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QUALITY, QUALITY MOTIVATION, RELIABILITY AND THE CONSUMER [1]

by

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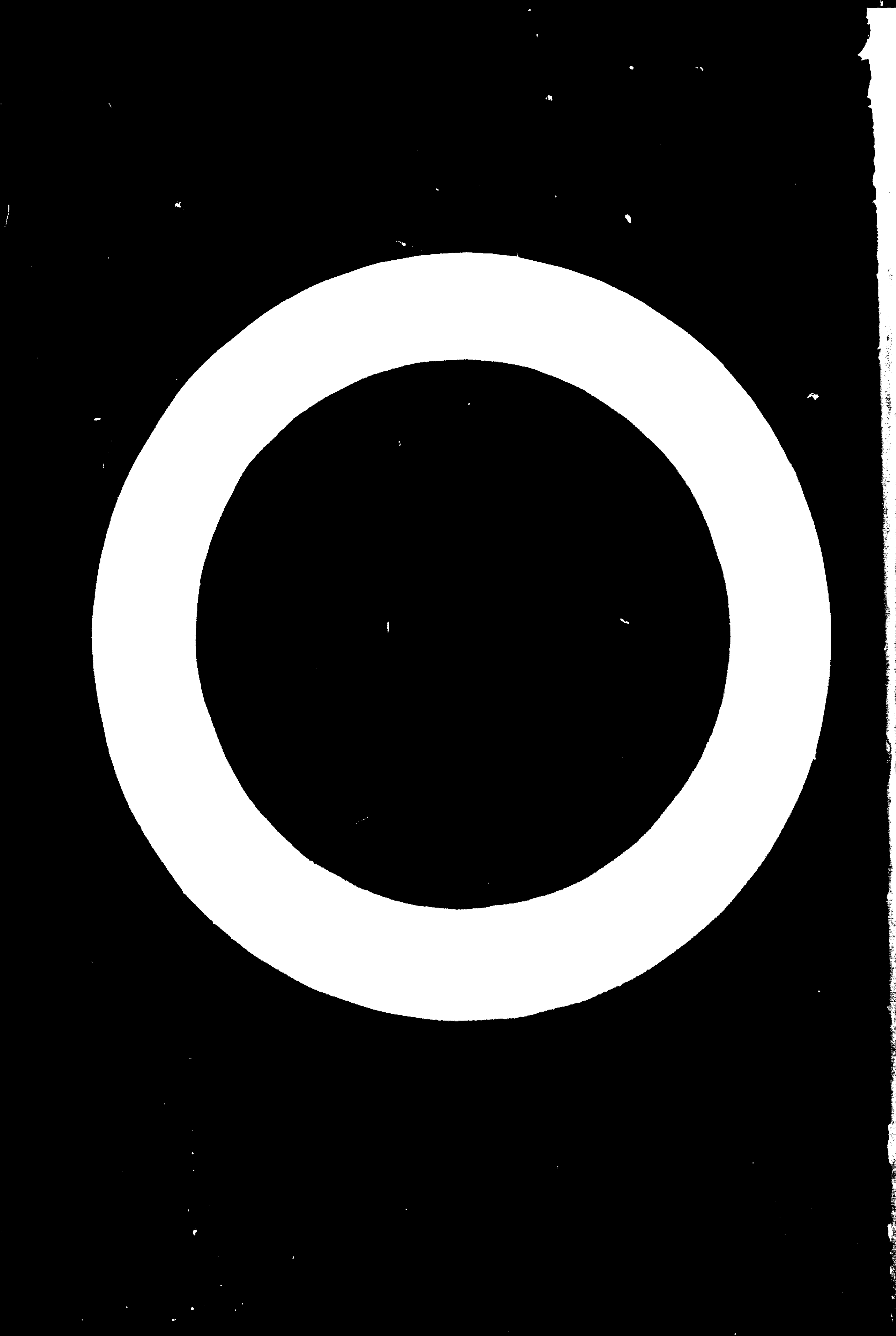

Products are often compared. Price and quality are taken into consideration. Some people are of the opinion that product A has a better quality than product B. Other people are of the opposite opinion, product B has a better quality than product A. It is impossible to say what is right. The result of a comparison of two products depends completely on what the people comparing the products consider to be the essence of the products. Each characteristic must be compared and evaluated as regards the use.

Consequently, we cannot, from a general point of view, say that the quality of butter is higher than the quality of margarine or vice versa. We must compare each characteristic, e. g. durability, taste, consistency, packing, vitamine content and in doing so consider the use— roasting, baking, preparing sandwiches, etc.

As a consequence, the quality of a product is something relative. Quality cannot exist in itself, it must be related to the use of the product. For that reason quality can be definied as fitness for use.

A consumer buying a product has some expectations. Many things influence these expectations, e. g. the purpose intenoed, the appearance and the performance of the product. But the expectations are also influenced by the goodwill of the trade-mark, as well as by the price of the product. A high price will give rise to greater expectations than a low price.

If the expectations are met, then the consumer is satisfied and he will consider the product to be of good quality. If the expectations are not met, then the consumer will consider the product to be of bad quality. Accordingly, the quality of the product reflects how the product will satisfy the expectations of the consumer. It might then be possible to define the quality of a product as a measure of the ability of the product to satisfy the expectations of the consumer.

The discussion above is referred to products. But we can just as well talk about the quality of services. Everyone who has gone through a bus trip with delays, over-crowdness and rough driving, certainly would not consider that to be a service of high quality. A doctor may make a diagnosis that is more or less correct. The quality activities in the service field are very important. This field will be increasingly exposed for demands of the consumers. It would then be necessary to explore means of taking care of this quality situation. However, at this opportunity I will only deal with quality activities related to industrial products.

Reliability.

There are different quality characteristics. The most important are appearance, performance and reliability.

The appearance is tied to the style, colour and finish of a product. This characteristic is the most difficult one to specify as well to evaluate objectively. For the individual consumer, however, it is very easy to have an opinion about the appearance.

The performance can be specified and evaluated by the producer. To some extent this might also be done by the consumer. Anyhow, at least, he has sometimes the possibility, before bying a product, to get an idea of the performance by studying information supplied by the producer or by a consumer organization. The performance is that quality characteristic to which the consumer organizations mainly have to direct their work.

Reliability means the continuing satisfactory performance of the product for the period required, under specified conditions of use and environment.

Within the International Electrotechnical Commission (IEC) who is carrying out standardization work in the electrotechnical field, there is a committee on reliability (TC56), especially associated with electronic components and equipment. This committee has, among other things, suggested definitions related to reliability.

IEC/TC56 has defined reliability in the following way:

> The ability of an item to perform a required function under stated conditions for a stated period of time.

The reliability can be expressed in numerical terms. For this purpose reliability characteristics are used.

The approach to a particular reliability characteristic may be from the point of view of success (i. e. performing a required function) or of failure.

Reliability characteristics related to success are:

Probability of success, probability of survival.

The probability of an item to perform a required function under stated conditions for a stated period of time.

Observed success ratio.

For a stated period of time, the ratio of the total number of occasions (or the duration of time) when an item performs a required function, to the total number of occasions (or the duration of time) that the item is subjected to stated conditions.

Alternatively, the ratio may be given as the proportion of a collection of items which performs a required function under stated conditions for a stated period of time.

Reliability characteristics related to failure are:

Mean failure rate.

The ratio of the total number of failures in a single population to the total cumulative observed time on that population. The observed mean failure rate is to be associated with particular, and stated, time intervals (or summation of intervals) and stress conditions.

Mean time between failures, MTBF (for repairable items).

For a stated period in the life of an item, the mean value of the length of time between consecutive failures computed as the ratio of the cumulative observed time (under stated stress conditions) and the number of failures.

This is the reciprocal of the observed failure rate during the period.

Mean time to failure, MTTF (for non-repairable items).

For truncated tests for a particular period, the cumulative time a population is observed divided by the total number of failures in the population during the period and under stated stress conditions.

Mean life.

The mean value of the lengths of observed times to failure of all specimens in a sample of items under stated stress conditions.

Useful life.

The period from a stated time, during which under stated conditions an item has an acceptable failure rate.

: most products the failure rate will change in course of time. In .eral this change can be illustrated by the so-called bath-tub curve e Figure 1).

:ing the first time of use the failure rate often is high and decreasing. .lures arising during this period, usually called the early failure iod, are often caused by weakness and latent failures in design and nufacture. The guarantee given by producers of cars and household lliances are aimed at preventing the consumers from the effect of se early failures.

In order to decrease the number of failures during the early failure period, some manufactures use so-called aging or burning-in. The latent failures are then considered to appear.

After the early failure period a period of an almost constant failure rate will follow. Consequently, this period is called the constant failure rate period.

The constant failure rate period is succeeded by the wear-out failure period. During this period the failure rate is increasing. Failures then arising are due to wear-out and aging. The wear-out failure period indicates the end of the useful life of the product.

There are products not following the bath-tub curve. For instance, ball-bearings have no period with a decreasing failure rate. For transistors no period with an increasing failure rate has been observed.

For a consumer it is essential that the product performs in a satisfactory manner for a long period of time. That means that the constant failure rate period must be long and that the failure rate during this period must be low.

The reliability is that quality characteristic that is the most difficult for a consumer to know anything about before buying a product. Not until the consumer has made use of the product, he is able to judge the reliability. This, of course, is a situation that is not satisfactory to the consumer. Unfortunately, the consumer organizations cannot do much to improve the situation because resources necessary to carry out reliability testing on consumer goods are enormous. Furthermore, this testing is time-consuming which means that the results might be available not until the product has disappeared from the market.

The reliability of a product is affected by the environment, i.e. the external conditions to which the product is exposed during use, transportation and storing, e.g. temperature, humidity, vibration.

The environment must be considered as well when settling the reliability requirements as when testing for the reliability. Testing during different environmental conditions is called environmental testing. IEC has prepared procedures for such testing. Environmental factors dealt with in this way are cold, dry heat, damp heat, vibration, shock, bump, mould growth, salt mist, low air pressure, change of temperature.

The environment can be made more or less hard by changing the parameters embraced. This is related to as different degrees of severity.

<u>Optimizing quality.</u>

It is frequently talked about the need of reaching an optimal level of quality. But the most interesting question is often left open and that is from whose point of view the optimization should be done? Should the optimization be done from the point of view of the producer or from the point of view of the consumer?

A consumer is generally interested in getting a service accomplished, e. g. transportation, cooking. For this purpose he has to rent or buy products as cars and cookers. The experience shows that the cost of making use of these products during their normal life often exceeds the purchase-price.

The first thorough study of the user's quality costs has recently been conducted by Dr. Frank M. Gryna, Jr. [1] Costs are broken down into seven major categories: repairs, effectiveness loss, extra capacity, damages, lost income, extra investment costs, and extra operating and maintenance costs. Cost data collected for five makes of automatic washing machines showed that the user paid between 1, 3 and 6, 9 times as much for repairs as the manufacture/dealer paid for guarantee repairs. On the basis of certain estimates it was further shown that for 10 types of household appliances, the cost of operation and maintenance was between 0, 77 and 3, 8 times the selling price.

For the consumer the major interest is to optimize the total cost for transportation, cooking, etc. How this cost is distributed on purchase and use (e. g. cost of maintenance) is of minor interest. Unfortunately, the consumer mostly has no idea of the cost of maintenance at the time

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1) Frank M. Gryna, Jr., User Costs of Poor Product Quality. University of Iowa, 1970 (Doctorate Thesis).

he is buying the product. Consequently, his choice must be based on price and perhaps sometimes on a certain emotional idea of the quality of the product. As I said earlier, the consumer organizations have difficulties in helping the consumer at this point by supplying information on the reliability.

Consumer organizations.

It is difficult for the individual consumer to exert an influence on manufacturers. His views are prone to be overlooked and as a result consumer organizations have been formed in many countries in order to strenghthen his position. Some of these consumer organizations wield considerable power in protecting the interests of consumers. The power and influence of consumer organizations will undoubtedly grow even stronger in the future.

A steady stream of new products appears on the market to compete with existing products. Their numbers increase still further due to the introduction of several different versions and makes, through product differentiation, and through the increasing occurrence of distributor brands. New materials, the properties of which are unknown to the consumer, have appeared. All this only succeeds in confusing the individual consumer and increasing the need for consumer information. And this is one of the more important goals of the consumer organizations.

Consumer information is provided by official government departments as well as by private independent organizations. This differs from country to country.

To promote international cooperation in all aspects of consumer information, education and protection, the International Organization of Consumers Unions (IOCU) was formed in 1960. By 1969, 37 organizations in 24 countries were members of this organization. At two-year intervals the IOCU publishes a Consumers Directory containing information (including address, aims and publications) concerning a large number of consumer organizations throughout the world.

In order to provide a direct channel of communication between the consumer organizations and the international standardization bodies working on testing procedures for household appliances, etc. , i. e. with the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), the International Standards Steering Committee for Consumer Affairs (ISCA) has been formed. This committee is to survey the needs of consumers in the field of international standardization and in doubtful cases, rule whether a case shall be dealt with by ISO or by IEC. Apart from ISO and IEC, consumer interests are represented in ISCA by the International Centre for Quality Promotion (CIPQ), the International Federation of Purchasing (FIA), the International Co-operative Alliance (ICA), the International Labelling Centre (ILC) and the International Organization of Consumers Unions (IOCU).

International standardization work on performance testing.

Being able to measure and compare the performance of products of different makes and from different manufacturing dates is in the interest of consumers and producers alike. The results of such measurements and consequently the assessment of performance is influenced by the method of testing used. For this reason, work is in progress on national and international levels with a view to establishing generally accepted methods of testing. Some testing methods are already standardised, additional testing methods will be standardized in time..

On an international level, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) are engaged in preparing standards for consumer products, for instance household appliances. I will give some information about the work done in the appliance field.

ISO has issued two publications dealing with refrigerators. These publications, which are issued in English, French, and Russian, define specifications of household refrigerators and lay down methods of measurement for the determination of their performance. Testing methods are described for door seal, mechanical strenght of shelves and similar components, doors and fittings, no-load adjustment, no-load operation, ice making, absence of odour of materials, thermal insulation, compartment temperature.

In 1965, IEC appointed a technical committee (TC 59) called "Performance of household electrical appliances". This committee was formed to "state and define the characteristics to be used to determine the performance of domestic electrical appliances in order to inform the consumer; to describe the standard methods for measuring these characteristics". Consequently, the intention is not to specify performance requirements but to standardize methods of testing that will give similar results wherever they are used.

The work of IEC is carried out by various sub-committees for different types of products: electric dishwashers, cooking appliances, small heating appliances, home laundry appliances, ironing and pressing appliances, floor treatment appliances, small kitchen machines.

IEC has issued publications (in both English and French) on electric blankets, irons and vacuum cleaners. Next in line for publication are testing methods for ranges, floor polishers, dishwashers, water heaters, washing machines, toasters, warming plates, steam irons, ironing machines and food preparation machines.

A characteristic that is of the utmost importance to a user of a product is the safety. When speaking about safety in household appliances, what is usually meant is that the appliances will neither cause accidents due to electrical and mechanical failures nor be the cause of fire. It is generally considered that safety in household appliances is extremely high. This is not due to chance, but to the sense of responsibility that producers, authorities and independent testing laboratories have long felt with regard to these matters.

Most countries have rules and standards governing the safety of household appliances. In some countries, conformity with these rules and standards is voluntary while in other countries, it is compulsory and required by law. Even if not required by law, producers often find it necessary for marketing reasons to follow existing safety standards to the letter and allow independent testing laboratories to check that the products incorporate the required degree of safety.

The International Commission on Rules for the Approval of Electrical Equipment (CEE) has prepared safety regulations for electrical household appliances, etc. CEE consists of about a score of European organizations, each of which is responsible in its own country for specifying the rules for electrical equipment and for testing, where this is carried out. Member organizations are not forced to follow CEE regulations, but the relevant authorities in the various countries are advised to adopt the regulations to as large an extent as possible.

Safety regulations for electrical household appliances are also being prepared by IEC. It is the intention of IEC to prepare regulations for the majority of electrical household appliances.

In this connection it ought to be mentioned that ISO also has a committee on consumer affaires (TC 73).

Coordination of the producer's quality activities.

In general terms, the aims of a producer are to determine the true needs of the market and subsequently develop, design, manufacture and sell products that satisfy these needs. In doing this, many people will come in touch with the products and, to a greater or less degree, influence the quality of the products.

The following functions are those primarily affecting the quality:

- Market studies.
  Identification of consumer quality needs.

- Product development.
  Development of products meeting the quality needs.
  Preparation of specifications.

- Manufacturing engineering.
  Choice of machines, processes and tools capable of meeting the specifications.

- Purchasing.
  Choice of vendors based on i. a. quality considerations.

- Production.
  Production of products meeting the specifications.

- Inspection.
  Prevention of defects and acceptance of products.

- Marketing.
  Selling the products to those for whom they were intendended.

- Service.
  Helping the customers.

These functions can be placed in a circle. Since all who work in the circle influence the product quality, the circle could be called the Quality Circle. (See Figure 2). The vendors fall on one side of the Quality Circle, the customers on the other side.

If the activities relating to the functions included in the Quality Circle are to result in products of high quality at reasonable cost, it is necessary to coordinate all activities pertaining to quality. Achieving this coordination is the object of the modern form of quality control called total quality control (sometimes quality assurance or product assurance). Accordingly, total quality control takes in a much broader working range than quality control in the conventional sense.

Without such a coordination,

- departmental goals will replace company goals. There will be a suboptimisation instead of a total optimization.

- the coordination will be loose and to a large extent influenced by chance.

- failures that in reality are caused by lack of coordination and planning will give rise to defensive steps and counter-charges with a bad climate for co-operation as a consequence.

In the total quality control three elements are necessary:

- Quality policy and objectives.
- Organisation.
- Quality sytem.

The quality policy consists of the principles that are guiding the activities in the quality field. The requirements on a quality policy are that it must be written down and that it must be well-known within the company and among the suppliers.

The objectives consist of the specific goals towards which the activities are to be directed. These goals might apply to the quality costs and be given as absolute numbers or relative figures, for instance cost of quality control and failure in relation to manufacturing cost. The goals might even be in the form of acceptable failure rate.

The quality system comprises a net-work of procedures that are to be followed in the quality work. It has to be built up in such a way that the best coordination of all the activities will be obtained without overlooking any element affecting quality.

The quality system might be devided into subsystems and elements. The most important subsystems are:

- Specification.
- Preproduction avtivities.
- Inspection planning.
- Vendor relations.
- Inspection.
- Quality studies.
- Quality information equipment.
- Quality information feedback.
- Quality audit.
- Quality motivation.

The quality system ought to be well-documented. This becomes more and more important, the larger the manufacturer is, as the problems of co-ordination and communication increase with the size of the manufacturer.

A suitable form of documentation is a quality manual. This is an excellent instrument for coordination of the quality activities around the Quality Circle.

The quality manual should be available for everyone in a key position with respect to the quality of the products. The manual will then become a reference-book in quality matters. It will assure a continuity in actions in spite of any changes in staff that may possibly occur.

Quality motivation.

It is a common conception that most of the failures, both internal and external failures, are caused by the operator standing at the machine or at the assembly line and that these failures are referred to carelessness and lack of quality-mindedness.

As a consequence of this conception, activities in order to improve quality ought to be, in the first place, directed towards changing the operator's attitude to quality by motivation. In fact, such activities have been carried out in many companies. The American Zero Defects movement is a good example of this.

However, life is not as simple as to blame the operator for the failures and to change his attitude. As shown before, many functions in a company are affecting quality. Motivation activities must be carried out all through these functions and on all levels.

Dr. J. M. Juran, the well-known quality specialist, divides the defects into operator-controllable defects and management-controllable defects. He is of the opinion that very often only 20 per cent of all the defects are operator-controllable and consequently as much as 80 per cent are management-controllable. Of course, the relations differ from one company to another. Anyhow, these figures show that, a priori, the operator is not to blame, although this seems to be right superficially. First of all it is necessary to make a careful analysis as to the true causes. If the causes are not known, the activities carried through in order to prevent defects will not give the intended result.

Operator errors may be classified as involuntary errors and wilful errors.

The involuntary errors are due to human imperfection. Lack of skill, monotony and fatigue affect the result. An example of this is the accuracy of inspection work done by human beings. Investigations indicate that the accuracy of such work is 80-90 per cent.

The wilful errors are due to operators deliberately committing errors.

Wilful errors can be due to fraud or collusion. One problem is the collusion between operators and inspectors. This might appear when the pay of the operators is heavily influenced by the result of the inspection.

Another type of wilful errors is that which is committed for the personal convenience of the inspector. The inspector falsifies the results. An example is shown in Figure 5. The inspector had to take a sample from each lot. A lot would be accepted if there were not more than three defects in the sample. As you can see, samples which have exactly three defects dominate. The inspector didn't want to find more defects because he found it to be too inconvenient to reject a lot. A rejection would require an 100 per cent inspection.

A common reason for wilful errors is that the quality standard is considered to be unimportant. This might apply as well to operators as to managers.

The remedy for wilful errors is motivation.

Motivation programs.

Motivation may be defined as the internal process that causes people to work towards goals that they feel will satisfy their needs. Consequently, motivation is a matter of being attracted, not pushed, towards goals.

There are several personal needs. The priority of these needs differs from one country to another, even from one person to another, as well as from time to time.

For each need there are special tools for getting quality motivation. In literature[1] the following combination of needs and motivator are given:

Physiological needs:

Increments of money for better quality and for ideas.

Safety needs:

Appeals based on job security. "Quality makes sales; sales make jobs".

Social needs:

Creation of team spirit and team activities.

1) J. M. Juran, F. M. Gryna. Jr., Quality Planning and Analysis, McGraw-Hill Book Company, New York, 1970.

Ego needs:

Appeal to pride of workmanship, to achieving a good score; trophies, publicity.

Self-fulfillment needs:

Appeal to creativity, working out of original ideas.

As the priority of the needs differs from one country to another, the motivation programs differ as well. The methods used in U. S. A., U. S. S. R. and Japan are quite different.

Zero Defects in U. S. A.

In a Zero Defects program, propagande fills a large place. Posters, company journals and meetings are used for this purpose.

The interest of a Zero Defects campaign is stimulated by rewards given to individuals or to groups of individuals showing the best result. A reward can bo in the form of a plaquette, a diploma, a parking-place close to the entrance or a lunch together with management. Very seldom money is used as reward.

A Zero Defects program can also include a so-called Error Cause Identification program. The objective of this program is to get a knowledge of things that might cause errors by giving rewards to people identifying such causes.

Many American companies have carried through a Zero Defects program. Why? Is it because these companies have analyzed the failures and then found that most of the failures are caused by the operators? This seems not to be the case. The main reason would probably be that the governmental institutions buying military and space material very much like the contractors and sub-contractors to have a Zero Defects program. Consequently, the position many companies take to the question of having a Zero Defects program or not is heavily influenced by commercial considerations. The relations to the customers would be better and this might result in more contracts.

There has been a lot of publicity about the Zero Defects programs and their success in decreasing failure cost. But I am quite sure that many companies have not had such a good experience.

The Saratov method in U. S. S. R.

The Saratov method gas got its name from that city in U. S. S. R. where this method was introduced. Some industries in the Saratov area started to use this method in 1955. After that this motivation program has become very popular in U. S. S. R.

In order to understand the Saratov method it is necessary to know the background. In the Soviet industry there has been a dividing-line between production and inspection. The task of the production function has been to manufacture without no particular concern in quality. The task of the inspection function has been to perform a screening of the units manufactured. The inspection function, not the production function, is responsible for quality.

The Saratov method means a change in the thinking of the quality responsibility. According to this method everyone in an industry is totally responsible for the quality of his job. He might then be a designer, an operator, a production engineer or a supervisor.

Everyone's performance is determined. As a measure of the performance of an operator the proportion of lots accepted at the first inspection is used.

Lots with defective units are handed back to the responsible operator. This is done when the inspector has found the first defect. The operator then has to screen the lot.

This procedure often leads the operator to inspect the lot himself before handing over the lot for inspection. This is considered to be a good development as it is easier for the operator to find the defects than for the inspector.

This principle of self-inspection and inspection is not only used for operators but also for designers.

People who get a good proportion of their work accepted at the first inspection are rewarded. As an example of a scale of rewards it can be mentioned that a proportion of accepted work between 70 and 80 per cent increases the pay with 10 per cent, between 80 and 90 per cent with 20 per cent and between 90 and 100 per cent with 30 per cent.

An operator whose work has not been rejected during a six month period doesn't have to hand over his lots to the inspection department for inspection. He inspects the lots himself and puts a marking on them. Such an operator would get an additional increase in pay of 5 to 10 per cent.

In U.S.S.R. the Saratov method is considered to be very effective. As an example it has been said that a machine manufacturer received 70 per cent less claims two years after the introduction of the Saratov method. Statements of this kind, no matter whether they are about the Zero Defects programs in U.S.A. or the Saratov method in U.S.S.R., should be looked upon with a little bit of scepticism.

Quality control circles in Japan

20 years ago, the quality of the Japanese industrial products was considered to be very low. From then on there has been a steady improvement of the quality reputation. Nowadays, Japanese products are considered to be among the best in the world.

The change of the quality of the products has been achieved by several steps as help from foreign specialists, training in quality control for all levels, setting up laboratories for testing products intended for export, rewards and other forms of attention to manufacturers and individuals who have made a valuable contribution in the quality control field. Also propaganda is used. The propaganda activities culminate in November, which every year is the special month of quality.

A new way for the quality work is the creation of so-called quality control circles. These circles consist of workers who after training in analyzing failures carry through quality studies and solve quality problems within their working area. The problems might be presented by management or might be taken up on the circle-members' initiative. Both ways are just as common.

The participation in the quality control circle activities is voluntary. The training and the work in the circles often take place out of the ordinary working-hours without any compensation than, at the best, the normal wage.

Within a company there is usually a quality control circle for each production area. The sise of the circles lies between 3 and 15 people.

The idea of quality control circles was born in 1962. After that the quality control circle movement has grown very rapidly. In 1966, there were about 10 000 circles, in 1968 100 000 circles.

Besides quality improvements by solving problems, he quality control circles have increased the quality mindedness.

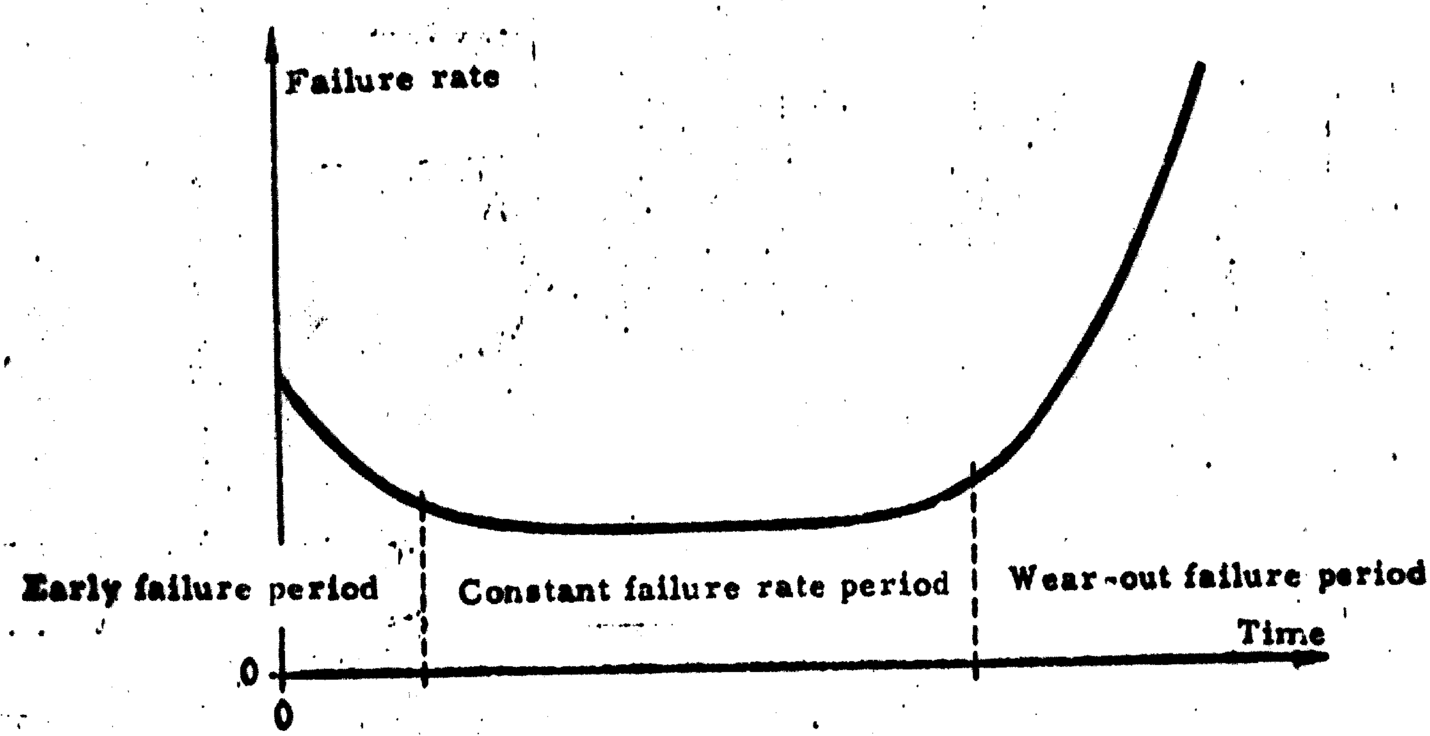

Figure 1. Bath-tub curve

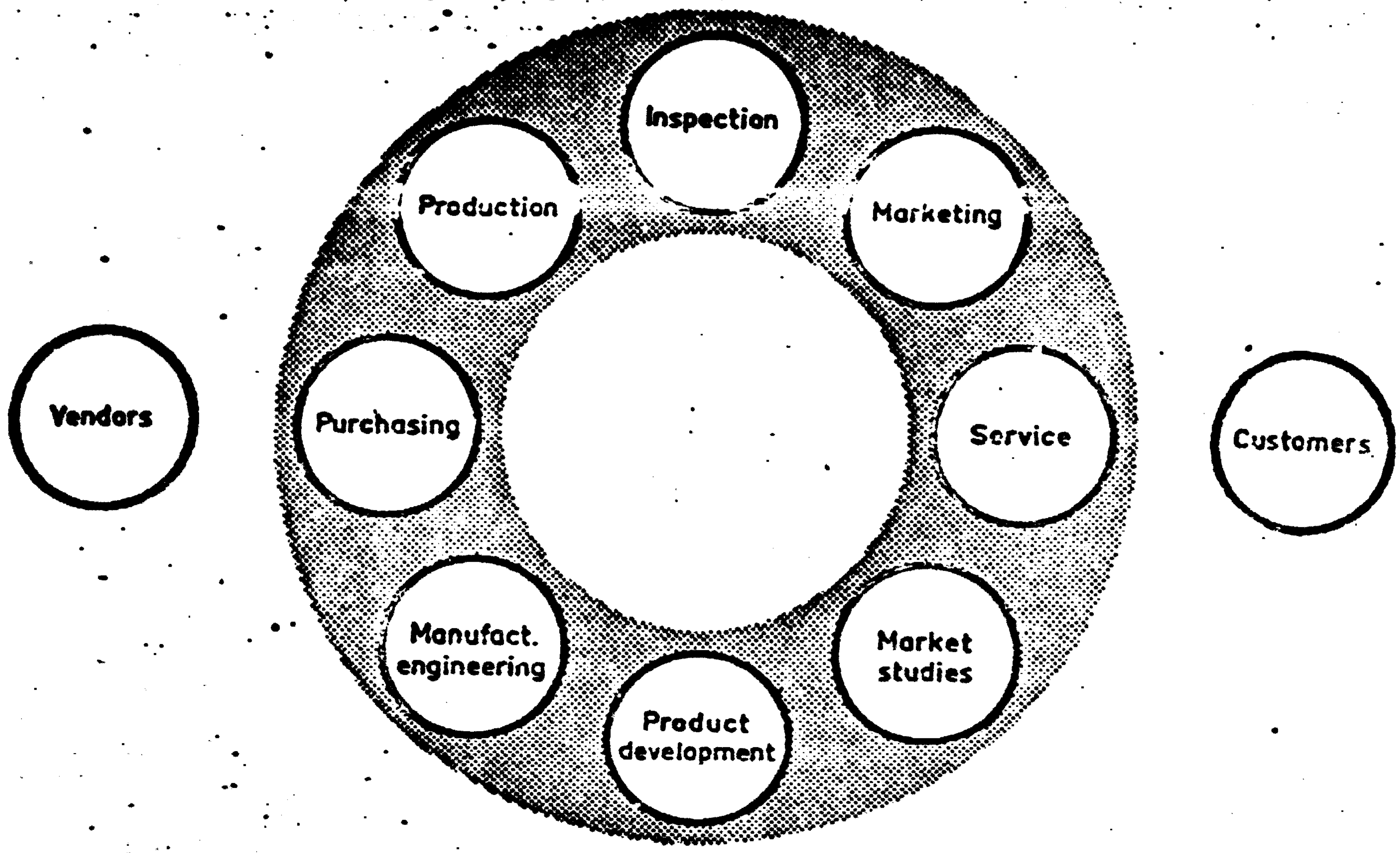

Figure 2. **Quality Circle. The circle shows the functions primarily affecting the quality.**

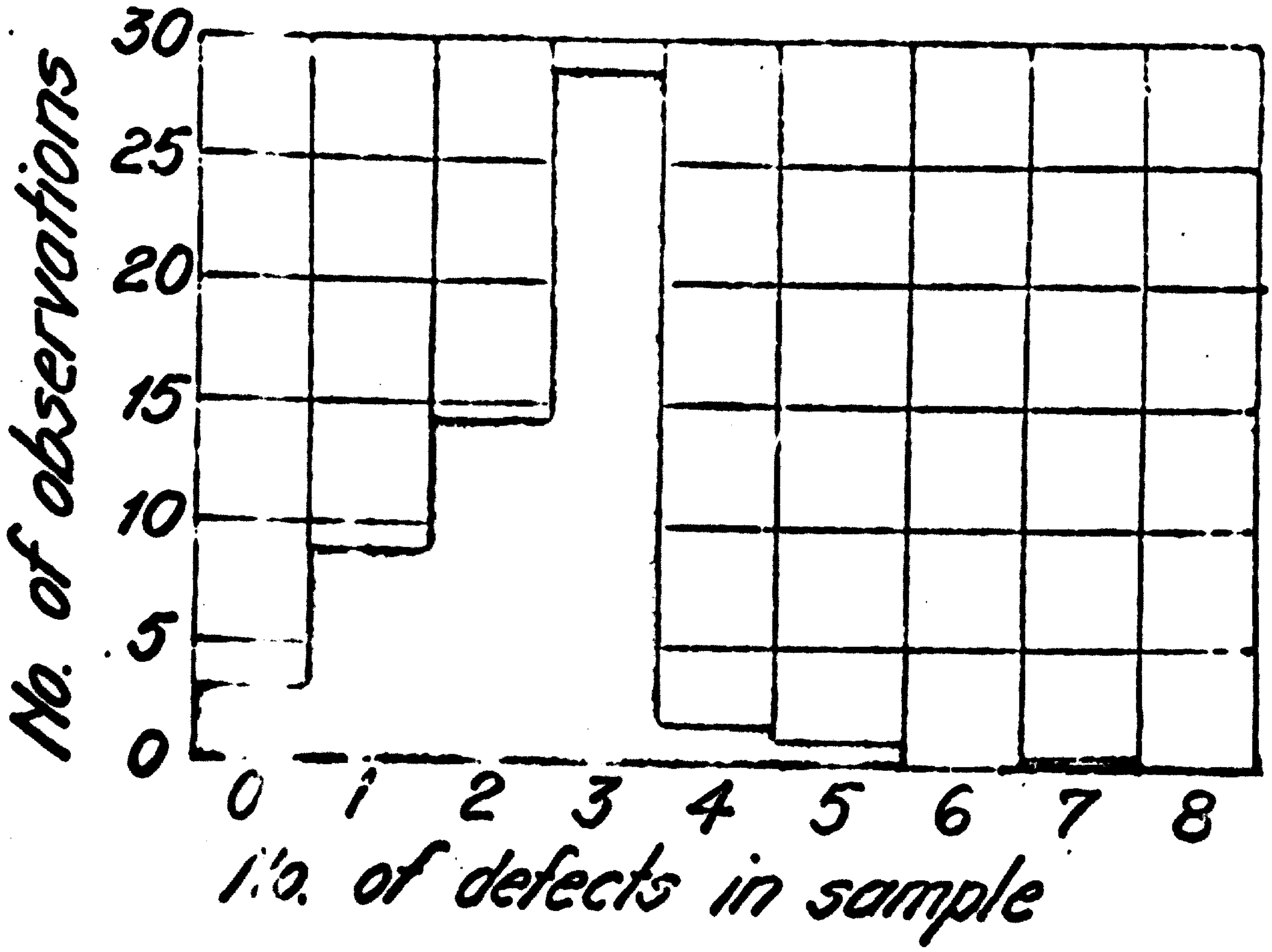

Figure 3. **Example of falsification of inspection results.**

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