciting we can:
  - Sometimes guess
  - Survey a small set of users (20-30)
- We ask two questions:
  - A functional question:
    How do you feel if a feature is present?
  - A dysfunctional question:
    How do you feel if that feature is absent?

Functional and Dysfunctional Forms

Functional form of question →

If your editor includes a voice recognition function, how do you feel?		
	I like it that way	X
	I expect it to be that way	
	I am neutral	
	I can live with it that way	
	I dislike it that way	

Dysfunctional form of question →

If your editor <u>does not</u> include a voice recognition function, how do you feel?		
	I like it that way	
	I expect it to be that way	X
	I am neutral	
	I can live with it that way	
	I dislike it that way	

Categorizing an Answer Pair

Functional Question \ Dysfunctional Question	Like	Expect	Neutral	Live with	Dislike
Like	Q	E	E	E	L
Expect	R	I	I	I	B
Neutral	R	I	I	I	B
Live with	R	I	I	I	B
Dislike	R	R	R	R	Q

B: Basic (Mandatory)

L: Linear

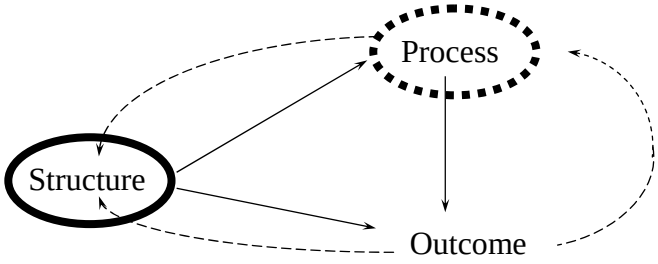
E: Excitement

R: Reverse

I: Indifferent

Q: Questionable

The SPO-Model with “feedback”

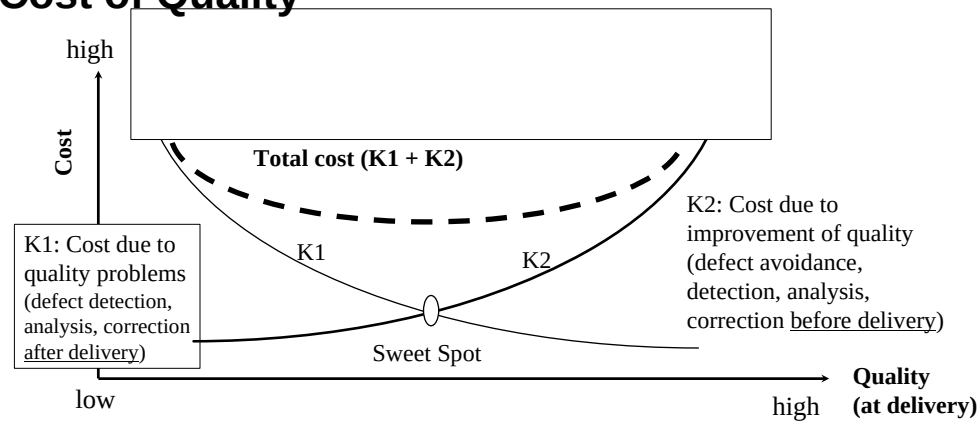


This model is will be used to structure the contents of this course.

Exercise

- What do think is meant by “quality is free, it is the lack of quality which costs” (Philip B. Crosby)?
- Do you agree?

Cost of Quality



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Increase Productivity through Systematic Approach

- **PLAN what you want to accomplish over a period of time and what you might do, or need to do, to get there**
- **DO what you planned to do**
- **CHECK the results of what you did to see if the objective was achieved**
- **ACT on the information – standardize or plan for further improvement**

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Improvement Planning ("Plan")

Where are we today?

Where do we want to be?

How do we get there?

- Initiating
- Analyse status
- Evaluate improvement possibilities
- Define goals and strategies
- Establish improvement plan

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