AUTOMATIC QUALITY CONTROL

Assoc. Prof. Georgi Nickolov Stoilov
Technical University, Branch Plovdiv

The conversion into free market economics, the policy of "open door" to the European Community and to the world, our aim to be a equivalent and competitive business partners has faced up the Bulgarian economy, technics and science with new serious challenges and requirements. We must meet them and fight for this share with others. First of all we must adapt and harmonize our economic environment making our standards related to the main vital "customer-supplier" model, where everyone is both a customer and a supplier. Predominant direction here are the safety principles CE and quality standards ISO 9000 of the manufactured goods.

The first works concerning the creation of a whole strategy for total quality management (TQM) have begun after Second world war and they are connected with the names of American explorers in the field of statistics Dr. W. Edwards Deming [1,2] and Dr Joseph M. Juran [3]. Their ideas (their help included) have been applied for first time in Japan. This has helped the country to rebuild Japan as an industrial force and to do way with the poor reputation the Japanese goods had. The TQM philosophy has been developed and enriched by the world known experts as Phigenboum [4], Krosby [6], Ishikava [5], Taguchy etc.

According to Buchvarov H. ..." the first systems for quality control have been determined by the military standards of USA in the 60s. Afterwards they have been implemented by the Ministry of defense in England... The British standard for quality control BS 5750" has been published. As a result a multiplication effect has appeared in several other countries and even in enterprises outside of the military industry. The international standard organization ISO especially its technical committee TK176 has summarized, systematized and piled up the experience and in the 80s created a part of the standards ISO 9000. European Committee on standardization accepted the developed standards as series of standards EN29000. Today about 120 countries in the world have ratified those series.

The development and fast implementation of these voluntary standards are forced by two factors: economic compulsion coming from the market competition, the protection of the market subject and, on the other hand, the economic advantages of the same these subjects. All these things are the reason that lead quality control systems (computer aided quality system- CAQS) to appear. When a manufacture has implemented CAQS it is known as a "white firm".

CAQS are based on one of the following three models: ISO 9001, ISO 9002, ISO 9003. The model ISO 9001 covers 20 stages in the product's life cycle; ISO 9002 - 19 stages without the design; ISO 9003 - 16. The differences above give a chance for a choice, which could be specific, but that does not give any advantage.

According to literature sources there are about 300,000 organizations which have implemented CAQ. They have done this more or less complete. Exemplary order of tasks; their distribution with respect to their object or problematics; methods and devices for a quality monitoring and estimation type off-line and on-line in CAQS are shown on the block-diagram. The achievements between columns 2&3 are more famous and widespread in the field of a machine building. They are described much more widely in the specialized literature on mechanical engineering and much less in electronics building. There is a paradox that could hardly be explained - the electronic and computer manufactures have done in the field of CAQ much more for the mechanical engineering than for themselves. It is looking like this, at least. The same proportion can be seen in the education of electronic specialists and engineers.

Automatic quality control without a human participation is a technical and technological problem, which is still locked in the science laboratories. The reason is that the automatic quality control systems (AQCS) are still expensive and they need much more investments. But they will keep their cost so high until somebody does something about their development. In a column 4 it can be seen a macroframe of AQCS in the electronic building that could have a network structure and computer environment by operational with application software. The same pattern can be used in the case if a respective education in the field of electronic must be organized.

A commencement point in the high technological agglomerate: "science - education - industry" could be the model of the controlled technological process (TP). The corresponding AQCS is shown on the figure in column 4 (see block - diagram). Here AR means automatic regulator.

The marked parameters of the state q(t) (of them observed x(t) and standardized S(t)), then controlling χ (t), the disturbance making f(t) are variables and are considered as multidimensional vector components.

QUALITY CONTROL

PROBLEMS and TASKS

Politics, Strategy, Logistics, Low insurance

Problem analysis and functions, activities identification through the whole chain

Marketing
Design
Providing

PPS
(production planing system)
MRP I & II
(manifacture resorce planning)
Flat requirement planning
Lot sezing and time

Production

JIT
(Just-in-time)
Pulling-pushing work
(pulling work through on a customer- demand basis as opposed to pushing work through based on forecasts

Service
Predictive Repair
Test
Monitoring
Trial
Training
Metrology
Statistic process testing
Investment/Expenditure
Audit (self audit)

OFF-LINE engineering methods and devices for testing,monitoring and estimation

QFD
(Quality function deployment)

FMEA
(Failor mode and effect analysis)

FTA
(Failor tree analysis)
CID
(Cause Inquest Diagram)

DoE
(Document experiment)

ON-LINE automized engineering methods and devices for testing, monitoring and estimation

SPS
(Statistic process control)

MIS
(Manifactoring information system)

SAQ
(Computer aided Quality)

CAES
(Computer aided engineering system)
1.OSI (open system intercinect)
2.MAP (manifactoring automation protocol)
3.IGES (initial grafics exchange specification)
4.EDIF (electronic design information interchange format

Automatic quality testing and control

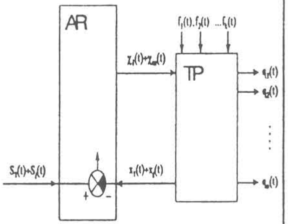

Fig.1Generalized structure model of the technological process as controled

1.Making structure models
2.Mathematical description
3.Sensible and realizable control
4. Control methods
-CIMS - Computer integrated manufactoring systems
CIMS=CAD/CAM+PPS+ +JIT+MIS+CAES+CAQ
5.Links and composite units of the system
6.Correction units
7.Devices which carry the connection out

Macroframe of an operational system being computer network and having a database with a lot of clientage sofware

Education, training and motivation

1.Principles:
- constancy
- differentiation
- thorough approach
-enterprise employees
- young specialists
- students.

2.What point to be as a begining:
- object indication which should be turned off proble maticaly

3.Arguments:
- fundamental preparation;
- professional mobility;
- deductive educational methods;
- Self creative preparation must be dominated

The AQCS state in each time moment t depends on the initial terms $q(t_o)$ and the vectors χ (t_o,t), $f(t_o,t)$. It can be described by the functional, id est

$$q(t) = Q \{ q(t_o) ; \chi (t_{o,} t); f(t_{o,} t)\}. \quad (1)$$

The equation (1) is a mathematical treatment of the model.

AQCS being a composition of links and actions can be submitted under some purposeful function which is determined by the functional extremes:

$$Extr=F\{ q(t); \chi (t); f(t)\}, \quad (2)$$

where on the q(t) and χ (t) are placed limits like:

$$q (t) \in Lim_1(t),$$

$$\chi (t) \in Lim_2(t). \quad (3)$$

The limits have a task to minimize the contradictions between technical and technological parameters of TP: productivity, accuracy and reliability. Those contradictions are inevitable and they are being solved in favour of the exploitation requirements. They reduce the grade of the optimum.

AQCS will be able to fulfill the purposeful function with respect to the functional:

$$E_{ff} = E_{ff} \{ E_{id} - E_{opt} \}, \quad (4)$$

where E_{id} is ideal, initial and theoretical, but E_{opt} real, secondary effective state, which is found out by analytic - experimental procedure.

And finely, the purposeful function can be represented by the following functional:

$$P = P\{E_{ff}, R\}, \quad (5)$$

where R is a criterion giving some point of view for the system property to be sensible and realizable.

As an example for a sensibility and reliability it can be considered a case in electronic industry which is typical because of the tradition that technological operations are flowing connected each-other by band conveyers and telphers. After the assembly is over, electronic products are moving to the work place by a conveyer in order to be monitored. Their quantity over the conveyer is $K \geq 1$. It depends on the process quickness. In the most favourable case K=1. Then the (n-1) product is assembled and completed; the n product is on the conveyer; the (n+1) product is under testing. Let assume that the test results of the (n+1) product are used for feedback and control impact over the (n-1) product. And let still assume that determined and low frequency random changes in the row material and in the operation mode parameters were lacking and only high frequency random changes have been impacting the manufacturing of the (n+1) product. But the probability they to occur when the (n-1) is being produced tends to zero. In this case the quality control is senseless. It may be harmful.

Therefore the quality control is sensible just in two general cases (fig.2):

The first case:

1.The probability for higher quality dispersion $\rightarrow 1$;

2.The TP accuracy < 100%;

3.The unfit >0;

4.Determined changes = 0;

5.Low frequance random changes = 0;

6.High frequency random changes ≠ 0

7.K < 1.

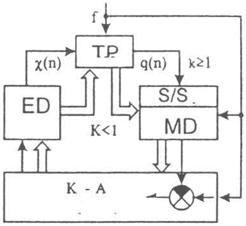

Fig.2.AQCS block cirquit
ED - executive devise
MD - monitoring devise
SS - statistic selection

The second case:

1. The probability for higher quality dispersion $\rightarrow 1$;

2. The TP accuracy < 100%;

3. The unfit >0;

4. Determined changes =/≠0;

5. Low frequance random changes ≠ 0;

6. High frequency random changes ≠ 0

7. K ≥ 1.

In the first case AQCS are popular as active quality control system (between operations control). They are complicated, multucircles, with distributed parameters. Here the controllable variables are intermediate product parameters. In the second case AQCS are simple, usually consist of one circle. They are popular as statistic automates with relay action.

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